SCHOOL ACHIEVEMENT AND FAILURE: PREVENTION AND INTERVENTION STRATEGIES

EDITED BY: Edgar Galindo, Adelinda Araujo Candeias, Małgorzata Lipowska, Óscar Conceição De Sousa and Marcus Stueck

PUBLISHED IN: Frontiers in Psychology and Frontiers in Education

frontiers Research Topics

ISSN 1664-8714
ISBN 978-2-83250-710-0
DOI 10.3389/978-2-83250-710-0

About Frontiers

Frontiers is more than just an open-access publisher of scholarly articles: it is a pioneering approach to the world of academia, radically improving the way scholarly research is managed. The grand vision of Frontiers is a world where all people have an equal opportunity to seek, share and generate knowledge. Frontiers provides immediate and permanent online open access to all its publications, but this alone is not enough to realize our grand goals.

Frontiers Journal Series

The Frontiers Journal Series is a multi-tier and interdisciplinary set of open-access, online journals, promising a paradigm shift from the current review, selection and dissemination processes in academic publishing. All Frontiers journals are driven by researchers for researchers; therefore, they constitute a service to the scholarly community. At the same time, the Frontiers Journal Series operates on a revolutionary invention, the tiered publishing system, initially addressing specific communities of scholars, and gradually climbing up to broader public understanding, thus serving the interests of the lay society, too.

Dedication to Quality

Each Frontiers article is a landmark of the highest quality, thanks to genuinely collaborative interactions between authors and review editors, who include some of the world's best academicians. Research must be certified by peers before entering a stream of knowledge that may eventually reach the public - and shape society; therefore, Frontiers only applies the most rigorous and unbiased reviews.
Frontiers revolutionizes research publishing by freely delivering the most outstanding research, evaluated with no bias from both the academic and social point of view. By applying the most advanced information technologies, Frontiers is catapulting scholarly publishing into a new generation.

What are Frontiers Research Topics?

Frontiers Research Topics are very popular trademarks of the Frontiers Journals Series: they are collections of at least ten articles, all centered on a particular subject. With their unique mix of varied contributions from Original Research to Review Articles, Frontiers Research Topics unify the most influential researchers, the latest key findings and historical advances in a hot research area! Find out more on how to host your own Frontiers Research Topic or contribute to one as an author by contacting the Frontiers Editorial Office: frontiersin.org/about/contact

SCHOOL ACHIEVEMENT AND FAILURE: PREVENTION AND INTERVENTION STRATEGIES

Topic Editors:
Edgar Galindo, University of Evora, Portugal
Adelinda Araujo Candeias, University of Evora, Portugal
Małgorzata Lipowska, University of Gdansk, Poland
Óscar Conceição De Sousa, Universidade Lusófona, Portugal
Marcus Stueck, DPFA Academy Group, Germany

Citation: Galindo, E., Candeias, A. A., Lipowska, M., De Sousa, Ó. C., Stueck, M., eds. (2022). School Achievement and Failure: Prevention and Intervention Strategies. Lausanne: Frontiers Media SA. doi: 10.3389/978-2-83250-710-0

Table of Contents

frontiers | Frontiers in Psychology

TYPE Editorial
PUBLISHED 21 October 2022
DOI 10.3389/fpsyg.2022.838057

OPEN ACCESS

EDITED AND REVIEWED BY
Ting-Chia Hsu,
National Taiwan Normal University, Taiwan

*CORRESPONDENCE
Edgar Galindo
edgar_galindo@hotmail.com

SPECIALTY SECTION
This article was submitted to Educational Psychology, a section of the journal Frontiers in Psychology

RECEIVED 17 December 2021
ACCEPTED 03 October 2022
PUBLISHED 21 October 2022

CITATION
Galindo E, Candeias AA, Lipowska M, Sousa OCd and Stueck M (2022) Editorial: School achievement and failure: Prevention and intervention strategies. *Front. Psychol.* 13:838057. doi: 10.3389/fpsyg.2022.838057

Editorial: School achievement and failure: Prevention and intervention strategies

Edgar Galindo[1]*, Adelinda Araújo Candeias[1], Małgorzata Lipowska[2], Oscar Conceição de Sousa[3] and Marcus Stueck[4]

[1]Comprehensive Health Research Center (CHRC), University of Evora, Évora, Portugal, [2]University of Gdansk, Gdańsk, Poland, [3]Universidade Lusófona de Humanidades e Tecnologias, Lisbon, Portugal, [4]Academy of Work and Health (DPFA), Leipzig, Germany

KEYWORDS

school achievement, school failure, academic achievement, academic self-efficacy, learning difficulties, mathematics achievement

Editorial on the Research Topic
School achievement and failure: Prevention and intervention strategies

School achievement is probably dependent on a set of social, psychological, family and environmental factors acting jointly in a complex way to foster learning (Christenson et al., 2001); more recent studies devoted to school refusal and academic achievement emphasize once again the complex relationship of individual and contextual factors in these matters (Filippello et al., 2019). At the same time, school failure seems to be a long process of disengagement from learning, often beginning in elementary school, in which the same set of factors plays a central role. So, attending school and classes, completing schoolwork, and participating in school activities are correlated with a positive school performance. Whereas, missing classes, not completing schoolwork, and getting low grades are correlated with school failure, as well as with problems like engaging in disruptive behavior, disinterest in school and low expectations of success. Educational agencies worldwide are increasingly concerned about school failure and, in turn, about the factors determining school achievement. Generally, school failure refers to children, adolescents or adults who have dropped out of school before acquiring basic education, or have completed basic education without going further, or who have dropped out of school before acquiring lower secondary education, or even those who have completed lower secondary education but dropped out before graduating at a higher level. The consequences of school failure seem to be severe and long lasting. These students are more likely to have mental health problems, to abuse of drugs, to commit crimes, to be unemployed, and to earn lower salaries (Lagana-Riordan et al., 2011).

In spite of constant efforts to solve the problem (see Eurydice, 1994; U.S. Department of Education, 2002), it persists. For instance, Carrie and Ballenger (2016) note that in the USA more than 1.3 million students drop out each year. Clycq et al. (2013) point out

that in spite of the high performance level of students in Belgium, school achievement depends strongly on SES and ethnic background. In Latin America, the average number of students who are two or more years overage in primary school (an index of school delay) for the region is 10%, and the percentage of students who did not reach the minimum school level (sixth grade) varies between 51% in Cuba and 94% in Nicaragua (UNESCO, 2022). Developing effective approaches to reducing school failure in all the different definitions is consequently a high priority in education.

School achievement and failure seem to be the result of multiple social, political, and individual factors. The origins of school failure are complex and are not limited to school, because family and community risk factors can foster or inhibit the individual's cognitive, social and emotional development. Ethnic minorities, students from low socioeconomic backgrounds, students with disabilities, and students taught in a second language are risk groups.

In this context, psychologists all over the world are researching the factors determining school failure, looking for prevention and intervention strategies. Individually, school achievement depends on cognitive, emotional, and behavioral factors. Children need social, cognitive, and emotional skills starting in kindergarten in order to be academically successful. Critical factors like motivation, social control, self-regulation, self-representations, parental involvement, and attitudes toward school are important. Nevertheless, the study of determining factors is only the first step to finding sound and scientifically based prevention and intervention strategies.

The content of this book reflects the state of the art in the research on school achievement and failure in Europe, Asia, North, and South America. The study of intervention and prevention strategies is increasingly important, while the analysis of the causes of school achievement and failure is still attracting researcher attention. Consequently, four studies are devoted to intervention strategies, three to prevention issues, and five analyze some of the social, emotional or cognitive variables affecting school achievement.

In the field of intervention, Cvencek et al. conducted a Spanish study designed to boost children's mathematical self-concept. They applied a multicomponent intervention combining explicit and implicit approaches to helping third grade school children to form more positive beliefs about math and themselves. They conclude that self-concepts can be taught, and social-cognitive interventions can boost children's beliefs about themselves and produce better math achievement. Also in Spain, Bermejo et al.b successfully applied a constructivist intervention program for the improvement of mathematical performance in first- and second-graders. The program established students as the main agents of their learning with their teachers serving as guides. The mathematical content was organized in terms of the complexity and significance for the student and cooperative work strategies were implemented. The authors suggest constructivist instruction seems to have positive effects on the acquisition of mathematical skills. Tordön et al. implemented a strategy to improve school performance using individual assessments and school-based interventions in Swedish children from 8 to 15 years of age living in foster care. The results showed improved skills in complex aspects of literacy, mathematics, and cognitive performance. It is therefore concluded that higher-order cognitive functions can develop positively when appropriate school support is provided.

Concerning prevention strategies,Urbina-Garcia applied a program to facilitate the transition from preschool to first grade in Mexican primary schools. The program comprised activities to help students develop cognitive, social and motor skills, as well as to promote home-school links and preschool-school links. The positive results show the importance of the training of previous skills for school children's successful development. Baker-Henningham et al. implemented a violence-prevention program in Jamaican preschools and observed the later effects on first grade achievement. They found that promoting child social-emotional competence led to positive outcomes across multiple child developmental domains. López et al. explored the effects of psychologists and social workers working in the Chilean school system on the academic achievement of 8th- to 10th-grade students and school dropouts. They analyzed national records of non-teaching professionals working as school staff members, looking for correlations with achievement scores on national tests. They found that the presence and number of school psychologists per school seemed to be positively associated with higher math achievement.

In the analysis of causes, Borchet et al. explored in Poland to what extent diverse types of parentification relate to academic achievement in adolescents. They found a positive relation between instrumental parentification and school achievement. Also in Poland, Rózycka-Tran et al. studied the influence of parent-child relations on academic performance in college students, comparing two different cultures, one individualistic (Poland) and the other collectivistic (Vietnam). The results show that in a more individualistic culture, a reciprocal mode is stronger predictor of study engagement, whereas the authoritarian mode is stronger in a collectivistic culture. In Sweden, Bertills et al. carried out a longitudinal study to analyze the effect of cognitive variables on Physical Education (PE) achievement in secondary school students with and without disabilities. They investigated the development of participation constructs as perceived by students, in order to explore how children's PE self-efficacy perceptions, general school self-efficacy and aptitude for participating in PE changed over time, and how these changes determined achievement. Bermejo et al.a analyzed in Spain the effects of teaching in a language different from the students' mother tongue on the mathematical thinking of 7–8-year-old children. They conclude that students who were taught mathematics in a second language had similar skills for resolution of algorithms to those students whose teaching

language coincided with their mother tongue, but they had more difficulties in the resolution of word problems or in the tests of mathematical competence. Assari et al. explored the factor parental education level on school performance of adolescents and young adults living in poor neighborhoods in the United States. They conclude that a high level of parental education is a salient determinant of educational outcomes, although to a lesser extent in less privileged neighborhoods. Finally, Kaloeti et al. analyzed in Indonesia a problem deeply related to school performance, namely peer bullying at school. They found that bullying significantly influences the onset of anxiety in 11–13-year-old-children, particularly cyberbullying.

We hope these studies will help to broaden and deepen the path toward finding sound, scientifically based prevention and intervention strategies to combat school failure.

Author contributions

All authors listed have made a substantial, direct, and intellectual contribution to the work and approved it for publication.

Funding

This work was carried out with support from the University of Evora (Portugal), the University of Gdansk (Poland), the Universidade Lusófona de Humanidades e Tecnologias (Portugal), and the Academy of Work and Health (Germany).

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

All claims expressed in this article are solely those of the authors and do not necessarily represent those of their affiliated organizations, or those of the publisher, the editors and the reviewers. Any product that may be evaluated in this article, or claim that may be made by its manufacturer, is not guaranteed or endorsed by the publisher.

References

Carrie, E., and Ballenger, J. (2016). The effectiveness of an online credit recovery program on improving the graduation rates of students at risk of school failure. *Sch. Leadersh. Rev.* 11, 7. Available online at: https://scholarworks.sfasu.edu/slr/vol11/iss1/7

Christenson, S. L., Sinclair, M. F., Lehr, C. A., and Godber, Y. (2001). Promoting successful school completion: critical conceptual and methodological guidelines. *Sch. Psychol. Q.* 16, 468–484. doi: 10.1521/scpq.16.4.468.19898

Clycq, N. A., Nouwen, M. A. W., and Vandenbroucke, A. A. (2013). Meritocracy, deficit thinking and the invisibility of the system: discourses on educational success and failure. *Br. Educ. Res. J.* 40, 796–819. doi: 10.1002/berj.3109

Eurydice (1994). *Measures to Combat Failure at School: A Challenge for the Construction of Europe*. Luxemburg: Office for Official Publications of the European Communities.

Filippello, P., Buzzai, C., Costa, S., and Sorrenti, L. (2019). School refusal and absenteeism: perception of teacher behaviors, psychological basic needs, and academic achievement. *Front. Psychol.* 10, 1471. doi: 10.3389/fpsyg.2019.01471

Lagana-Riordan, C., Aguilar, J. P., Franklin, C., Streeter, C. L., Kim, J. S., Tripodi, S. J., et al. (2011). At-Risk students' perceptions of traditional schools and a solution-focused public alternative school. *Prev. Sch. Fail.* 55, 105–114. doi: 10.1080/10459880903472843

U.S. Department of Education (2002). *No Child Left Behind Act: A Desktop Reference*. U.S. Department of Education. Available online at: http://ww.ode.state.or.us/nclb/pdfs/nclb-deskreference.pdf

UNESCO (2022). *Sistema de Información de Tendencias Educativas en América Latina (Information System on Educational Tendencies in Latin-America)*. Paris: UNESCO. Retrieved from https://siteal.iiep.unesco.org/eje/educacion_basica

frontiers in Education

ORIGINAL RESEARCH
published: 09 April 2020
doi: 10.3389/feduc.2020.00030

Place-Based Diminished Returns of Parental Educational Attainment on School Performance of Non-Hispanic White Youth

Shervin Assari[1], Shanika Boyce[2], Mohsen Bazargan[1,3], Cleopatra H. Caldwell[4] and Marc A. Zimmerman[4]*

[1] Department of Family Medicine, College of Medicine, Charles R. Drew University of Medicine and Science, Los Angeles, CA, United States, [2] Department of Pediatrics, College of Medicine, Charles R. Drew University of Medicine and Science, Los Angeles, CA, United States, [3] Department of Health Behavior and Health Education, University of Michigan School of Public Health, Ann Arbor, MI, United States, [4] Department of Family Medicine, University of California, Los Angeles, Los Angeles, CA, United States

OPEN ACCESS

Edited by:
Małgorzata Lipowska, University of Gdańsk, Poland

Reviewed by:
Katarzyna Sitnik-Warchulska, Jagiellonian University, Poland
Jolanta Jonak, Northeastern Illinois University, United States

***Correspondence:**
Shervin Assari
assari@umich.edu

Specialty section:
This article was submitted to Educational Psychology, a section of the journal Frontiers in Education

Received: *20 January 2020*
Accepted: *12 March 2020*
Published: *09 April 2020*

Citation:
Assari S, Boyce S, Bazargan M, Caldwell CH and Zimmerman MA (2020) Place-Based Diminished Returns of Parental Educational Attainment on School Performance of Non-Hispanic White Youth. Front. Educ. 5:30. doi: 10.3389/feduc.2020.00030

Background: Youth educational outcomes are a function of a wide range of factors including parental education level. This effect, however, is shown to be smaller for African American, Hispanic, and Asian American youth, a pattern called Marginalization-related Diminished Returns (MDRs). It is, however, unknown if it is race/ethnicity or other conditions associated with race/ethnicity (e.g., poor neighborhood quality) which reduces the marginal returns of parental education for youth.

Aim: To explore whether MDRs are only due to race/ethnicity or if they also remain for non-Hispanic Whites in poor neighborhoods, we compared the association between parental education level and adolescents' school performance based on neighborhood quality in a nationally representative sample of non-Hispanic Whites in the United States.

Methods: This cross-sectional study used wave 1 of the Add Health study, an ongoing nationally representative cohort, 1994–2019. Participants included 849 non-Hispanic White adolescents between the ages of 12 and 21 years and their parents. The independent variable was parental education level, which was treated as a continuous measure. Age, grade, gender, and parental marital status were the covariates. The dependent variable was school performance (sum of school grades in Math, English, History, and Science). Linear regression models were used for data analysis.

Results: Overall, worse neighborhood quality was associated with worse school performance. Parental education level, however, was not directly associated with youth school performance. We found a statistically significant interaction between parental education level and neighborhood quality suggesting that the strength of the association between parental education and youth school performance weakens as neighborhood quality declines.

Conclusion: Parental education level is a more salient determinant of youth educational outcomes in better neighborhoods. The result suggests that MDRs may not be solely due to race/ethnicity but contextual factors that commonly covary with marginalization and poverty. These contextual factors may include segregation, concentration of poverty, and social and physical neighborhood disorder.

Keywords: socioeconomic position, socioeconomic status, education, adolescents, youth, education, GPA

INTRODUCTION

Educational and developmental outcomes are worse for youth from non-marginalized compared to the non-marginalized background (Messiah et al., 2013; Butler, 2017; Guglielmo et al., 2018). Research, for example, has established worse educational outcomes for African American (AA) and Hispanic than non-Hispanic White youth (Arellano et al., 1998; Albrecht and Gordon-Larsen, 2013). Similarly, youth from families with lower socioeconomic status (SES) also report worse educational and developmental outcomes than high SES youth (Arellano et al., 1998; Albrecht and Gordon-Larsen, 2013; Benjet et al., 2009). These patterns can be seen for physical health (Butler, 2017), psychological well-being (Malhotra et al., 2015; Assari and Caldwell, 2017), aggression (Wallace et al., 2009; Basch, 2011), risk behaviors (Wallace et al., 2009; Basch, 2011), and school performance (Arellano et al., 1998; Basch, 2011). Socially marginalized youth are at risk for poor school performance (Chavous et al., 2008).

The mechanisms by which marginalized youth report worse educational and developmental outcomes have not been well understood. Racial/ethnic minority and low SES (e.g., parental education) individuals are particularly at risk of poor school performance (Carlo et al., 2011; Butler, 2017). Although researchers have attempted to decompose the effects of race/ethnicity and SES to social and developmental inequalities (Lau et al., 2012; Rossen and Schoendorf, 2012; Jones, 2018), these attempts have not generated conclusive results.

One of the proposed mechanisms for worse developmental and educational outcomes in marginalized youth is exposure to high levels of adversity and low level of SES resources in impoverished low-quality neighborhoods (Carlo et al., 2011; Butler, 2017). In this view, place should be seen as an explanatory mechanism for why socially marginalized youth develop sub-optimal outcomes (Assari and Lankarani, 2016). Researchers, however, have proposed a complementary mechanism (i.e., differential effects) (Assari and Lankarani, 2016). Based on Marginalization-related Returns (MDRs), the effects of SES indicators particularly parental education on generating tangible economic, developmental, and health outcomes, are smaller for marginalized rather than socially privileged families (Assari, 2017, 2018a). Several examples have shown that parental education generates fewer positive outcomes for racial and ethnic minority (Assari, 2017, 2018a). MDRs suggest that not all of the worse outcomes in marginalized people are due to lower SES but also lower marginal returns of available SES resources for disenfranchised groups (Assari, 2017, 2018a). The MDRs literature, however, has not previously defined marginalization based on the neighborhood quality.

For youth educational outcomes, parental education is one of the most significant resources that shape youth educational (Mercy and Steelman, 1982; Davis-Kean, 2005) and health (Wills et al., 1995; Appleton-Arnaud, 2008; Ali and Elsayed, 2018) outcomes. In line with MDRs framework, however, researchers have documented smaller health gains from parental educational attainment for AA than non-Hispanic White adolescents (Assari, 2018b,c; Assari and Hani, 2018; Assari et al., 2018a,b,e). Diminished returns of parental education level are shown for AA youth in the areas of attention deficit hyperactivity disorder (Assari and Caldwell, 2019), self-rated health (Assari, 2018c), anxiety (Assari et al., 2018c), depression (Assari and Caldwell, 2018; Assari et al., 2018d), smoking (Bachman et al., 2011), aggression (Assari et al., 2020a), impulse control (Assari et al., 2018a), school attainment/performance (Assari, 2018b, 2019d), and school bonding (Assari, 2019c). This literature, however, is bound by the definition of marginalization based on race/ethnicity. As such, we have limited research on how place can marginalize individuals and reduce gains from available resources (i.e., similar to MDRs due to race/ethnicity). Place is the major context in which families live in, thus it can generate MDRs through shaping access to available resources and opportunities (Prentice and Jebb, 2003; Li et al., 2009; Blok et al., 2015; Patel et al., 2017). In the case of educational outcomes, school quality widely varies across neighborhoods (Sisco et al., 2015; Mackenbach et al., 2017). Worse neighborhoods, segregated areas, stressful places, and resource-scarce places can all interfere with application of resources as well as actualization of potentials. Although place can generate diminished returns, place-based MDRs are rarely studied. While MDRs are historically overlooked as a mechanism for health inequalities (Assari, 2017, 2018a), this is even worse for contexts in which MDRs emerge. Most research on social inequalities have focused on direct effects of neighborhoods (i.e., differential exposure hypothesis) which means that neighborhoods, adversities, or resources would mediate social inequalities. Studying MDRs, however, requires testing how context and neighborhood reduces the marginal return of available resources (e.g., parental education) on outcomes (e.g., youth school performance).

Aim

Building on the MDRs literature (Assari, 2017, 2018a) and using a national sample of United States adolescents (Hyland et al., 2017; Tourangeau et al., 2018), we compared the effect of parental

education level on adolescents' educational outcomes based on neighborhood quality. The unique contribution of this study is that it expands the MDRs literature from a literature almost exclusively focused on racial and ethnic differences (Assari et al., 2018a,b,e) to include effects of marginalization based on place. We hypothesize that MDRs would be relevant based on place meaning that the effects of parental educational attainment on youth school performance are expected to be weaker in low-resource neighborhoods. Although neighborhood has various aspects, we could only look at perceived neighborhood quality. We had data on perceptions of garbage and drugs in the neighborhood as an indicator of poor-quality neighborhoods (social disorder).

We argue that MDRs may not be only relevant to race/ethnicity but any type of marginalization (based on place in this paper). As a result, we hypothesize that MDRs may be even relevant to White youth who are socially marginalized and live in low-quality neighborhoods. Due to the social stratification, we expect MDRs of parental education for families who reside in neighborhoods with low quality. Built on MDRs, we define marginalization based on place; poor neighborhood quality may be associated with fewer returns for non-Hispanic Whites. If we find support for our hypothesis, neighborhood and context may explain poor outcomes in race/ethnic minority families, across SES levels.

MATERIALS AND METHODS

Design and Settings

This secondary analysis borrowed the existing wave 1 data of the National Longitudinal Study of Adolescent Health (Add Health) study, 1994–2019 (ongoing). Add Health has enrolled a nationally representative sample of American youth. The study was designed and conducted by University of North Carolina to better understand contextual determinants of health, behaviors, and outcomes of adolescents and young adults in the United States. Time 1 data collection of Add Health took place in 1994–1995 (mean age = 16, SD = 2).

Funded by the National Institutes of Health (NIH), Add Health is the primary source of information regarding development, health, and health behaviors of United States adolescents. Add Health has enrolled 12–21 years old adolescents who are representative of the United States adolescents. Publicly available data includes 6504 participants. The analytical sample for this study was non-Hispanic White adolescents that were a part of the public data. This study only included non-Hispanic Whites and excluded AAs, Hispanics, Asian Americans, and American Indians/Alaska Natives (AINAs).

Sample and Sampling

The Add Health study's samples in wave 1 were United States adolescents, who were between ages 12 and 21 years, and were non-institutionalized. The sample in this study was composed of 849 non-Hispanic White adolescents. We used the publicly available database of the National Longitudinal Study of Adolescent Health (Add Health) (McQueen et al., 2015). The public database included half of the Add Health core sample who completed the baseline in-home interview and the oversample of AA adolescents who had a parent who were college graduates. The Add Health study used a multi-stage stratified probability sampling. The analytical sample was smaller than the original study because parental education was missing in a large proportion of participants, and most participants had not reported their grade for Math, English, Science, and History. Our analysis was limited to individuals who had complete data for our main variables.

Study Variables

Parental Education Level

Parents reported their level of education as a 9-level categorical variable. This variable was operationalized as a continuous measure, ranging from 1 to 9, with a higher score indicating a higher level of education.

Demographic Factors

Age, grade, gender, and family structure (marital status of the parents) were the study covariates. Age was a continuous variable ranging from 12 to 21. Grade was a continuous variable with a range from 7 to 12. Age, grade, and gender were reported by the adolescents; however, family structure was reported by the parent.

Neighborhood Quality

Two items were used to measure subjective neighborhood quality. These items included "In this neighborhood, how big a problem is litter or trash on the streets and sidewalks?" and "In this neighborhood, how big a problem are drug dealers and drug users?" These items were both asked from parents. These items showed a positive, modest, and significant correlation ($r = 0.45$, $p < 0.001$). Responses for each question were: no problem at all (1), a small problem (2), and a big problem (3). We calculated a mean score of the two items. Total score ranged from 1 to 3, with a higher score indicating worse neighborhood quality (Mean = 1.53, SD = 0.53). Although perceived presence of garbage and drugs in the neighborhood is not the best measure of neighborhood quality (Lang et al., 2008), these two items are frequently applied to measure objective and subjective neighborhood quality. Additionally, these two measures may reflect social disorder (Ross and Mirowsky, 1999). Perceived neighborhood is one of the main determinants of health and development (Ross and Mirowsky, 1999). Perceived neighborhood is also closely associated with objective measures of neighborhood quality (Williams et al., 2008; Osypuk et al., 2009; Assari, 2016).

School Performance

A cumulative score composed of self-reported grades of Math, English, Science, and History were conceptualized as overall school performance. Overall, 4 items were asked. Example item was "At the most recent grading period/last grading period in the spring, what was your grade in mathematics?" Similar items were used Reponses included did not take (1), took but did not grade (2), Ds (3), Cs (4), Bs (5), and As (6). Participants could also refuse

to answer (did not include in the analysis). The overall school performance ranged from 4 to 24, with a higher score indicating better school performance (Mean = 3.31, SD = 0.68).

Statistical Analysis

We applied SPSS 23.0 (IBM Corporation, Armonk, NY, United States) to analyze the data. For this report, we first explored the independent and joint distribution of all our study variables including parental education level, outcomes, and covariates. First, we ruled out multicollinearity between the variables. Age was strongly correlated with grade, so we needed to use one of the two variables. As our outcome (school performance) and predictor (parental education) was continuous, we performed linear regression for our multivariable analysis. We ran two regression models, both in the pooled sample. *Model 1* included only main effects of parental education and the neighborhood perception variable but did not include the interaction term. *Model 2* included the interaction term between perceived neighborhood quality and parental education level (i.e., multiplication of parental education and neighborhood quality). We did not center our variables because there was no risk of collinearity. From our linear regression models, we reported Beta (B) and 95% Confidence Intervals (CI). p values less than 0.05 were statistically significant.

Ethics Statement

All adolescent participants in the Add Health study provided written assent. Their parents provided written informed consent. The institutional review board of the University of North Carolina approved the Add Health study protocol. Charles R. Drew University of Medicine and Science institutional review board exempted the current secondary analysis from a full review.

RESULTS

Descriptive Statistics

Table 1 summarizes descriptive statistics. This study included 849 non-Hispanic White American adolescents who were between 12 and 21 years old. These students were in grades 7 to 12.

Bivariate Correlations

Grade and age were negatively correlated with school performance. Higher neighborhood problem was associated with worse school performance (**Table 2**).

Linear Regression Models

Table 3 presents the summary of our two linear regression models in the pooled sample. In both these models, parental education level was the main independent variable, neighborhood quality was the moderator, and school performance was the outcome. While *Model 1* only entered the main effects of our variables, *Model 2* also included a statistical interaction term between parental educational level (1–9) and neighborhood quality.

Based on *Model 1*, parental education was not associated with better educational performance, however, worse neighborhood quality was associated with worse school performance. Based on *Model 2*, a statistically significant interaction was found between neighborhood quality and parental educational attainment on school performance, meaning that the boosting effect of high parental educational attainment on adolescents' school performance is smaller for those who live in worse than better neighborhoods.

TABLE 1 | Descriptive statistics in the overall sample (n = 849).

	Mean	Std. Deviation
Age	16.22	1.67
Grade	9.69	1.61
Parent education (1–9)	4.82	2.27
Neighborhood problem (1–3)	1.53	0.53
School performance (Cumulative score) (1–4)	3.31	0.68
	N	**%**
Male		
Female	424	49.9
Male	425	50.1
Parental marital status		
Not married	480	56.5
Married	368	43.3

DISCUSSION

We found an interaction between perceived neighborhood quality and parental education level on non-Hispanic White youth school performance. This finding is suggestive of a smaller effect of parental education level on school performance of non-Hispanic White youth in (subjectively) poor neighborhoods. Another interpretation of this finding is that poor neighborhoods have a larger detrimental effect on families with higher parental education. Both interpretations suggest that the effect of resource and context are multiplicative, with resource showing the highest level of effect at the best context (or context showing the largest effects at the top of the social strata). Our finding is indicative of the existence of place-based MDRs of parental educational attainment on youth school outcome.

The results suggested that ecological/cross level influences exist on youth educational development and neighborhood context has major implications on educational outcomes of the youth. According to the Bronfenbrenner's ecological system theory, child development is affected by their surrounding environment (Bronfenbrenner and Morris, 1998). We observed that some of the effects of place may not be direct but rather are due to place-based diminished returns of the SES Indicator.

Similar to past research showing that MDRs emerge due to race, ethnicity, and sexual minority status (Assari, 2018a), the new result suggests that MDRs phenomenon also applies to marginalization due to poor neighborhood. This means MDRs emerge as a result of marginalization, broadly defined, and not merely due to race, ethnicity, or sexual orientation. This study documented MDRs for non-Hispanic White youth in poor neighborhoods. The unique contribution of this study

TABLE 2 | Correlation matrix (n = 849).

	1	2	3	4	5	6	7
1 Gender (Male)	1	−0.07	−0.02	−0.07*	0.08*	0.02	0.06
2 Parental marital status (Married)	–	1	0.04	0.05	0.01	−0.09**	−0.06
3 Age (Years) (12–21)	–	–	1	0.91**	−0.01	0.01	−0.30**
4 School grade (7–12)	–	–	–	1	0.04	−0.02	−0.34**
5 Parental education (1–9)	–	–	–	–	1	−0.16**	−0.01
6 Poor neighborhood quality	–	–	–	–	–	1	−0.05
7 School performance (English, Math, Science, and History) (1–4)	–	–	–	–	–	–	1

*$p < 0.05$, **$p < 0.001$.

TABLE 3 | Summary of linear regressions (n = 849).

	Model 1 Main effects							Model 2 Model 1 + Interactions						
	Beta	B	SE	95% CI		t	p	Beta	B	SE	95% CI		t	p
Grade	−0.34	−0.14	0.01	−0.17	−0.12	−10.73	<0.001	−0.34	−0.14	0.01	−0.17	−0.12	−10.72	<0.001
Gender (Male)	0.04	0.05	0.04	−0.03	0.13	1.19	0.234	0.04	0.05	0.04	−0.03	0.14	1.21	0.226
Parental marital status (Married)	−0.05	−0.07	0.04	−0.15	0.02	−1.55	0.121	−0.05	−0.06	0.04	−0.15	0.02	−1.46	0.144
Parental education	−0.01	0.00	0.01	−0.02	0.02	−0.16	0.872	0.19	0.06	0.03	0.00	0.11	1.94	0.052
Neighborhood quality (Problems)	−0.06	−0.08	0.04	−0.16	0.00	−2.02	0.043	0.07	0.09	0.09	−0.09	0.27	1.00	0.317
Neighborhood quality (Problems) × Parental education	–	–	–	–	–	–	–	−0.23	−0.04	0.02	−0.08	0.00	−2.11	0.035
Intercept		4.82	0.16	4.51	5.12	30.95	<0.001	–	4.55	0.20	4.16	4.94	22.67	<0.001

is that it suggests that MDRs can even be seen in socially disadvantaged White youth.

Previous research has shown smaller effects of parental education on AA and Hispanic youth GPA (Assari, 2019d; Assari et al., 2020a), school attainment (Assari, 2018b), and school bonding (Assari, 2019c). This is probably the first study that reports place-based MDRs for White youth.

We found evidence supportive of neighborhood quality as a potential cause of MDRs in non-Hispanic White youth. What was previously known was the role of race/ethnicity as a source of MDRs. Parental education show smaller effects for marginalized people across domains (Assari et al., 2020a) even when race is not a factor. For example, parental education has shown smaller effects on Attention Deficit Hyperactivity Disorder for AAs than non-Hispanic Whites (Assari and Caldwell, 2019). The same is shown for mental health problems (Assari, 2018c) such as depression (Assari and Caldwell, 2018; Assari et al., 2018d). Parental education has also shown smaller effects on impulse control (Assari et al., 2018a), smoking (Bachman et al., 2011), and aggression (Assari et al., 2020a) for AA and Hispanic youth than their White counterparts. As shown in the literature, MDRs phenomenon also applies to non-academic outcomes such as mental health (Assari and Caldwell, 2018; Assari et al., 2018d) and health behaviors (Bachman et al., 2011).

As similar patterns are observed across SES resources, outcomes, and definitions of marginalization, MDRs are believed to be a consequence of societal forces (Assari, 2017, 2018a). Such social forces would reduce the efficiency of the effects of available resources on outcomes. Social stratification, segregation, racism, labor market discrimination, and poor education quality in urban areas may be among upstream mechanisms that can interfere with the process of translation of available social determinants on various outcomes across various marginalized groups. While racism may operate for AAs, high risk neighborhoods may impose all groups (regardless of race) to the risk of MDRs. The unique contribution of this study is to suggest that poor neighborhood quality may be one of the contextual mechanisms by which SES loses its effect for marginalized people, even when they are non-Hispanic White.

This study documented MDRs of parental educational attainment on school performance for 12–21 years old non-Hispanic White adolescents. MDRs are not limited to adolescents as they are also found for adults (Bachman et al., 2011). These patterns are not merely seen for parental education level (Assari, 2018c) as similar patterns are shown for own education (Assari, 2019a,b). While MDRs are shown for (Assari et al., 2020b) AAs (Assari et al., 2018a,b,e), Hispanics (Assari et al., 2020a), and American Indians and Alaska Natives (AIANs) (Assari and Bazargan, 2019b), this study adds to this literature by showing that MDRs may also be relevant to non-Hispanic Whites. We believe that this is a major step forward in our understanding about the social conditions that are associated with MDRs.

Relative to families that live in better neighborhoods, youth who live in poor quality neighborhoods show poor

school performance, even when they have highly educated parents. Living in poor quality neighborhoods may reflect social marginalization. However, it is yet unknown which neighborhood features better reflect structural and contextual factors that cause MDRs. The same pattern is shown for ethnic minority youth with highly educated parents (Assari et al., 2020a). While past research shows that MDRs can emerge due to race (Assari et al., 2018e), ethnicity (Assari et al., 2019), and sexual orientation (Assari and Bazargan, 2019a), this study suggests that it may also be shaped by place. As a result of such MDRs, youth develop undesired outcomes despite having highly educated parents.

As a result of MDRs, we see worse than expected outcomes in middle class people who have been marginalized. To be more specific, the findings of this study suggests that we should expect worse than expected educational outcomes in middle-class non-Hispanic White families who have access to human capital (education) but for some reasons live in undesirable neighborhoods. Thus, inequalities and disparities impact people across all levels of education (social class), and such inequalities are not limited to lack of access to education (lower social class) but is sometimes shaped across SES strata. The 2nd contribution of this study is that MDRs might be seen due to contextual (social) rather than individual behaviors. That is, individual level resources may fail to protect people in poor contexts. The results suggest that place matters but one of the mechanisms of the effects of place may be through reducing the marginal return of SES indicators. In other terms, while some parts of the inequalities are due to lack of access, some other parts might be due to weakened effects of available resources in those with access to resources (in poor contexts). As shown here, middle class White families who live in places with societal and structural barriers may not be able to most effectively leverage their family resources and secure maximum outcomes for their youth.

Limitations

No study is without limitations. Due to a cross-sectional design, we cannot make any causal inferences. The reason we have taken a causal language in this paper is to help articulate our big picture framework. The results should be read as correlational rather than causal. This study only included non-Hispanic Whites. Although this can be seen as a problem, it may also serve as a main strength of the paper. As mentioned above, this is the first paper to show that MDRs may also apply to non-Hispanic Whites. Our decision to limit the sample to Whites was also because MDRs emerge as a result of race/ethnicity, and we did not want to complicate the study with other sources of MDRs due to race/ethnicity. Future research should also include similar interactions for AAs, Hispanics, Asians, AINAs, and Asian Americans. We only included parental education level as a SES indicator. Other family SES indicators such as household income, employment, wealth, and employment should be studied in the future attempts. While we measured subjective neighborhood quality, it is unknown what objective structural and contextual factor accounts for our findings. All study variables were individual level, and more work is needed across various levels of data.

Some of the limitations of this study was because we used existing data. So, we were bounded with the data which were available. In this study we did not have access to the zip code data. Future research may explore the type of contextual and neighborhood factors than can reduce returns of resources for marginalized families. Neighborhood quality in this study was subjective rather than objective. Segregation, density of poverty, school quality, and physical and social neighborhood disorder may all have some role. Despite these short comings, this study still contributes to the existing literature by extending MDRs from a study of race/ethnicity to contextual causes of poor outcomes. A large sample size, a random sampling, multiple ethnic groups, and multiple outcomes studied resulted in knowledge which is generalizable to the United States adolescents.

CONCLUSION

In the United States, adolescents who live in worse neighborhoods are at a relative disadvantage compared to their counterparts who live in better neighborhoods regarding the magnitude of the effect of their parental education level on their school performance. This study suggested that MDRs are not specific to racial and ethnic minority groups and also hold for non-Hispanic Whites. In this paper we found place-based diminished returns or SES which is similar to race-based diminished returns. All of these MDRs are due to some type of social stratification.

DATA AVAILABILITY STATEMENT

The datasets generated for this study are available on request to the corresponding author.

ETHICS STATEMENT

All adolescent participants in the Add Health study provided written assent. Their parents provided written informed consent. The institutional review board of the University of North Carolina approved the Add Health study protocol. Charles R. Drew University of Medicine and Science institutional review board exempted the current secondary analysis from a full review.

AUTHOR CONTRIBUTIONS

SA developed the MDRs theory, conceptualized the study, analyzed the data, prepared the first draft of the manuscript, and acquired the funding, full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis. MB, SB, and CC contributed to the revision and conceptualization of the study. All authors approved the final draft of manuscript.

FUNDING

The research was reported in this publication was supported by the National Institutes of Health (NIH) awards: U54MD008149, R25 MD007610, 5S21MD000103, and U54CA229974. The funder did not interfere with the design and conduct of the study; collection, management, analysis, and interpretation of the data; preparation, review, or approval of the manuscript; and decision to submit the manuscript for publication. Health study is supported by multiple NIH awards including P01-HD3192.3.

REFERENCES

Albrecht, S. S., and Gordon-Larsen, P. (2013). Ethnic differences in body mass index trajectories from adolescence to adulthood: a focus on Hispanic and Asian subgroups in the United States. *PLoS One* 8:e72983. doi: 10.1371/journal.pone.0072983

Ali, F. R. M., and Elsayed, M. A. A. (2018). The effect of parental education on child health: Quasi-experimental evidence from a reduction in the length of primary schooling in Egypt. *Health Econ.* 27, 649–662. doi: 10.1002/hec.3622

Appleton-Arnaud, J. (2008). Parental education key to health for parents and children. *Prev. Chronic Dis.* 5:A68;author reply A69.

Arellano, C. M., Chavez, E. L., and Deffenbacher, J. L. (1998). Alcohol use and academic status among Mexican American and white non-Hispanic adolescents. *Adolescence* 33, 751–760.

Assari, S. (2016). Perceived neighborhood safety better predicts risk of mortality for whites than blacks. *J. Racial Ethn. Health Disparities* doi: 10.1007/s40615-016-0297-x [Epub ahead of print].

Assari, S. (2017). Unequal gain of equal resources across racial groups. *Int. J. Health Policy Manag.* 7, 1–9. doi: 10.15171/ijhpm.2017.90

Assari, S. (2018a). Health disparities due to diminished return among black Americans: public policy solutions. *Soc. Issues Policy Rev.* 12, 112–145. doi: 10.1111/sipr.12042

Assari, S. (2018b). Parental education attainment and educational upward mobility; role of race and gender. *Behav. Sci. (Basel)* 8:107. doi: 10.3390/bs8110107

Assari, S. (2018c). Parental educational attainment and mental well-being of college students; diminished returns of blacks. *Brain Sci.* 8:193. doi: 10.3390/brainsci8110193

Assari, S. (2019a). Education attainment and obesity differential returns based on sexual orientation. *Behav. Sci. (Basel)* 9:E16. doi: 10.3390/bs9020016

Assari, S. (2019b). Educational attainment and exercise frequency in American women; blacks' diminished returns. *Womens Health Bull.* 6:e87413.

Assari, S. (2019c). Family socioeconomic position at birth and school bonding at age 15; blacks' diminished returns. *Behav. Sci. (Basel)* 9:E26. doi: 10.3390/bs9030026

Assari, S. (2019d). Parental educational attainment and academic performance of American college students; blacks' diminished returns. *J. Health Econ. Dev.* 1, 21–31.

Assari, S., and Bazargan, M. (2019a). Education level and cigarette smoking: diminished returns of lesbian, gay and bisexual individuals. *Behav. Sci. (Basel)* 9:103. doi: 10.3390/bs9100103

Assari, S., and Bazargan, M. (2019b). Protective effects of educational attainment against cigarette smoking; diminished returns of American Indians and Alaska Natives in the national health interview survey. *Int. J. Travel Med. Glob. Health* 7, 105–110. doi: 10.15171/IJTMGH.2019.22

Assari, S., Bazargan, M., and Caldwell, C. H. (2020a). Association between parental educational attainment and youth outcomes and role of race/ethnicity. *JAMA Netw. Open* 2:e1916018. doi: 10.1001/jamanetworkopen.2019.16018

Assari, S., Boyce, S., Bazargan, M., and Caldwell, C. H. (2020b). Mathematical performance of American Youth: diminished returns of educational attainment of asian-american parents. *Educ. Sci.* 10:32. doi: 10.3390/educsci10020032

Assari, S., and Caldwell, C. H. (2017). Mental health service utilization among black youth; psychosocial determinants in a national sample. *Children (Basel)* 4:40. doi: 10.3390/children4050040

Assari, S., and Caldwell, C. H. (2018). High risk of depression in high-income African American boys. *J. Racial Ethn. Health Disparities* 5, 808–819. doi: 10.1007/s40615-017-0426-1

Assari, S., and Caldwell, C. H. (2019). Family income at birth and risk of attention deficit hyperactivity disorder at age 15: racial differences. *Children (Basel)* 6:E10. doi: 10.3390/children6010010

Assari, S., Caldwell, C. H., and Bazargan, M. (2019). Association between parental educational attainment and youth outcomes and role of race/ethnicity. *JAMA Netw. Open* 2:e1916018.

Assari, S., Caldwell, C. H., and Mincy, R. (2018a). Family socioeconomic status at birth and youth impulsivity at age 15; blacks' diminished return. *Children (Basel)* 5:E58. doi: 10.3390/children5050058

Assari, S., Caldwell, C. H., and Mincy, R. B. (2018b). Maternal educational attainment at birth promotes future self-rated health of white but not black youth: a 15-year cohort of a national sample. *J. Clin. Med.* 7:E93. doi: 10.3390/jcm7050093

Assari, S., Caldwell, C. H., and Zimmerman, M. A. (2018c). Family structure and subsequent anxiety symptoms; minorities' diminished return. *Brain Sci.* 8:E97. doi: 10.3390/brainsci8060097

Assari, S., and Hani, N. (2018). Household income and children's unmet dental care need; blacks' diminished return. *Dent. J. (Basel)* 6:E17. doi: 10.3390/dj6020017

Assari, S., and Lankarani, M. M. (2016). Reciprocal associations between depressive symptoms and mastery among older adults; black-white differences. *Front. Aging Neurosci.* 8:279. doi: 10.3389/fnagi.2016.00279

Assari, S., Lankarani, M. M., and Caldwell, C. H. (2018d). Does discrimination explain high risk of depression among high-income African American men? *Behav. Sci. (Basel)* 8:E40. doi: 10.3390/bs8040040

Assari, S., Thomas, A., Caldwell, C. H., and Mincy, R. B. (2018e). Blacks' diminished health return of family structure and socioeconomic status; 15 years of follow-up of a national urban sample of youth. *J. Urban Health* 95, 21–35. doi: 10.1007/s11524-017-0217-3

Bachman, J. G., O'Malley, P. M., Johnston, L. D., Schulenberg, J. E., and Wallace, J. M. (2011). Racial/ethnic differences in the relationship between parental education and substance use among U.S. 8th-, 10th-, and 12th-grade students: findings from the Monitoring the Future project. *J. Stud. Alcohol Drugs* 72, 279–285. doi: 10.15288/jsad.2011.72.279

Basch, C. E. (2011). Aggression and violence and the achievement gap among urban minority youth. *J. Sch. Health* 81, 619–625. doi: 10.1111/j.1746-1561.2011.00636.x

Benjet, C., Borges, G., Medina-Mora, M. E., Zambrano, J., Cruz, C., and Mendez, E. (2009). Descriptive epidemiology of chronic childhood adversity in Mexican adolescents. *J. Adolesc. Health* 45, 483–489. doi: 10.1016/j.jadohealth.2009.03.002

Blok, D. J., de Vlas, S. J., Bakker, R., and van Lenthe, F. J. (2015). Reducing income inequalities in food consumption: explorations with an agent-based model. *Am. J. Prev. Med.* 49, 605–613. doi: 10.1016/j.amepre.2015.03.042

Bronfenbrenner, U., and Morris, P. A. (1998). "The ecology of developmental processes," in *(Orgs.), Handbook of Child Psychology: Theoretical Models of Human Development*, Vol. 1, eds W. Damon, and R. M. Lerner (New York, NY: John Wiley), 993–1028.

Butler, A. M. (2017). Social determinants of health and racial/ethnic disparities in type 2 diabetes in youth. *Curr. Diab. Rep.* 17:60. doi: 10.1007/s11892-017-0885-0

Carlo, G., Crockett, L. J., Carranza, M. A., and Martinez, M. M. (2011). Understanding ethnic/racial health disparities in youth and families in the US. *Nebr. Symp. Motiv.* 57, 1–11. doi: 10.1007/978-1-4419-7092-3_1

Chavous, T. M., Rivas-Drake, D., Smalls, C., Griffin, T., and Cogburn, C. (2008). Gender matters, too: the influences of school racial discrimination and racial identity on academic engagement outcomes among African American adolescents. *Dev. Psychol.* 44:637. doi: 10.1037/0012-1649.44.3.637

Davis-Kean, P. E. (2005). The influence of parent education and family income on child achievement: the indirect role of parental expectations and the home environment. *J. Family Psychol.* 19:294. doi: 10.1037/0893-3200.19.2.294

Guglielmo, D., Gazmararian, J. A., Chung, J., Rogers, A. E., and Hale, L. (2018). Racial/ethnic sleep disparities in US school-aged children and adolescents: a review of the literature. *Sleep Health* 4, 68–80. doi: 10.1016/j.sleh.2017.09.005

Hyland, A., Ambrose, B. K., Conway, K. P., Borek, N., Lambert, E., Carusi, C., et al. (2017). Design and methods of the population assessment of tobacco and health (PATH) study. *Tob. Control* 26, 371–378. doi: 10.1136/tobaccocontrol-2016-052934

Jones, A. (2018). Race, socioeconomic status, and health during childhood: a longitudinal examination of racial/ethnic differences in parental socioeconomic timing and child obesity risk. *Int. J. Environ. Res. Public Health* 15:E728. doi: 10.3390/ijerph15040728

Lang, I. A., Llewellyn, D. J., Langa, K. M., Wallace, R. B., Huppert, F. A., and Melzer, D. (2008). Neighborhood deprivation, individual socioeconomic status, and cognitive function in older people: analyses from the English longitudinal study of ageing. *J. Am. Geriatr. Soc.* 56, 191–198. doi: 10.1111/j.1532-5415.2007.01557.x

Lau, M., Lin, H., and Flores, G. (2012). Racial/ethnic disparities in health and health care among U.S. *adolescents. Health Serv. Res.* 47, 2031–2059. doi: 10.1111/j.1475-6773.2012.01394.x

Li, F., Harmer, P., Cardinal, B. J., Bosworth, M., and Johnson-Shelton, D. (2009). Obesity and the built environment: does the density of neighborhood fast-food outlets matter? *Am. J. Health Promot.* 23, 203–209. doi: 10.4278/ajhp.071214133

Mackenbach, J. D., Lakerveld, J., van Oostveen, Y., Compernolle, S., De Bourdeaudhuij, I., Bardos, H., et al. (2017). The mediating role of social capital in the association between neighbourhood income inequality and body mass index. *Eur. J. Public Health* 27, 218–223. doi: 10.1093/eurpub/ckw157

Malhotra, K., Shim, R., Baltrus, P., Heiman, H. J., Adekeye, O., and Rust, G. (2015). Racial/ethnic disparities in mental health service utilization among youth participating in negative externalizing behaviors. *Ethn. Dis.* 25, 123–129.

McQueen, M. B., Boardman, J. D., Domingue, B. W., Smolen, A., Tabor, J., Killeya-Jones, L., et al. (2015). The national longitudinal study of adolescent to adult health (add health) sibling pairs genome-wide data. *Behav. Genet.* 45, 12–23. doi: 10.1007/s10519-014-9692-4

Mercy, J. A., and Steelman, L. C. (1982). Familial influence on the intellectual attainment of children. *Am. Sociological Rev.* 47, 532–542.

Messiah, S. E., Arheart, K. L., Lopez-Mitnik, G., Lipshultz, S. E., and Miller, T. L. (2013). Ethnic group differences in cardiometabolic disease risk factors independent of body mass index among American youth. *Obesity (Silver Spring)* 21, 424–428. doi: 10.1002/oby.20343

Osypuk, T. L., Diez Roux, A. V., Hadley, C., and Kandula, N. R. (2009). Are immigrant enclaves healthy places to live? The multi-ethnic study of atherosclerosis. *Soc. Sci. Med.* 69, 110–120. doi: 10.1016/j.socscimed.2009.04.010

Patel, O., Shahulhameed, S., Shivashankar, R., Tayyab, M., Rahman, A., Prabhakaran, D., et al. (2017). Association between full service and fast food restaurant density, dietary intake and overweight/obesity among adults in Delhi, India. *BMC Public Health* 18:36. doi: 10.1186/s12889-017-4598-8

Prentice, A. M., and Jebb, S. A. (2003). Fast foods, energy density and obesity: a possible mechanistic link. *Obes. Rev.* 4, 187–194. doi: 10.1046/j.1467-789x.2003.00117.x

Ross, C. E., and Mirowsky, J. (1999). Disorder and decay: the concept and measurement of perceived neighborhood disorder. *Urban Aff. Rev.* 34, 412–432. doi: 10.1177/10780879922184004

Rossen, L. M., and Schoendorf, K. C. (2012). Measuring health disparities: trends in racial-ethnic and socioeconomic disparities in obesity among 2- to 18-year old youth in the United States, 2001-2010. *Ann. Epidemiol.* 22, 698–704. doi: 10.1016/j.annepidem.2012.07.005

Sisco, S., Gross, A. L., Shih, R. A., Sachs, B. C., Glymour, M. M., Bangen, K. J., et al. (2015). The role of early-life educational quality and literacy in explaining racial disparities in cognition in late life. *J. Gerontol. B Psychol. Sci. Soc. Sci.* 70, 557–567. doi: 10.1093/geronb/gbt133

Tourangeau, R., Yan, T., Sun, H., Hyland, A., and Stanton, C. A. (2018). Population assessment of tobacco and health (PATH) reliability and validity study: selected reliability and validity estimates. *Tob. Control* 28, 663–668. doi: 10.1136/tobaccocontrol-2018-054561

Wallace, J. M. Jr, Vaughn, M. G., Bachman, J. G., O'Malley, P. M., Johnston, L. D., and Schulenberg, J. E. (2009). Race/ethnicity, socioeconomic factors, and smoking among early adolescent girls in the United States. *Drug Alcohol Depend.* 104(Suppl. 1), S42–S49. doi: 10.1016/j.drugalcdep.2009.06.007

Williams, D. R., Costa, M. V., Odunlami, A. O., and Mohammed, S. A. (2008). Moving upstream: how interventions that address the social determinants of health can improve health and reduce disparities. *J. Public Health Manag. Pract.* 14(Suppl.), S8–S17. doi: 10.1097/01.PHH.0000338382.36695.42

Wills, T. A., McNamara, G., and Vaccaro, D. (1995). Parental education related to adolescent stress-coping and substance use: development of a mediational model. *Health Psychol.* 14, 464–478. doi: 10.1037//0278-6133.14.5.464

Conflict of Interest: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

frontiers in Psychology

ORIGINAL RESEARCH
published: 24 April 2020
doi: 10.3389/fpsyg.2020.00718

Improved Intelligence, Literacy and Mathematic Skills Following School-Based Intervention for Children in Foster Care

Rikard Tordön[1], Marie Bladh[1], Gunilla Sydsjö[1] and Carl Göran Svedin[2]*

[1] Department of Biomedical and Clinical Sciences, Linköping University, Linköping, Sweden, [2] Department of Social Sciences, Ersta Sköndal Bräcke University College, Stockholm, Sweden

Interventions aimed at improving school performance for children in foster care are few and are generally not implemented. By preventing failure in school, the prospect of reducing the risk for future poor health, substance abuse, unemployment, and other detrimental social conditions are met. This paper focuses on the change of preconditions for compulsory school performance in out-of-home care children, following an intervention called "Skolfam" that aims to improve school performance by individual assessments and school-based interventions. In this study, data were compiled from prospective repeated tests of 475 children in foster care in Sweden. Educational preconditions were analysed for compulsory school performance, such as intelligence (WISC-IV), psychosocial (SDQ) and adaptive behavior (ABAS-II), literacy (Reading Chains) and mathematical skills (Magne Mathematic Diagnoses) before and after the first 2 years of the "Skolfam" intervention. All tests were age-standardized and performed by experienced professionals. The results showed improved skills in complex aspects of literacy, mathematics, and cognitive performance, but no improvement in less complex literacy skills, adaptive behavior or mental health symptoms. In conclusion, higher-order cognitive functions can develop positively when appropriate school support is provided. Affective function, adaptive behavior, and psychosocial well-being present a more pervasive challenge for children in foster care. Implications for future research, practice in social services, and school is that further development of methods to aid future prospects for children in out-of-home care should aim to improve both cognitive higher-order executive-, and affective functions.

Keywords: out-of-home care, intervention, assessment, intelligence, mathematics, literacy

OPEN ACCESS

Edited by:
Edgar Galindo,
University of Évora, Portugal

Reviewed by:
Adelinda Araujo Candeias,
University of Évora, Portugal
Lucia Herrera,
University of Granada, Spain

****Correspondence:***
Rikard Tordön
rikard.tordon@liu.se

Specialty section:
This article was submitted to Educational Psychology, a section of the journal Frontiers in Psychology

Received: *04 February 2020*
Accepted: *24 March 2020*
Published: *24 April 2020*

Citation:
Tordön R, Bladh M, Sydsjö G and Svedin CG (2020) Improved Intelligence, Literacy and Mathematic Skills Following School-Based Intervention for Children in Foster Care. Front. Psychol. 11:718. doi: 10.3389/fpsyg.2020.00718

INTRODUCTION

Children placed in out-of-home care are exposed to higher risk of poor outcomes with respect to health (Teyhan et al., 2018), physical and sexual abuse (Tordön et al., 2019), and substance abuse (Kobulsky, 2019). Also, these children have a poor outcome in terms of school performance (Berlin et al., 2011; Romano et al., 2015). Typically, incremental steps in school performance widen the gap with peers who are not in out-of-home care and differences become more pronounced when the children reach high school and college (Jackson and Cameron, 2012).

These children are also subject to more actions when the school situation does not work as expected, for example being subject to more special education, retention and disciplinary actions (Scherr, 2007).

In a developed and modern society, high-level educational achievement can benefit both the individual as well as society (Dee, 2004). Also, an association between school achievements and a reduction of risk of adverse outcomes for children in out-of-home care has been found in quantitative register and qualitative method studies (Cameron et al., 2012; Forsman et al., 2016).

In the study by Berlin et al. (2011), the risks for suicide attempts, substance abuse, serious criminality, and public welfare dependency were reduced by 38–52% when controlling for poor school performance in the final compulsory school year. The authors concluded that "If society wants to improve life opportunities for care leavers, it is necessary to give them effective help with their schooling and education while they are in care" (Berlin et al., 2011, p. 2496). Interventions aimed at improving school performance for children in out-of-home care have been developed and, to a limited extent, evaluated. A review by Forsman and Vinnerljung (2012) found 11 studies on interventions, of which nine reported positive results. Liabo et al. (2013) found promising interventions but highlighted the lack of evidence for efficacy in interventions. In a more recent review, Männistö and Pirttimaa (2018), found 19 studies of interventions aimed at supporting school performance. They concluded that there was sufficient and robust evidence to support the practice and policy-making needed to strengthen foster care children's educational and socio-emotional development. However, they also stated that there was still a need to improve both the quality and quantity of research to evaluate the interventions.

Interventions aimed at improving school performance for children in foster care vary in their design and setting. Some operate on a strategic level by appointing liaison persons (Zetlin et al., 2004) or resource coordination managers, such as the Virtual School Head Pilot[1]. Others try to enhance literacy and numeracy skills by using books or games as gifts that are mailed directly to the foster child, such as "Letterbox Club" (Griffiths, 2012). Some provide extra-curricular study support by providing tutoring assistance, by instructing foster parents on how to enhance their ability to support children in performing their school tasks (Vinnerljung et al., 2014; Hickey and Flynn, 2019). Some interventions enhance skills by engaging external resources such as voluntary university students, using a specific Direct Instruction method delivered in a group setting (Harper and Schmidt, 2012).

Children growing up in poor socioeconomic conditions (Franzén et al., 2008; Cameron et al., 2012; Simkiss et al., 2013), or children of parents with low educational attainment (Vinnerljung et al., 2005) are overrepresented in out-of-home care. The associations have been found to be stronger for younger children. Socioeconomic disadvantages have also been found to be robust over time. These disadvantages influence long-term trajectories of work- and health-related disadvantages for children investigated for social care interventions, or with earlier experiences of out-of-home care (Brännström et al., 2017; Almquist and Brännström, 2019).

Disruptions in family and change of school are other factors that affect children in foster care more than their peers. In a comprehensive study of factors that mediate school performance, Hattie (2008) found that a change of school influenced performance with a moderate effect size and was associated with developing new peer relations. In a study by Lewis et al. (2007) on adopted children with and without the experience of placement instability, the authors found associations between instability in early placements and adverse effects on social-emotional development.

The experience of previous success in school may also be an important factor. Hattie (2008) concluded that earlier acquired study skills have a great effect on scholastic performance. Also, the conclusions from the pan-European YiPPEE study "Young people in Public Care: Pathways to Education in Europe" (Jackson and Cameron, 2012), stressed the importance of early school success experiences as well as the detrimental effects of school changes.

There are other factors that could be regarded as pre-care adversities or disruptions that have a long-lasting influence on cognitive and intellectual abilities through school. In a study of the effects of early psychosocial deprivation on memory and executive function, Bos et al. (2009) found a detrimental impact on visual memory and executive functioning following early years of psychosocial deprivation in institutional care. When comparing 8-year-old children that were randomly assigned to foster care with those remaining in institutional care, no significant differences regarding measures of memory or executive functioning were found. This suggests that there might be traits of early adversities that are more resistant to change, where foster care alone does not provide an adequate remedy.

In a review of literature concerning the effects of early life stress on humans, Pechtel and Pizzagalli (2011, p. 55) concluded that "higher-order, complex cognitive and affective functions associated with brain regions undergoing protracted postnatal development are particularly vulnerable to the deleterious effects of early life stress." Particularly affective deficits appeared to persist years after the stressor(-s) had ceased, while higher-order cognitive functions were to some extent, restored.

There is a need for well-conducted intervention studies aiming to improve school performance for children in out-of-home care, i.e., studies covering large populations with baseline measurements and with adequate follow-up times with the use of validated instruments.

Thus, the aim of the present study was to explore how literacy and mathematical skills, adaptive behavior, intelligence, and psychosocial strengths and difficulties change over the first 2 years of a school-based intervention aimed at improving school performance for children in foster care.

MATERIALS AND METHODS

The Skolfam Working Model

In Sweden, a working model called Skolfam, (*School effort in Family care*), was developed in 2005. The objective was to improve compulsory school results for children in foster care by

individual assessments, and cross-professional and cross-agency collaboration, followed by consultative support for school staff and foster parents and monitoring of the children's progress. The first pilot was evaluated by Tideman et al. (2011), replicated by Tordön et al. (2014) and evaluated nationally in a quasi-experimental design by Durbeej and Hellner (2017). Durbeej and Hellner compared 54 foster care children in Skolfam to 37 in the comparison group, where the latter group did not receive any extra interventions other than regular school resources. Despite the small samples and a short timeframe for measuring improvements, the authors concluded: "the model may serve as a protective factor against adverse outcomes" (Durbeej and Hellner, 2017, p. 475).

Skolfam is staged in the ordinary school environment, using existing teachers and other school resources for interventions, but adding individual assessments with age-standardized instruments of foster children's literacy, numeracy, intelligence, adaptive behavior, and psychosocial condition. It is a manualized model emphasizing collaboration between social services and schools by forming a team comprising a psychologist, a special education teacher, and the social service officers of both the child and the foster parents. After baseline assessment, a plan is made jointly by the school, the Skolfam team and the foster family, including the child. The objective is to fill knowledge gaps and optimize teaching based on objectively and individually assessed prerequisites. The team monitors progress by regular meetings in school and provides consultative support to staff and on school-related issues in the foster family when needed. A follow-up assessment, using the same age-standardized instruments, is performed after the first 2 years. In this follow-up, the progress is evaluated and, if necessary, the plan for the remainder of compulsory school is adjusted.

Participants

Since the start in 2005, to 2018, 1034 children had been included in Skolfam in 25 different Swedish municipalities with a total of 39 Skolfam teams, whereof 22 municipalities participated in the study. Data from 104 children were not available due to teams no longer being operative or not participating. Another 74 data sets were missing in the compilation from reporting teams. An analysis of the 856 cases with at least one baseline assessment was done and reported separately (Tordön et al., 2020). When out-of-home care ends, either by the care returning to a birth parent or by legally transferring the caregiver responsibility to foster parents, the Skolfam intervention is usually terminated. This was the case for 67 of the children in our sample. Of the children in Skolfam, 475 had in September 2018 been in the intervention long enough to be assessed twice, thereby providing data for pairwise tests of how prerequisites for school performance develop in the first 2 years with an individually adapted, school-based intervention, aimed at improving school performance (see **Figure 1**).

A dropout analysis of the cases that were included in the first assessment but dropped out of Skolfam before the second assessment ($n = 67$) showed no mean difference ($p = 0.106–0.929$) to the follow-up group in regard to the test results from the first assessments.

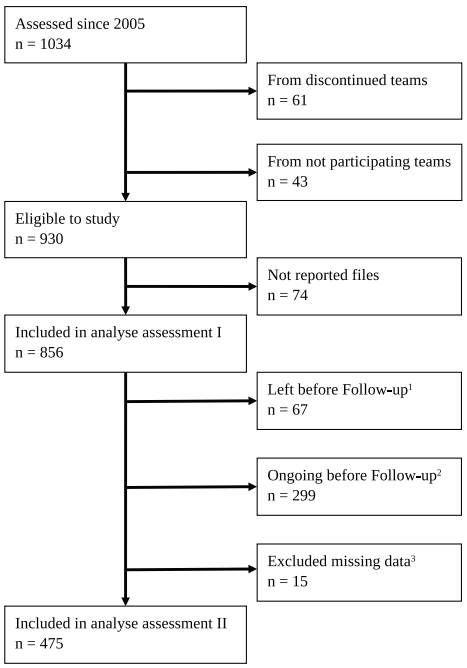

FIGURE 1 | Flowchart of participants. (1) Reasons for leaving Skolfam can be a return to parent care, the foster parents becoming legal caregivers, or transfer to residential or institutional care. (2) Children assessed once but have not yet reached the time for 2-year follow-up. (3) Excluded cases due to extensive missing data, or missing test dates.

Inclusion criteria for children in the Skolfam intervention, and subsequently for the study were:

- Placed in foster care by a municipality committed to the *Skolfam* working model, regardless of residing in the same municipality or another.
- Placed in potential long-term foster care.
- In preschool-class (typically age six) to seventh year of compulsory school (typically age 13) at inclusion.

Exclusion criteria were:

- Placed in a short term-/acute-/temporary foster home.
- Meeting the criteria for inclusion in school for children with learning disabilities due to mental retardation.

There were no other selection criteria or prioritizations advised by the regulations in the manual.

Children remain in Skolfam until the end of compulsory school in the ninth grade, unless the intervention is terminated due to a change in the legal caregiver condition. In Sweden, the transfer of the legal caregiver to foster parents is the common policy, whereas other countries' policies more commonly stipulate native adoption.

Gender distribution, school-year, native language, number of placements, and length of placement are presented in **Table 1**.

Ethical Approval

In order to take part in Skolfam, legal caregivers, predominantly birth parents, provide written consent after receiving information about the working model, including a statement that depersonalized data will be collected for research purposes. For children cared for under compulsory law, the consent can be given by the appointed social officer *in loco parentis*. Children themselves are also given the right to decline participation in parts of, or the complete intervention. The Regional Ethical Board of Linköping approved the study on March 20th, 2018, registration number 2018/96-31.

Measures

The Skolfam assessment battery aims primarily to aid the assessment of children's prerequisites for school and to evaluate progress, and as a secondary aim, to aggregate research data. Aside from the tests and questionnaires included in the study, the full assessment is based on background interviews with foster parents, teachers, reviews of documentation in school healthcare and social service journals, and interviews with the child. In this study, data that could be operationalized and analyzed systematically were compiled and no additional qualitative data were collected. Assessments were performed for the first time when the child was included in Skolfam and were repeated after 24 months. Due to the naturalistic study design, and due to some children's wish not to participate in parts of Skolfam, there was internal data dropout. This dropout varied between different tests and scales, thus it was not possible to perform full assessments with all instruments as stated by the Skolfam manual. Also, literacy tests typically have narrow age spans, measuring different aspects of literacy development of different ages, which also leads to high variance between different tests in the number of cases.

TABLE 1 | Socio-demographic background data. *N* = 475.

	N	%
Gender		
Boy	250	52.6
Girl	225	47.4
Native language		
Swedish	327	68.8
Non-Swedish	117	24.6
Unknown	31	6.5
School year at assessment II		
2–3 (age 8–9)	83	17.5
4–6 (age 10–12)	202	42.6
7–9 (age 13–15)	142	29.9
10 or first-year upper secondary	2	0.4
Unknown	46	9.7
No. placements		
1	126	26.5
2	82	17.3
3 or more	80	16.8
Unknown	187	39.4
Placement length (months), mean/SD	69.08/34.63	
Placement length (months), median/min-max	60/25.5–172	

The validated and standardized instruments used in Skolfam are Swedish versions of:

The Wechsler Intelligence Scale for Children (WISC), editions III and IV (Wechsler, 1991, 2003). The WISC assesses intelligence using different composite index scales and as a full-scale intelligence gradient on a standardized score with a fixed mean of 100 and a fixed range of 15 points for one standard deviation (hereafter SD). Wechsler intelligence tests have been used in most countries since the 1950s (Wechsler, 1949) and are considered as reliable in measuring intelligence according to the theoretical model chosen by their designer (Kaufman et al., 2016; Canivez et al., 2017). Internal consistency coefficients for the WISC-IV indexes are 0.94 for the Verbal Function Index, 0.92 for the Perceptual Reasoning and Working Memory Indexes, 0.88 for Processing Speed Index, and 0.97 for the Full Scale Index (The Psychological Corporation, 2003, Table 4.1, p. 34). Validity, in terms of corrected correlation coefficients to previous version was (r_{12} = 0.89) in the Full Scale Index (Williams et al., 2003). All WISC assessments were performed by the Skolfam team's psychologist.

The first 25 children from 2005 to 2008 were assessed using the third edition of WISC. From 2008 and onward, the fourth edition was used. Some index scales overlap between versions, and these data have been combined in the analyses. From 2017, the use of the fifth edition started in Skolfam municipalities, but none of these cases had gone through the follow-up assessments before data collection during autumn 2018 and were therefore not included in the current study.

The Adaptive Behavior Assessment System (ABAS-II), version II. The ABAS-II assesses adaptive behavior in nine domains, presented in conceptual, social and practical composite indexes and a general ability composite index, using the Wechsler scale. The assessments are performed by parents and teachers and compiled by the team's psychologist. In Skolfam, foster parents answer the parent questionnaire. Adaptive behavior is sometimes referred to as *daily life skills*, reflecting how an individual can adapt behavior to cope with different conditions or tasks in life (Harrison and Oakland, 2008). Internal consistency in the ABAS-II is high, with reliability coefficients of 0.85–0.99 for the General Adaptive Composite, and the three adaptive domains (Oakland, 2011). Test-retest reliability is above 0.80. The construct validity is strong in factor analyses and it has shown a strong concurrent validity, r = 0.82, with the Vineland Adaptive Behavior Scales (Harrison and Oakland, 2008).

The Strengths and Difficulties Questionnaire, Swedish (SDQ). Strengths and difficulties were assessed by the SDQ (Goodman, 1997) and compared to the United Kingdom teacher test norms (Meltzer et al., 2003), due to the lack of Swedish norms for teacher rating, and the most recent Swedish parent norms (Bjornsdotter et al., 2013). The instrument has 25 items in four scales reflecting problems (*emotional problems, conduct problems, hyperactivity,* and *peer relations*) and one strength scale (*prosocial behavior*). The range is 0–10 in each scale and 0–40 in the *total difficulties* score, with a higher score reflecting more

problems, except for the prosocial behavior scale where scores are inverted and not included in the total score. The SDQ has showed a good reliability in the Swedish normative study of paper-and-pen versus Internet administered version by Bjornsdotter et al. (2013), with internal consistency in the subscales (polychoric ordinal alpha) ranging from 0.85 to 0.91. Teacher assessment reliability and validity was investigated by van den Heuvel et al. (2017). They report the internal consistency to alpha 0.80 for the total difficulties scale. Concurrent validity to the Teacher Report Form was found strong in all subscales, ranging from 0.54 to 0.73, with exception for the peer problems subscale, 0.46. The SDQ is compiled by the team psychologist.

Reading Chains [Swedish "Läskedjor"] versions I and II. Reading chains are primarily aimed at assessing skills in visual decoding of letters/digits, words or sentences. During the years 2005 to 2014 the first edition of these tests was used (Jacobson, 2001), and from 2014 Reading Chains-2 was used (Jacobson, 2014). *Letter chains* were used instead of *Digit chains* in the first school year and *Sentence chains* from the second school year, explaining the variance in the number of cases. There are no norm means or SDs spanning all school years reported from the standardization studies in the literacy tests, making a more precise calculation impossible. These tests are performed by the Skolfam team's special education teacher. The tests in language and mathematics skills use the Stanine scale one – nine, with five as the mean and two scale steps representing one SD.

Diagnosis in Reading and Spelling (Swedish "DLS"). DLS is a test for reading and writing skills, more broadly aimed than just visual decoding, with subtests developed by Järpsten and Taube (2002) including Word comprehension, Reading, Reading comprehension, Spelling, and Reading speed. The subtest Reading is taken in school years one and two, Spelling and Word comprehension in school years three to nine, Reading comprehension in school years two and three, and Reading speed in school-years four to nine. DLS tests are performed by the Skolfam team's special education teacher.

Reading and Spelling (Swedish "LäSt") for decoding and reading index. The LäSt reading index is a test measuring text decoding of non-words and words, which reports a result in percentiles reflecting these aspects called the "Reading index." This test was developed by Elwér et al. (2013). In the Skolfam setting, LäSt was used in school years one to five but occasionally also in the sixth year. LäSt tests are performed by the Skolfam team's special education teacher.

Olof Magne Mathematics Diagnoses (Swedish). Numeracy skills were assessed with the Olof Magne mathematics series of tests. These tests were standardized in three studies 1977, 1986, and 2002 in a municipality with around 2,000 pupils in compulsory school (Engström and Magne, 2003). The Magne diagnostic tests aim to assess numeracy skills in different areas, such as number or quantity perception, number values, position, basic algebra, units and applied numeracy comprehension. Internal consistency in the normative study ranged from alpha 0.89 in the diagnoses for third school-year, to 0.97 in the diagnoses for seventh school-year (Engström and Magne, 2003). The Magne mathematics tests are performed by the Skolfam team's special education teacher.

The Skolfam manual, in Swedish, is available online, at www.skolfam.se/artiklar-och-rapporter-om-skolfam/.

Procedure

The procedure for testing foster care children in Skolfam is described in the manual. It is left to the team's discretion to decide in cooperation with the child when and where the tests are conducted. Typically, the tests performed by the special education teacher are done in one session and those performed by the psychologists in another session. In some cases, these two sessions are done in one single day. If the child show signs of assessment fatigue, another session is scheduled to avoid bias from fatigue and assure optimal test conditions.

All municipalities in the Skolfam national network 2018 were sent a letter inviting them to participate. In addition to the invitation to participate, the letter also included instructions. Three municipalities could not participate due to temporary staff vacancies. In each municipality, the team or teams compiled data from their tests in an Excel template for each child along with the name of the team. They gave each child a unique code number and then transferred the data to the researcher who merged each individual file into a complete data file containing all anonymous data. For integrity reasons, background data was limited to test dates, gender, school-year at tests one and two, native language "Swedish" or "other," number of placements and length of placement in months. No further actions engaging children were taken in order to compile data.

Statistical Analyses

Comparable index scales in WISC-III and WISC-IV, *verbal comprehension* and *full scale* were combined. Categorical data are presented as numbers (n) and percent (%). Means for scales in the different instruments were calculated along with SD, and compared to norm groups from sources either in test manuals or from peer-reviewed published literature. The data is presented with the sample size (n) available for each subscale. Paired sample tests for means were performed to calculate differences. Where statistically significant ($p < 0.05$, two-sided) differences between first (T_1) and second assessments (T_2) were discovered, a calculation of effect size (d) was carried out, using a within-subjects calculator online, https://memory.psych.mun.ca/models/stats/effect_size.shtml.

The statistical analyses were performed using IBM SPSS Statistics 25 (IBM Inc., Armonk, NY, United States).

RESULTS

Intelligence

Intelligence, as assessed with the WISC-IV full-scale index, showed at the first baseline assessment more than 0.5 SD under the mean for the age-standardized norm in the population. We also found an atypical profile variance of 12.66 points between a substantially lower working memory index mean and a perceptual reasoning mean close to the norm (see **Table 2**).

In all function indexes of WISC-IV, as well as the full-scale IQ index, the results showed improvements ($p < 0.001$) in the range of small to medium effect size after the first 2 years of the intervention. Results ranged from verbal comprehension index ($d = 0.217$) to perceptual reasoning index ($d = 0.375$). In the full-scale index, results improved with a medium effect size ($d = 0.423$) (see **Table 2**).

Adaptive Behavior

Adaptive behavior also showed baseline means lower than the age-standardized norm, close to one full SD in teacher assessments in *general ability composite*. Foster parents' assessment means were more than a full SD below norms in *general ability composite*. In comparison to the intelligence indexes, profile variance between sub-scale indexes was small in teachers' assessments, with a 2.8 points difference between the lowest, *social composite* and the highest, *practical composite*. In foster parents' assessments, the profile variance was higher with a difference of 8.11 points between the lowest, *conceptual composite* and the highest, *practical composite* (see **Table 2**).

Contrary to the results in intelligence, adaptive behavior did not change in any sub-scale or general ability index in either teachers' or foster parents' assessments. Means showed a tendency to decline in teachers' assessments and there was a slight, but not significant incline in foster parents' assessments (see **Table 2**).

Language and Mathematics Skills

Language and mathematics skills at baseline were found to be approximately 0.5 SD lower than age-standardized means in *reading chains*, the *DLS test*, and the *Magne mathematics* diagnoses.

In *reading chains*, reflecting text decoding skills, letter-, digit-, and word chains showed no significant changes between T_1 and T_2. *Sentence chains*, however, increased ($p = 0.001$, $d = 0.211$) (see **Table 3**).

Results in the *DLS test*, reflecting a more comprehensive aspect of reading and writing skills, showed no change between T_1 and T_2 in the *word comprehension* sub-test. The *reading comprehension* test improved ($p = 0.007$, $d = 0.364$) and the *DLS spelling* test also showed improvements ($p = 0.018$, $d = 0.127$). *Reading speed* means declined ($p = 0.037$, $d = 0.143$) (see **Table 3**).

Mathematics skills showed a marked lower stanine scale means (in relation to age-standardized population norms at baseline) and an improvement ($p < 0.001$, $d = 1.194$) during the first 2 years of the intervention (see **Table 3**).

Strengths and Difficulties

Psychosocial well-being was assessed by the *SDQ -Strengths and Difficulties Questionnaire* for teachers' and (foster-) parents' assessments. At baseline, all sub-scales and the *total problems* scale showed higher levels ($p < 0.001$) compared to norms, and the *prosocial behavior* scale lower levels ($p < 0.001$) than norms, in teachers' as well as in foster parents' assessments. Norm values are included for comparison in **Table 4**.

The results show a small decline ($p = 0.032$, $d = 0.116$) in the *hyperactivity* sub-scale in teachers' assessments following the first 2 years of the intervention, but there was no significant change in any other sub-scale, the *total problems* scale, or in the *prosocial behavior* scale.

In the foster parents' assessments, means declined ($p = 0.008$, $d = 0.148$) in the sub-scale *emotional symptoms*, and in the *hyperactivity* sub-scale ($p = 0.005$, $d = 0.156$). In the *total problems* scale, means declined ($p = 0.004$, $d = 0.156$).

TABLE 2 | Comparison of cognitive and adaptive behavior functioning between test 1 and test 2.

	Test I results n/mean/SD	Test II results mean/SD	Difference m2 – m1/SD	Paired samples test t/p	Effect size Cohens d[1]
WISC-IV					
Verbal comprehension	419/93.37/13.26	95.52/14.67	2.15/9.90	−4.45/<0.001	0.217
Perceptual reasoning	417/97.95/14.06	101.66/13.63	3.72/9.89	−7.67/<0.001	0.375
Working memory	418/85.29/13.14	88.74/13.59	3.45/12.00	−5.88/<0.001	0.287
Processing speed	418/92.58/13.12	94.94/13.78	2.36/11.19	−4.32/<0.001	0.211
Full scale IQ	414/91.14/12.79	94.73/13.40	3.59/8.35	−8.76/<0.001	0.423
ABAS-II Teacher					
Conceptual composite	320/85.61/19.61	84.40/19.91	−1.21/18.89	1.14/0.253	NA
Social composite	313/84.43/19.91	82.40/21.16	−2.03/21.20	1.70/0.091	NA
Practical composite	315/87.23/21.49	87.26/22.44	0.02/21.82	−0.18/0.986	NA
General ability comp.	331/85.60/20.26	85.26/21.58	−0.34/19.54	0.32/0.753	NA
ABAS-II Foster parent					
Conceptual composite	310/75.58/21.48	77.54/24.35	1.96/20.90	−1.65/0.100	NA
Social composite	310/75.99/19.98	76.92/21.39	0.93/18.83	−0.87/0.386	NA
Practical composite	310/83.69/19.13	84.35/21.17	0.66/20.63	−0.56/0.575	NA
General ability comp.	329/78.96/20.02	80.26/22.54	1.30/19.82	−1.19/0.234	NA

[1] *Using Within-Subjects calculator at https://memory.psych.mun.ca/models/stats/effect_size.shtml.*

TABLE 3 | Comparison of language and numeracy skills between test 1 and test 2.

	Test I results n/mean/SD	Test II results mean/SD	Difference m2 – m1/SD	Paired samples test t/p	Effect size Cohens d[1]
Reading Chains					
Letter Chains	70/3.99/1.49	4.29/1.65	0.30/1.43	1.76/0.083	NA
Digit Chains	178/3.88/1.93	4.07/1.91	0.19/1.76	1.45/0.149	NA
Word Chains	351/3.96/2.00	3.93/1.86	−0.03/1.63	−0.33/0.743	NA
Sentence Chains	234/3.71/1.78	4.01/1.73	0.30/1.42	3.26/0.001	0.211
DLS (Read and Write)					
Word comprehension	165/4.20/1.97	4.24/1.90	0.04/1.78	0.31/0.760	NA
Read comprehension	59/3.56/1.86	4.22/1.92	0.66/1.82	2.80/0.007	0.364
Spelling	341/4.25/2.06	4.45/2.07	0.20/1.57	2.38/0.018	0.127
Reading speed	212/4.13/1.98	3.92/2.01	−0.21/1.47	−2.10/0.037	0.143
LäSt					
Reading Index	70/52.39/27.32	53.91/29.32	1.52/20.23	0.63/0.531	NA
Magne Mathematics					
Total score	406/3.43/2.22	3.87/2.19	0.43/2.27	3.86/<0.001	0.194

[1] *Using Within-Subjects calculator at https://memory.psych.mun.ca/models/stats/effect_size.shtml.*

TABLE 4 | Comparisons of strengths and difficulties between test 1 and test 2.

	Norm data n/mean/SD	Test I results n/mean/SD	Test II results mean/SD	Difference m2 – m1/SD	Paired samples test t/p	Effect size Cohens d[1]
SDQ Teacher[2]						
Emotional symptoms	8208/1.4/1.9	337/1.91/2.08	1.94/2.08	0.02/2.20	0.210/0.834	NA
Conduct problems	8208/0.9/1.6	338/2.04/2.35	2.00/2.39	−0.05/2.34	−0.360/0.719	NA
Hyperactivity	8208/2.9/2.8	338/4.85/3.32	4.52/3.14	−0.33/2.85	−2.149/0.032	0.116
Peer problems	8208/1.4/1.8	338/2.19/2.28	2.23/2.36	0.04/2.46	0.287/0.774	NA
Prosocial behavior	8208/7.2/2.4	336/6.47/2.92	6.68/2.79	0.21/3.17	1.203/0.230	NA
SDQ total problems	8208/6.6/6.0	361/11.01/7.58	10.49/7.32	−0.52/6.93	−1.432/0.153	NA
SDQ Foster parent[3]						
Emotional symptoms	946/1.4/1.7	329/2.54/2.46	2.21/2.15	−0.33/2.24	2.672/0.008	0.148
Conduct problems	946/1.1/1.3	330/2.50/2.16	2.41/2.25	−0.08/2.03	0.745/0.457	NA
Hyperactivity	946/2.3/2.1	330/4.99/2.92	4.60/2.91	−0.39/2.51	2.822/0.005	0.156
Peer problems	946/1.2/1.5	330/2.57/2.48	2.52/2.40	−0.05/2.17	0.419/0.676	NA
Prosocial behavior	946/8.5/1.6	330/6.70/2.62	6.93/2.62	0.23/2.63	−1.583/0.114	NA
SDQ total problems	946/6.1/4.8	351/12.67/7.36	11.72/7.36	−0.95/6.10	2.912/0.004	0.156

[1] *Using Within-Subjects calculator at https://memory.psych.mun.ca/models/stats/effect_size.shtml.*[2] *Norm data from SDQ British standardization study, n = 8208 (Meltzer et al., 2003).* [3] *Norm data from Swedish standardization study, n = 946 (Bjornsdotter et al., 2013).*

Despite the decline in some of the SDQ sub-scales, means remained high, well above norms for the normal population in all sub- and total problems scales, and lower in the *prosocial* scale.

DISCUSSION

This study investigated how literacy and mathematical skills, adaptive behavior, intelligence, and psychosocial strengths and difficulties changed during 2 years of a school-based intervention aimed at improving school performance for children in foster care. The results can be summarized in four main findings.

Intelligence and Adaptive Behavior

First, all indexes in the Wechsler scales showed improved results, with the largest effect size on the *perceptual reasoning* index and the smallest on the *processing speed* index. This is probably one of the first studies to report a positive development of the measured intelligence of children in foster care. Since there is no reference group of foster care children to compare with in our study, results are related to the study by Durbeej and Hellner (2017). In their study, the control group of children in foster care showed a tendency to decreased results in intelligence, literacy and mathematic skills, while the Skolfam group showed tendencies to improved scores over time. Another study of 2 453 children in the United States National Survey of Child and Adolescent Well-Being (Berger et al., 2009) found foster care alone having no influence on intelligence.

Providing individually adapted school-based training for under-stimulated children in foster care might facilitate their development of higher-order executive functions. To our knowledge, this positive effect has not previously been observed

in the normal population or foster care children without specific academic interventions.

Second, contrary to expectations, changes in adaptive behavior were not apparent. The results remained on a level one full SD below the norm in the teachers' assessments and even lower in the foster parents' assessments. This finding contrasts with a study by Horwitz et al. (2001) in which a positive improvement was found over time in foster care.

The rationale underpinning the Skolfam design was that once deficits in overt behavior skills were revealed in the first assessment, it would be a reasonably easy task to train children specifically in those areas. This was meant to be achieved by using well-proven methods from behavioral psychology with instruction and reinforcement of desired behavior. But the results reveal difficulties in improving adaptive behavior among children in foster care in this sample.

There is a plausible reason for the absence of development in adaptive behavior since it is regarded as more sensitive to affective functions than to higher-order cognitive functions. As concluded by Pechtel and Pizzagalli (2011), both cognitive and affective functioning can be impaired by early life stress experiences. But when there seems to be a catch-up effect for high-order cognitive functions upon relief of the stressors, affective functioning appears to be more resistant to change. Attention deficits (McLaughlin et al., 2015) and inhibitory control, as suggested by Pears et al. (2015) can also be regarded as factors that could impact the ability to re-learn adaptive behaviors, providing another piece to understanding the lack of improvements in this domain.

Literacy and Mathematic Skills

Third, the starting point for literacy and mathematics skills for children in our study was an average level in line with intelligence, around 0.5 SD below the normal population as expressed in the norms. There is growing support in the literature for a reciprocal relation between intelligence and mathematics (Cowan et al., 2018). The results from this study provide support for that hypothesis, meaning that development in mathematical ability can possibly influence intelligence, and developments in general cognitive ability can influence mathematics. How this process works has not yet been described. Other studies suggest reading skills contribute to the growth of general cognitive skills and vice versa (Ferrer et al., 2007; Ritchie et al., 2015). For our study the results in mathematics were limited to one school-year standardized stanine value of generic/general mathematic skills per test, whereas the wider range of literacy measures provided a more diversified analysis of different components.

One interesting point is that in literacy, no change in measurements of less complex skills such as letter-, digit- or word chains, or word comprehension was found. However, there was a positive development in more complex literacy skills such as sentence chains, reading comprehension and spelling. The latter set of more complex literacy skills requires more than mere decoding.

In the literacy tests, only reading speed showed decreased skills over the 2-year timeframe, suggesting no functional relation with processing speed in the cognitive tests, which increased. A plausible, but not proven explanation would be that children in Skolfam develop a quality reading strategy, deliberately slowing down their pace in order to comprehend text, rather than process as many words as possible.

Psychosocial Well-Being

Fourth, the development of psychosocial well-being and function, based on assessments from teachers and foster parents using the SDQ, were more discouraging. The starting point at the first assessments revealed higher levels in all sub-scales reflecting problems, and a lower level in the prosocial behavior scale for children in foster home care. The results after the second assessment revealed significant improvements with lowered means in the teachers' assessments in the sub-scale *hyperactivity*. This result makes sense in light of the positive development in literacy and numeracy skills, and the positive intellectual progress in the WISC assessments. Children who develop cognitive abilities and start to master the scholastic challenges would logically be perceived as less hyperactive.

In the foster parents' assessments, *hyperactivity* along with means in *emotional symptoms* was found to decline, which in turn also led to a decrease in the *total problems scale*, since there were no increased means in other scales.

Nevertheless, means in teachers' assessments are still high above those of peers in the scales *emotional symptoms*, *conduct-* and *peer problems*, and below peers in *prosocial behaviour*. And in foster parents' assessments, the scores after intervention were still reflecting more problems in all sub-scales, close to the cut-off levels for clinical importance suggested by Goodman (1997).

Results from the analysis of the SDQ scores indicates that foster care, even with added interventions to aid good school progress, does not ensure broad psychosocial well-being for children in out-of-home placements, but it can contribute to reducing hyperactivity both in school and at home as well as emotional problems at home.

The mean levels and size of change between tests were similar to those found by Durbeej and Hellner (2017) in their quasi-experimental effect evaluation on a smaller portion in the same sample as ours, providing support for their conclusions. In their study, a matched comparison group of foster care children showed a negative development between tests, with increased means in the total problems scale and decreased means in the prosocial scale.

Implications for Developing Interventions to Support Foster Children's School Achievements

In general, most interventions aimed at strengthening school achievements for children in foster care show promising results, but they are too diverse in methodology or output measures to make systematic meta-analyses feasible, or they lack the statistical power needed to draw valid conclusions. Research on interventions in foster care is also an area with obstacles to staging high standard RCT studies for evaluation purposes, due to weak research infrastructure for controlled trials and culture in social

sciences (Mezey et al., 2015) combined with the need for long timeframes for measurable effects.

One hypothesis to explain the diversity in the design rationale for interventions is that there is no scientific consensus on the most important causes of out-of-home care children's educational underachievement in school. Depending on the idea of what causes underachievement, the understanding of the factors mediating school performance for children placed in foster care will vary, and subsequently so will the design of interventions. Our results reflect what can and cannot be achieved through school-based intervention for foster children in primary school. Skolfam has some core characteristics if comparisons of different methods are to be made in this respect. First, it has broad aims, targeting both literacy and mathematic skills in school, and pays attention to the whole environment although focusing on the child's ability to perform at school. Second, it is ongoing over a long time, monitoring the progress through scheduled meetings in school until the end of primary school. Third, it involves all children in foster care in a population such as a municipality, regardless of whether there are any manifest problems or not. Skolfam has a selective group preventive design, not waiting to target problems with remedies when already visible.

Limitations

The study utilizes a design without a control group for comparisons, which makes valid generalizations of effects not feasible. Instead, it reports on how conditions for school performance change in Swedish foster children who are provided with an intervention designed to address their prerequisites for school performance by more precise directed support in the school environment, following individual assessments. Another aspect that may impact the study validity is whether it has a retrospective or prospective design. All the tests that generated data for the study were performed prospectively, as the children entered the Skolfam intervention. The collection, compilation, and analysis were carried out retrospectively. This creates a risk for bias by skewed external dropout, but no signs, or remarks of any such skewness or attempts at selection in data were found or reported from the teams. The ability for children to decline participation in selective tests could skew the results through internal dropout. If so, the tests would probably be ones the child had previous poor experiences in. Thus, there would be fewer poor results, leading to higher means in our compilation and an underestimation of problems.

Another limitation is related to background data. The collected data have no information about the reasons for care, birth parents' educational level, economic conditions or health status. There was also a fairly large internal data dropout regarding the number of placements (N = 187) and months in the present foster home. This was due to less rigorous routines for documenting information that did not have direct relevance for the operational assessments in the teams.

The study unfortunately lacks data regarding specific interventions given to children in Skolfam. Interventions were heterogeneous and varied from one school to another and over time. A coarse systematic frame to report widely defined interventions such as "intense reading training", "special education support" or "working memory training" was included, but few teams had systematically noted provided interventions in their records.

The fact that data was collected several years after the intervention program has probably resulted in a larger external dropout than what would have been if collection of data had been done during intervention. On the other hand, this is not considered to have skewed results in a particular direction.

Relevance and Implications

This study has several strengths related to relevance for practice. First, the naturalistic design, using prospectively collected data, provides a reliable base and well reflects the population of foster care children in compulsory school. Second, the large sample adds to the reliability of the analyses through ensuring good statistical power. Third, the use of widely used, age-standardized comprehensive instruments adds to methodological transparency and reproducibility, even though literacy and mathematics instruments would need to be nationally adapted.

Based on our findings, school interventions for children in foster care should focus on school matters such as mathematics, literacy and other factors related to a good study environment. Health-related aspects, affective functioning, attachment, and relational problems are of course important to address, but are not necessarily the only prerequisites for school performance, and they should not to be expected to improve via school interventions. Adding interventions aimed at addressing affective functioning and psychosocial well-being for children in foster care is recommended in the future based on the results of this study.

CONCLUSION

This was a study of 475 foster care children in compulsory school, given a school-based preventive intervention aimed at strengthening school performance. Conclusions are that higher-order cognitive functions, such as mathematics skills, intelligence, and some aspects of literacy can develop in a positive direction when appropriate school support is provided constantly during compulsory school. Also, affective function, adaptive behavior, and psychosocial well-being present a more pervasive challenge that does not necessarily change when school performance does, nor can affective function or psychosocial well-being serve as sole prerequisites for school achievement, but they could possibly contribute. Thus, studies of the role of affective versus higher-order executive functions is an important field for the future development of interventions for children and youth in out-of-home care.

In short, Skolfam at least prevents further detrimental development in school, as stated by Durbeej and Hellner (2017), showing a small to medium effect after the first 2 years on intelligence, mathematics and higher-order executive aspects of literacy. Skolfam shows no measurable effect on variables sensitive to affective function, such as psychosocial well-being and adaptive behavior.

DATA AVAILABILITY STATEMENT

The datasets generated for this study are available on request to the corresponding author.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by The Regional Ethical Board of Linköping March 20th 2018, reg. nr. 2018/96-31. Written informed consent to participate in this study was provided by the participants' legal guardian/next of kin.

AUTHOR CONTRIBUTIONS

RT contributed to the design of the study, communicated internally with participating municipalities, applied for grants from the Children's Welfare Foundation, compiled the data, contributed to statistical analyses, and wrote the manuscript. MB contributed to statistical analyses and to setting out the results in the tables. CS and GS supervised the design and ethical approval. All the authors have been involved in the manuscript writing and interpretation of the results.

FUNDING

The study has been partly funded by grants from the Children's Welfare Foundation, grant 2019-255. FORTE, the Swedish Research Council for Health, Working Life and Welfare, partly funded salary for the main author's doctoral studies, grant 2015-01009.

ACKNOWLEDGMENTS

The authors would like to thank the Children's Welfare Foundation and FORTE for funding the study, and the persons in the Skolfam teams for all their efforts. Authors are also grateful to Emma Tengwall, Children's Welfare Foundation, for assisting some teams in compiling data.

REFERENCES

Almquist, Y. B., and Brännström, L. (2019). Do trajectories of economic, work- and health-related disadvantages explain child welfare clients' increased mortality risk? A prospective cohort study. *BMC Public Health* 19:418. doi: 10.1186/s12889-019-6752-y

Berger, L. M., Bruch, S. K., Johnson, E. I., James, S., and Rubin, D. (2009). Estimating the "impact" of out-of-home placement on child well-being: approaching the problem of selection bias. *Child Dev.* 80, 1856–1876. doi: 10.1111/j.1467-8624.2009.01372.x

Berlin, M., Vinnerljung, B., and Hjern, A. (2011). School performance in primary school and psychosocial problems in young adulthood among care leavers from long term foster care. *Child. Youth Serv. Rev.* 33, 2489–2497. doi: 10.1016/j.childyouth.2011.08.024

Bjornsdotter, A., Enebrink, P., and Ghaderi, A. (2013). Psychometric properties of online administered parental strengths and difficulties questionnaire (SDQ), and normative data based on combined online and paper-and-pencil administration. *Child Adolescent Psychiatry Ment. Health* 7:40. doi: 10.1186/1753-2000-7-40

Bos, K. J., Fox, N., Zeanah, C. H., and Nelson Iii, C. A. (2009). Effects of early psychosocial deprivation on the development of memory and executive function. *Front. Behav. Neurosc.* 3:16. doi: 10.3389/neuro.08.016.2009

Brännström, L., Forsman, H., Vinnerljung, B., and Almquist, Y. B. (2017). The truly disadvantaged? Midlife outcome dynamics of individuals with experiences of out-of-home care. *Child Abuse Neglect* 67, 408–418. doi: 10.1016/j.chiabu.2016.11.009

Cameron, C., Jackson, S., Hauari, H., and Hollingworth, K. (2012). Continuing educational participation among children in care in five countries: some issues of social class. *J. Educ. Policy* 27, 387–399. doi: 10.1080/02680939.2011.644811

Canivez, G. L., Watkins, M. W., and Dombrowski, S. C. (2017). Structural validity of the Wechsler Intelligence Scale for Children-Fifth Edition: confirmatory factor analyses with the 16 primary and secondary subtests. *Psychol. Assess.* 29, 458–472. doi: 10.1037/pas0000358

Cowan, R., Hurry, J., and Midouhas, E. (2018). The relationship between learning mathematics and general cognitive ability in primary school. *Br. J. Dev. Psychol.* 36, 277–284. doi: 10.1111/bjdp.12200

Dee, T. S. (2004). Are there civic returns to education? *J. Public Econ.* 88, 1697–1720. doi: 10.1016/j.jpubeco.2003.11.002

Durbeej, N., and Hellner, C. (2017). Improving school performance among Swedish foster children: a quasi experimental study exploring outcomes of the Skolfam model. *Child. Youth Serv. Rev.* 82, 466–476. doi: 10.1016/j.childyouth.2017.10.014

Elwér, Å, Fridolfsson, I., Samuelsson, S., and Wiklund, C. (2013). *LäSt - Test i läsförståelse, läsning och stavning*. Stockholm: Hogrefe Psykologiförlaget AB.

Engström, A., and Magne, O. (2003). *Medelsta-Matematik Hur väl behärskar grundskolans elever lärostoffet enligt Lgr 69, Lgr 80 och Lpo 94?*. Örebro: Pedagogiska institutionen.

Ferrer, E., McArdle, J. J., Shaywitz, B. A., Holahan, J. M., Marchione, K., and Shaywitz, S. E. (2007). Longitudinal models of developmental dynamics between reading and cognition from childhood to adolescence. *Dev. Psychol.* 43, 1460–1473. doi: 10.1037/0012-1649.43.6.1460

Forsman, H., Brännström, L., Vinnerljung, B., and Hjern, A. (2016). Does poor school performance cause later psychosocial problems among children in foster care? Evidence from national longitudinal registry data. *Child Abuse Negl.* 57, 61–71. doi: 10.1016/j.chiabu.2016.06.006

Forsman, H., and Vinnerljung, B. (2012). Interventions aiming to improve school achievements of children in out-of-home care: a scoping review. *Child. Youth Serv. Rev.* 34, 1084–1091. doi: 10.1016/j.childyouth.2012.01.037

Franzén, E., Vinnerljung, B., and Hjern, A. (2008). The epidemiology of out-of-home care for children and youth: a national cohort study. *Br. J. Soc. Work* 38, 1043–1059. doi: 10.1093/bjsw/bcl380

Goodman, R. (1997). The strengths and difficulties questionnaire: a research note. *J. Child Psychol. Psychiatry* 38, 581–586. doi: 10.1111/j.1469-7610.1997.tb01545.x

Griffiths, R. (2012). The Letterbox Club: an account of a postal club to raise the achievement of children aged 7 to 13 in foster care. *Child. Youth Serv. Rev.* 34, 1101–1106. doi: 10.1016/j.childyouth.2012.01.039

Harper, J., and Schmidt, F. (2012). Preliminary effects of a group-based tutoring program for children in long-term foster care. *Child. Youth Serv. Rev.* 34, 1176–1182. doi: 10.1016/j.childyouth.2012.01.040

Harrison, P., and Oakland, T. (2008). *Adaptive Behavior Assessment System - Second Edition [Swedish translation]*. San Antonio, TX: Harcourt Assessment, Inc.

Hattie, J. A. C. (2008). *Visible Learning: A Synthesis of Over 800 Meta-Analyses Relating to Achievement*. Abingdon: Routledge.

Hickey, A. J., and Flynn, R. J. (2019). Effects of the TutorBright tutoring programme on the reading and mathematics skills of children in foster care: a randomised controlled trial. *Oxford Rev. Educ.* 45, 519–537. doi: 10.1080/03054985.2019.1607724

Horwitz, A. V., Widom, C. S., McLaughlin, J., and White, H. R. (2001). The impact of childhood abuse and neglect on adult mental health: a prospective study. *J. Health Soc. Behav.* 42, 184–201.

Jackson, S., and Cameron, C. (2012). Leaving care: looking ahead and aiming higher. *Child. Youth Serv. Rev.* 34, 1107–1114. doi: 10.1016/j.childyouth.2012.01.041

Jacobson, C. (2001). *Läskedjor Manual*. Stockholm: Hogrefe Psykologiförlaget AB.

Jacobson, C. (2014). *LäsKedjor-2. För skolår 1 – år 1 i gymnasiet*. Stockholm: Hogrefe Psykologiförlaget AB.

Järpsten, B., and Taube, K. (2002). *DLS Handledning för klasserna 4-6; DLS handledning för klasserna 2-3; DLS handledning för klasserna 4-6; DLS handledning för skolår 7-9 och år 1 i gymnasiet*. Stockholm: Hogrefe Psykologiförlaget AB.

Kaufman, A. S., Flanagan, D. P., Alfonso, V. C., and Mascolo, J. T. (2016). Test review: wechsler intelligence scale for children, Fourth Edition (WISC-IV). *J. Psychoeduc. Assess.* 24, 278–295. doi: 10.1177/0734282906288389

Kobulsky, J. M. (2019). The prevalence of substance use in child welfare and general population eighth graders in the United States. *Subst. Misuse* 54, 1618–1626. doi: 10.1080/10826084.2019.1594907

Lewis, E. E., Dozier, M., Ackerman, J., and Sepulveda-Kozakowski, S. (2007). The effect of placement instability on adopted children's inhibitory control abilities and oppositional behavior. *Dev. Psychol.* 43, 1415–1427. doi: 10.1037/0012-1649.43.6.1415

Liabo, K., Gray, K., and Mulcahy, D. (2013). A systematic review of interventions to support looked-after children in school. *Child Fam. Soc. Work* 18, 341–353. doi: 10.1111/j.1365-2206.2012.00850.x

Männistö, I. I., and Pirttimaa, R. A. (2018). A review of interventions to support the educational attainments of children and adolescents in foster care. *Adopt. Foster.* 42, 266–281. doi: 10.1177/0308575918791627

McLaughlin, K. A., Sheridan, M. A., Tibu, F., Fox, N. A., Zeanah, C. H., and Nelson, C. A. (2015). Causal effects of the early caregiving environment on development of stress response systems in children. *Proc. Natl. Acad. Sci. U.S.A.* 112, 5637–5642. doi: 10.1073/pnas.1423363112

Meltzer, H., Gatward, R., Goodman, R., and Ford, T. (2003). Mental health of children and adolescents in Great Britain. *Int. Rev. Psychiatry* 15, 185–187. doi: 10.1080/0954026021000046155

Mezey, G., Robinson, F., Campbell, R., Gillard, S., Macdonald, G., Meyer, D., et al. (2015). Challenges to undertaking randomised trials with looked after children in social care settings. *Trials* 16:206. doi: 10.1186/s13063-015-0708-z

Oakland, T. (2011). "Adaptive behavior assessment system – Second Edition," in *Encyclopedia of Clinical Neuropsychology*, eds J. S. Kreutzer, J. DeLuca, and B. Caplan, (New York, NY: Springer New York), 37–39. doi: 10.1007/978-0-387-79948-3_1506

Pears, K. C., Kim, H. K., Buchanan, R., and Fisher, P. A. (2015). Adverse consequences of school mobility for children in foster care: a prospective longitudinal study. *Child Dev.* 86, 1210–1226. doi: 10.1111/cdev.12374

Pechtel, P., and Pizzagalli, D. A. (2011). Effects of early life stress on cognitive and affective function: an integrated review of human literature. *Psychopharmacology* 214, 55–70. doi: 10.1007/s00213-010-2009-2002

Ritchie, S. J., Bates, T. C., and Plomin, R. (2015). Does learning to read improve intelligence? A longitudinal multivariate analysis in identical twins from age 7 to 16. *Child. Dev.* 86, 23–36. doi: 10.1111/cdev.12272

Romano, E., Babchishin, L., Marquis, R., and Fréchette, S. (2015). Childhood maltreatment and educational outcomes. *Trauma Violence Abuse* 16, 418–437. doi: 10.1177/1524838014537908

Scherr, T. G. (2007). Educational experiences of children in foster care:meta-analyses of special education, retention and discipline rates. *Sch. Psychol. Int.* 28, 419–436. doi: 10.1177/0143034307084133

Simkiss, D. E., Stallard, N., and Thorogood, M. (2013). A systematic literature review of the risk factors associated with children entering public care. *Child Care Health Dev.* 39, 628–642. doi: 10.1111/cch.12010

Teyhan, A., Wijedasa, D., and MacLeod, J. (2018). Adult psychosocial outcomes of men and women who were looked-after or adopted as children: prospective observational study. *BMJ Open* 8:e019095. doi: 10.1136/bmjopen-2017-019095

The Psychological Corporation, (2003). *WISC-IV Technical and Interpretive Manual*. San Antonio, TX: The Psychological Corporation.

Tideman, E., Vinnerljung, B., Hintze, K., and Aldenius Isaksson, A. (2011). Improving foster children's school achievements: promising results from a swedish intensive study. *Adoption Fost.* 35, 44–56. doi: 10.1177/030857591103500106

Tordön, R., Bladh, M., Svedin, C. G., and Sydsjö, G. (2020). Challenging intellectual, behavioral and educational prerequisites for interventions aimed at school aged children in foster care. A compilation of Swedish test results. *Child. Youth Serv. Rev.* 108:104598. doi: 10.1016/j.childyouth.2019.104598

Tordön, R., Svedin, C. G., Fredlund, C., Jonsson, L., Priebe, G., and Sydsjö, G. (2019). Background, experience of abuse, and mental health among adolescents in out-of-home care: a cross-sectional study of a Swedish high school national sample. *Nord. J. Psychiatry* 73, 16–23. doi: 10.1080/08039488.2018.1527397

Tordön, R., Vinnerljung, B., and Axelsson, U. (2014). Improving foster children's school performance: a replication of the Helsingborg study. *Adopt. Fost.* 38, 37–48. doi: 10.1177/0308575913518003

van den Heuvel, M., Jansen, D. E. M. C., Stewart, R. E., Smits-Engelsman, B. C. M., Reijneveld, S. A., and Flapper, B. C. T. (2017). How reliable and valid is the teacher version of the Strengths and Difficulties Questionnaire in primary school children? *PLoS One* 12:e0176605. doi: 10.1371/journal.pone.0176605

Vinnerljung, B., Öman, M., and Gunnarson, T. (2005). Educational attainments of former child welfare clients - A SWEDISH national cohort study. *Int. J. Soc. Welfare* 14, 265–276. doi: 10.1111/j.1369-6866.2005.00369.x

Vinnerljung, B., Tideman, E., Sallnäs, M., and Forsman, H. (2014). Paired Reading for foster children: results from a Swedish replication of an English literacy intervention. *Adopt. Fost.* 38, 361–373. doi: 10.1177/0308575914553543

Wechsler, D. (1949). *Wechsler Intelligence Scale for Children*. San Antonio, TX: Psychological Corporation.

Wechsler, D. (1991). *Manual for the Wechsler Intelligence Scale for Children-Third Edition*. San Antonio, TX: Psychological Corporation.

Wechsler, D. (2003). *Wechsler Intelligence Scale for Children-Fourth Edition*. San Antonia, TX: PsychCorp.

Williams, P. E., Weiss, L. G., and Rolfhus, E. L. (2003). *WISC-IV Technical Report #2 Psychometric Properties*. San Antonia, TX: Pearson.

Zetlin, A., Weinberg, L., and Kimm, C. (2004). Improving education outcomes for children in foster care: intervention by an education liaison. *J. Educ. Stud. Placed Risk* 9, 421–429. doi: 10.1207/s15327671espr0904_5

Conflict of Interest: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

frontiers in Education

ORIGINAL RESEARCH
published: 07 July 2020
doi: 10.3389/feduc.2020.00095

An Intervention Programme to Facilitate the Preschool Transition in Mexico

*Angel Urbina-Garcia**

School of Education and Social Sciences, University of Hull, Hull, United Kingdom

Over the last two decades there has been a growing interest in promoting a smooth transition to the first grade of primary school, given the potential long-term change this can have in preschool children at an academic and personal level. Research shows that psycho-educational interventions help improve children's academic and personal skills, lessening the effects of this challenging period. The effectiveness of transition-related interventions has been mainly focused on developed economies, such as Australia, the US, the UK, Italy, Hong Kong, etc. However, there is limited evidence regarding how this type of intervention could support stakeholders in developing economies, such as Latin America. The Latin American region displays some of the lowest rates of academic performance and highest rates of social inequality in the world, making this region a priority in the international research agenda. This study sought to explore the efficacy of an intervention programme to facilitate this transition in Mexico City. Findings provide evidence of the positive impact of the preschool transition-intervention programme on children's cognitive, social and fine motor skills, as well as in the frequency with which preschool teachers (PT) and the teaching assistants (TA) use transition practices that promote literacy in preparation for the first grade of primary school. Parents reported that the quality and closeness of the primary school were the main factors to consider when choosing the primary school that their child will attend. Parents reported that promoting academic skills in their child is essential to prepare them for this transition. Implications for policy and practice are discussed.

Keywords: preschool transition, intervention programme, primary school transition, Mexican children, teachers' transition practices

OPEN ACCESS

Edited by:
Edgar Galindo,
University of Evora, Portugal

Reviewed by:
Óscar Conceição De Sousa,
Universidade Lusófona, Portugal
Gemma Filella,
Universitat de Lleida, Spain

***Correspondence:**
Angel Urbina-Garcia
m.urbina-garcia@hull.ac.uk

Specialty section:
This article was submitted to Educational Psychology, a section of the journal Frontiers in Education

Received: *10 February 2020*
Accepted: *26 May 2020*
Published: *07 July 2020*

Citation:
Urbina-Garcia A (2020) An Intervention Programme to Facilitate the Preschool Transition in Mexico. Front. Educ. 5:95. doi: 10.3389/feduc.2020.00095

INTRODUCTION

Research on the preschool transition to first grade has received a great deal of attention in the last two decades which has prompted international researchers to explore a number of variables involved in this challenging change in children starting primary school (Kagan and Tarrant, 2010; Haciibrahimoglu and Kargin, 2017). Going from preschool to first grade poses new challenges to children, which they have to face, including a new environment, relationships, teachers, and new rules—all of which have been found to have an important impact on their attitudes and roles (Fabian and Dunlop, 2005; Perry et al., 2014; Salmi and Kumpulainen, 2019; Urbina-Garcia, 2019). However, whilst there have been some efforts in exploring the effectiveness of transition-related interventions (mainly in developed economies such as Australia, the US, the UK, Italy,

Hong Kong), it is still unknown how this type of intervention could support teachers, teaching assistants, children and parents in developing economies, such as Latin America, that have specific cultural and educational policy-related particularities. Moreover, the positive outcomes of intervention programmes have been widely documented (Schulting et al., 2005; Morrison et al., 2010; Ahtola et al., 2011), showing that interventions are positively associated with a better academic performance in first grade children. Nevertheless, such research is influenced by the socio-cultural context of developed economies, and thus, our understanding of the impact of these interventions in developing economies is limited. The international literature on interventions has provided a wealth of evidence for the positive impact on children, teachers and parents during this transition, which has ultimately helped children make the move successfully. For instance, Lee and Gogh (2012) undertook an action-research in Singapore with 14 children aged 5 and 6. Findings revealed a positive change in children's attitudes about first grade, as well as a decrease in parents' levels of anxiety triggered by this period of change. However, the limited number of children included in this study poses challenges in terms of data-generalization. Berlin et al. (2011) carried out a 4-week summer programme in the US to facilitate the transition to kindergarten based on a randomized control trial. Results revealed a better development of social skills for girls but, surprisingly, not for boys. Kindergarten teachers reported that this programme did not appear to have a significant impact on children's efficacy regarding academic demands. Nevertheless, authors reported a significant effect on the ability to adapt to the school routines of children participating in this programme. However, this study included only children at risk of academic failure, which does not allow for generalization of the data. Moreover, in the study by Berlin et al. (2011), the authors did not include a base-line assessment of the children's cognitive and social domains, which means the impact of such programmes in these areas cannot be identified.

In Hong Kong, Li et al. (2013) used a randomized control trial design including 143 families where a play-integrated preparatory programme was implemented. Results from the control and experimental groups indicated decreased levels of worry and increased levels of happiness, 6 weeks and 3 months after the intervention. Nevertheless, while the authors claimed that in order for children to have a smooth transition, children need to develop self-control skills so they can cope with stressful and anxious situations when transitioning, such skills were not assessed in the study. Furthermore, the authors claimed that the programme served this purpose, but no assessment of self-awareness, self-control or self-efficacy was carried out.

Hart (2012) implemented two different programmes to help children behaviorally at-risk in transitioning to kindergarten in US preschool centers and evaluated their efficacy. A focus (low intervention) and experimental group (high intervention) were created to implement a 4-week summer programme to support this transition. Results indicated fewer behavioral and academic problems for children in the high intervention programme than in the low intervention programme. The high intervention group showed better behavioral adaptation during the first year of kindergarten. Parents showed a major involvement in the high intervention group—arguably having a positive effect in helping children during this period. In line with this, the role of significant adults for children (i.e., parents, teachers and caregivers) has been highlighted in this transition. Giallo et al. (2010) reported that the implementation of transition programmes (i.e., aimed at providing transition practices, establishing home-school links and fostering children's development) resulted in a higher rate of parents' self-efficacy perception, which in turn, led to a greater involvement in their child's education. The authors also concluded that when parents are provided with information regarding this transition, they become more interested and tend to establish a more frequent and active home-school interaction. Parents' involvement in transition activities organized by schools has been associated with the acquisition of useful transition-related parental practices.

These intervention programmes included several activities worth noting. Lee and Gogh (2012) used an action-research design to promote cognitive and affective skills in children in Singapore. Activities included teaching children how to work with money, creating play opportunities to buy and sell using money and allowing children to buy their food in preparation to a visit to a primary school. The programme was assessed by using audio-recordings, observations and photographs of children engaged in the activities implemented. A US-based randomized test trial was used by Berlin et al. (2011) aimed at promoting children's social competence, pre-literacy and pre-numeracy skills, school routines, and parental involvement. The experimental group received the STARS programme while the control group did not receive the intervention, however, there is no description of the content of the STARS programme. Activities included weekly parent group meetings, a 4-days teacher training on family involvement and home visits. The programme was assessed by collecting data from parents, teachers and children with Likert type scales.

Another randomized control trial was conducted by Li et al. (2013) in Hong Kong aimed at promoting children's happiness and enhancing parents' psychological adjustment. The authors followed a 4-weeks play-integrated programme with an experimental and a control group. The intervention programme included activities to help the children become familiar with primary school life such as organizing their school bags and following school rules and regulations. Other activities focused on promoting children's problem-solving skills, emotional expression, interpersonal communication and coping with stress. Data from children and parents were collected with Likert type scales to assess the programme. In the US, Hart (2012) implemented a 4-weeks summer intervention programme with two different groups of at-risk pre-schoolers. Group 1 (high intervention) aimed at promoting children's behavioral, social-emotional, and academic functioning. This group received weekly parent transitional workshops (before, during and after the start of the kindergarten year) and monthly school consultations. Group 2 (low intervention) received parent transitional workshops only, without any intervention on children and no school consultations. Pedagogical activities for this study were adapted from various documents including the Florida State standards for maths, reading and science and

the Florida Center for Reading Research. The programme was assessed in the fall and spring of the kindergarten year via teachers' and parents' self-report measures. Likert type scales were used to measure children's behavioral, social-emotional, and academic functioning.

A randomized control trial was conducted in Australia by Giallo et al. (2010), aimed at implementing an intervention programme to improve parent knowledge and confidence about the transition process, improve parent involvement in their child's education and improve child adjustment to starting school. The programme consisted of four sessions (1.5 to 2 h in duration each) to address practical and development issues relevant to children/parents (for a detailed description of the programme see Giallo et al., 2010). Classroom teachers received a 2 h professional training session prior to the intervention. The intervention programme was assessed by collecting data from teachers and parents with the use of Likert type scales. Taken together, these programmes show a variety of activities which have been implemented to support children and parents ahead of the transition to school. However and although few programmes have been implemented for several weeks (i.e., four), it is important to recognize that none of these programs have been designed to intervene for longer periods of time (i.e., more than 1 month) to maximize the impact of the intervention programme. Similarly, these programmes have emphasized the use of quantitative measures to assess parents whereby their lived experiences during the implementation of these programmes have not been recognized.

Some studies have suggested that parents can become aware of the importance of the transition process after participating in transition programmes (Schulting et al., 2005; Carida, 2011), which leads to a greater participation in school-related activities with their children. Interestingly, in some studies, parents have shown a greater interest in this process, and specifically with regard to their child's education (Dockett and Perry, 2007), whilst in others, this interest and awareness have been related to parents' quest for additional information about how best to support their child (Wildenger and McIntyre, 2011). Taken together, these findings provide compelling evidence about the effectiveness of interventions during this period of change, which provide and promote knowledge, awareness and practices for teachers and parents. These studies show how designing and implementing an intervention can lead to better support children, teachers and parents to successfully transit through this change and build a sense of community needed for this change. Notably, research shows that this change can be experienced in a smoother way if children, parents, teachers are included in intervention programmes. The constant exchange of information and constant interactions among adults in this process is a key element in this transition and is known as *bridging* (Malsch et al., 2011), which is one of the principles of the Ecological and Dynamic Model of Transitions proposed by Rimm-Kauffman et al. (2000) which is the model that underpins the present study. Following this theoretical model, the constant interaction and exchange of information among contexts was of utmost importance in this study to ensure developmentally and academically appropriate practices within the intervention to ease the transition.

Little is known about the way in which the context of developing economies shapes this transition to primary school, and how intervention programmes must be adapted to cultural practices, values, educational policies and curriculum. The novelty of this study is that this intervention considered various levels—namely: school, home, home-school, and school-school links (framed by the particularities of the culture of a developing economy including but not limited to high level of social inequality, low salaries for parents, limited resources for public schools, high levels of crime and violence in the city)—and included children, parents, and teachers, whilst previous research has focused only on teachers or parents separately in either preschool and/or primary school. Based on research conducted in developed economies, we know that children can greatly benefit from this type of intervention. Similarly, research on parents and teachers shows that adults can play a key role supporting pre-schoolers during this period of change. Research focused on interventions has provided a wealth of evidence regarding essential elements that need to be considered when designing and implementing an educational intervention. Worryingly, most of the research in this respect and its positive findings have been framed by the socio-cultural context of developed economies, whilst, to our knowledge, there is no research on preschool transition in developing economies, such as Latin America. This study aims to fill these gaps by designing and implementing an intervention programme to facilitate the transition to first grade with Latino families, with a view to exploring its efficacy within the Mexican cultural context. A number of transition activities reported in the international literature were carefully analyzed and adapted for the present study, considering the Mexican context.

METHODS

Design

This study followed a quasi-experimental design with a pre-test and post-test for preschool children and teachers. This study was carried out during one academic year in two preschool classrooms (one control and one experimental) from two different public schools -to avoid contaminating data- belonging to a government institution that provides social services to the children of government workers in Mexico City.

Participants

Each preschool classroom included 20 children ($N = 40$), with their respective classroom teacher and teaching assistant ($N = 4$). Children were in the final year of their preschool education ranging from 5 to 6 years old ($M = 5.6$). The two preschool teachers (PT) reported holding an undergraduate diploma in preschool education whilst both teaching assistants (TA) had vocational training. The researcher fully disclosed the main aims of the study to headteachers to obtain permission to recruit families of the preschool children involved. Forty families were contacted to explain the main aim of this study and accepted to participate in this project by signing a consent form. Most of

parents were female (85%) reporting that their highest academic degree was undergraduate degree (80%) and vocational-training (20%). Parents' age ranged from 30 to 60 years old ($M = 44.67$).

Groups

We included two intact groups that had already been formed by the administrator of the schools at the beginning of the academic year, following the normal protocols of the Ministry of Education. Two public schools were recruited in order to have one control group in one school, and one experimental group in another. A Mann Whitney U test revealed no significant differences in either the scores of children's skills (i.e., cognitive, social, and fine motor) or teachers' early literacy practices at the beginning of the intervention.

Measures

Children's skills were assessed by using the Assessment and Evaluation Programming System for Infants and Children (AEPS; Bricker et al., 2002) which is a criterion-referenced test to measure children's skills in six different key developmental domains. However, only three main domains were included in this study due to their relevance in this transition process (Margetts and Kienig, 2013)—namely: cognitive, social, and fine motor skills. The AEPS instrument has reported to have sound psychometric properties, showing high internal consistency reflecting a strong relationship among domain scores and items, in addition to showing satisfactory inter-rater reliability (Noh, 2005). Additionally, the reliability and validity of the instrument have been furthered confirmed when used in other studies (Cadigan and Missall, 2007; Gao and Grisham-Brown, 2011; Lemire et al., 2014).

Children's skills were measured considering a 3-point scale: "0 = Does not show the skill"; "1 = Inconsistent use of the skill" and "2 = Consistent use of the skill." Cognitive skills included "Identification of numbers/figures," social skills included "Showing affect to others," and fine motor skills included "Use of scissors by following geometrical shapes."

PT and TA practices that promote literacy in preschool classrooms, which have been reported to aid in this transition (Berlin et al., 2011), were assessed with a self-report questionnaire adapted from the "Inventory of Early Literacy Practices" (Neuman et al., 2000) including 40 items. The adapted version of this questionnaire was assessed by one emeritus professor and two professors of educational psychology and their feedback was considered to produce a final version. Preschool teachers and TAs rated the extent to which they use these practices in their everyday routine to promote early literacy skills in pre-schoolers based on a 3-point rating scale: "0 = Does not use the practice"; "1 = Inconsistent use of the practice" and "2 = Consistent use of the practice." Both instruments were piloted prior to the final administration by using a different group of participants.

Parents' views about the way in which they thought they could prepare their child for this transition were gathered with three open-ended questions developed by the author for the purpose of this study: *(a) What factors will you consider for choosing the primary school to which your child will attend?; (b) In which way do you support your child in this transition?; and (c) What have you talked about with your child regarding the primary school?* Parents' satisfaction with the intervention was rated with a single-item on a 5-point scale (*1 = Very Dissatisfied* to *5 = Very Satisfied*). These questions were reviewed and assessed by the same external professors and feedback was considered.

Procedure

Educational authorities granted permission and the researcher contacted headteachers and parents from both schools to fully explain the main aims of the study. Ethical approval was not required for the governmental institution providing the educational service. However, personal consent forms were obtained from parents and teachers/TAs. Children's consent was also obtained by the researcher. At the beginning of the academic year, a pre-test was carried out to assess children's skills and PT and TAs' practices, by using participant observation and direct testing (Taylor et al., 2015), the researcher assessed children's skills in both classrooms. Preschool teachers and TAs each completed a 40-item, self-report questionnaire, separately, in a room specifically designated by headteachers to avoid data-contamination. The post-test was carried out at the end of the academic year following the same procedure. At this point, parents' views and overall satisfaction with the programme were gathered. The intervention programme was implemented in the experimental group, whilst the control group received the usual pedagogical activities planned by the preschool teacher.

Intervention

This evidence-informed transition programme included transition activities that have proven useful to enhance preschoolers' transition in previous studies (Claes, 2010; Peters, 2010; Hedegaard and Fleer, 2013), adapting them to the cultural particularities of the city and considering the internal educational policies of the preschool center. A group work was created for the researchers to work collaboratively (i.e., 3 days per week for 4 weeks) with PT and TAs, with the aim of choosing and defining the pedagogical activities (see **Table 1**) to be integrated in the program. The ample working experience of the PT and TAs and their knowledge of local policies, curriculum as well as pupils and parents, was paramount to define the activities to be implemented. Such experience and knowledge were further complemented by a synthesis of relevant literature and previous intervention programs provided by the researchers. The final version of the intervention programme was sent to a panel of three experts (i.e., professors of educational psychology and child development) in preschool and primary education. The final version of the program considered the feedback provided by the experts. The implementation of this programme was proactive and intensive, working alongside the PT and TAs in the classroom for 6 consecutive months with 3 sessions per week. All activities were mainly led by the PT and TAs, with minor interventions of the researcher. This intervention (see **Appendix A**) comprised of a range of activities to help: (a) develop cognitive skills through activities that promote early literacy; (b) promote children's social competence; (c) develop fine motor skills; (d) promote home-school links (e.g., involving

TABLE 1 | List of pedagogical activities implemented in classroom to aid the development of children's cognitive, social, and fine motor skills.

The Power and Pleasure of Literacy
Teacher encourages children to choose and "read" books (i.e., wordless and books with words) during different stages in the daily routine (e.g., morning circle time, reading corner, reading to parents, end of the day circle time)
Teacher encourages children to choose their favorite books and to actively participate in reading stories within the "circle time"
Teacher encourages children to read books as a group. Peers complement the story initiated by one pre-schooler. The book is passed on to other children to complete the story
Teacher creates opportunities for children to engage constantly in practicing their writing skills (e.g., a labels with child's name for their school bag, writing his/her name in drawings, creating labels for the classroom such as "door," "window," "table," "cloakroom" hand sanitizer" etc.)
Teacher encourages children to try some letters and write their names on all the artwork children create
Teacher helped children to use playdough to make letters of the alphabet and numbers
School Literacy Environment
Teacher supports children's fine motor and writing skills by allowing them to create legends, signs, labels and other printed materials around the classroom (e.g., a label with child's name for school bag, writing his/her name in drawings, creating labels for the classroom such as "door," "window," "table," "cloakroom" hand sanitizer" etc.)
Teacher and children engage in a project to create and enrich the "reading corner" to trigger children's motivation and interests in reading materials on their own and with their peers
Based on a project-based activity, teacher and children create the "Library corner" with labels created by children and books selected by children
Language Development
Teacher made use of boardgames and groupwork for children to create and practice rimes with different words
Teacher encourages children to turn the pages and talk about what they see
Teacher guides children's eyes from left to right across the page as they read, and point out certain words or phrases
Sharing Ideas and Opinions
Teacher organises a circle time for children to share their thoughts after each pedagogical activity. Children are encouraged to write their ideas on the whiteboard
Teacher encourages children to take the lead with reading—for example, 'Where do we start from?'
Teacher encourages children to talk about their drawings and help children write down the words they use to describe them
Knowledge of Printing Material
Teacher guides children in knowing that printed words and letters are read from left to right and top to bottom
Teacher explains children the characteristics of a book, such as the author cover and title. Teacher invites children to recognize and say out loud the sounds of letters
Teacher promotes in children the recognition of capital letters, lowercase letters, punctuation and other characteristics of the printed letter
Different Forms of Text
Teacher encourages children to act out role(s) of their favorite storybook
Teacher guides children to recognize and play with lift-the-flap books or touch-and-feel books
Phonological Awareness
Teacher creates activities for children to make use of rimes in small groups and during circle time
Teacher guides and offers opportunities for children to practice the sound of letters and words they already know. Teacher also introduces new sounds and letters
Teacher organises a project where children create a storyboard allowing children to "write" their own stories (e.g., what happened at home the previous day, what they will do for holidays)
Following a project-based activity, children create a board where children write words with similar sound (i.e., using words children are familiar with and teacher introduces new words)
Recognition of Words and Letters
Teacher promotes the identification of letters of the alphabet. Children take turns to point to the letters they are familiar with. Children point to the letters from their name
Teacher creates and activity for children to make use of cardboard-made alphabet letters to "write" their names and from new words
Teacher makes sure she has a variety of material (e.g., crayons, watercolors, finger paint, pencils, water-based crayons, paper, cardboard, post it's) available for children to use freely
Teacher encourages children to work in groups to create a "shopping list"

families in this transition intervention); and e) promote school-school links (e.g., visits to the primary school). The intervention programme included:

Collaborative Work in Classroom

The researcher closely worked with the PT and TAs in a collaborative way, whereby emphasis was placed on planning the pedagogical activities (see **Appendix A**) that promote the cognitive, social and fine motor skills necessary for the transition (Brownell et al., 1997). The inclusion of these pedagogical activities was based on the preschool and first grade curriculum, as well as what the literature reported as effective transition activities.

Modeling and Teaching Key Developmental Aspects During This Transition

The researcher contributed to PT and TAs knowledge of developmental aspects and children's skills during the activities that were included in the daily routine. PR and TAs did not receive any specific training *per se* considering a traditional approach. Rather than following a traditional teaching approach where the researchers are the "experts" and teachers are "passive learners," we followed the principles of learning through modeling outlined by Loughran (2002) and principles of the scaffolding approach suggested by García and Ruiz-Higueras (2011). The researcher modeled the implementation of pedagogical activities—unknown to the teacher—that were included in the weekly-pedagogical plan of the PT. A 2 h group

discussion including the researchers, PT and TAs was held weekly -at the end of each week for the duration of the intervention- to feed back on the advantages and difficulties encountered during the week. These discussions focused on helping PT and TAs reflect upon their own practice as well as discussing topics related to stages of child development, tailoring pedagogical activities and how different activities could be used to promote the development of children's cognitive, social and fine motor skills. These sessions helped improve the intervention for the following week. This approach was adopted given that it has been highlighted as essential in order to help teachers develop new skills and acquire new knowledge regarding child development (Loughran, 2002).

Improvement of Classroom-Areas

Working collaboratively, the researcher, the preschool teacher and TA re-designed the distribution of pedagogical material included in different areas in which the preschool classroom was divided as per curriculum guidelines. New pedagogical material was included in some areas, whilst there was also material that did not correspond to the aim of a given area, and thus was reallocated. Changes were carried out in areas such as the child's library, pretend play, free-play, science, Lego blocks and literacy. In all activities regarding the improvement of classroom-areas as well as the pedagogical activities proposed by the PT and the TA, children were actively involved. A traditional approach was always avoided (i.e., the teacher is the expert and leads all activities with minimal involvement of children). The inclusion of children as leaders in each activity and project (e.g., preparing lunch for school visits, Teddy's diary, labeling classroom furniture) was of utmost importance during this intervention. This aimed at promoting peer-to-peer and teacher-child interaction focused on supporting children develop their social skills.

School-Home Links

The researcher, preschool teacher and TA designed a series of activities whereby parents attended the preschool classroom three times a week in order to interact with pre-schoolers. Activities included storytelling by parents and children, explaining to children different types of jobs parents have and talking about what parents' primary school was like.

Literacy-Related Activities Book

An activities-book was developed by the researcher and the preschool teacher containing 20 different attractive activities focused on the development of early literacy skills appropriate for pre-schoolers. There were given to parents for them to complete during the Easter holidays, together with their child. Emphasis was placed on the need to carry out these activities alongside their child.

Teddy's Diary

A project-based activity led by the PT and TAs resulted in the creation of a diary, which was taken home every day by a different child. The name "Teddy" was decided by preschoolers by participating in a poll. All the paraphernalia needed for this activity (i.e., tickets, names, posters, labels, and so forth) were created by preschoolers in an attempt to provide opportunities to practice and thus enhance their skills. In this diary, children recorded the activities he/she had done during his/her day after school. Parents were also asked to help their child "write" and produce drawings of the activities he/she had decided to include. Additionally, parents were also asked to help their child by writing the activities their child decided to tell his/her peers. The following day, there was a time allocated for reading the diary, which was facilitated by the main teacher, where preschoolers exchanged ideas regarding the activities shared by their peers.

School-School Links (Visits to Primary School)

Preschoolers, alongside the PT and TAs, visited the primary school at three different times throughout the intervention, ranging from a 1 to 2 h-visit, depending on the activities planned.

A) First visit. First grade teachers toured preschoolers around the premises of the primary school. Preschoolers were introduced to different first grade teachers by visiting their classrooms and meeting first grade students. Play-based activities were facilitated by one first grade teacher and carried out in the playground of the primary school.

B) Second visit. Preschoolers were taken on a tour around the premises of the primary school in addition to experiencing the "recess" with first graders. For this activity, the PT and the researcher planned and facilitated a project-based activity in the preschool classroom, prior to this visit, where the nutritionist was also involved to help preschoolers prepare their "lunch" for the visit.

C) Third visit. Preschoolers visited one first grade-classroom and carried out activities with the first grade teacher and first graders. First graders shared their chairs with preschoolers so they could be seated for the activities prepared by the teacher. The teacher facilitated an "ice-breaking" activity for preschoolers to feel welcomed, in addition to the central activity focused on the recognition of numbers, alphabet letters and the production of drawings. First graders also showed preschoolers the classroom materials, such as classroom rules, science experiments, books, maps, and so on. Preschoolers worked together with first graders who lent their coloring pencils, books, notebooks, and white sheets to preschoolers to carry out the activity. First graders gave preschoolers a "present" once the visit had finished, which had been prepared in advanced.

School-School Links (First Grade Teachers Visiting Preschool Classroom)

Three different first grade teachers visited the preschool classroom (i.e., experimental group) on three different occasions to share their experience with preschoolers transitioning to first grade. First grade teachers highlighted the main differences between the preschool and primary school. Preschoolers were encouraged to ask questions about the primary school, which were answered and clarified by first grade teachers. After every activity related to home-school and school-school bridging (Malsch et al., 2011), preschool teachers facilitated an activity whereby preschoolers were asked to draw what they "saw," "heard," and "lived" not only during the visits to the primary school, but also during the first grade teachers' visits. Preschoolers

shared their drawings with their peers and their parents in an "open-door" activity organized by the preschool teacher.

DATA ANALYSIS

Descriptive statistics were obtained from the children's and teachers' measures. A Wilcoxon signed rank two-tailed test was computed to determine differences between the paired ratings of children's and PT/TAs from pre/post-test. This non-parametric test was considered since it allows the identification of differences in a Likert-type scale measurement in pre-post designs, taking into account the magnitude and direction of differences (Haslam and McGarty, 2014). In order to obtain the magnitude and differences in scores obtained, all analyses were conducted at $p < 0.05$ significance level. A Mann-Whitney U-test was computed to compare the scores obtained in the pre-tests from the control and experimental groups for both, in order to establish a baseline before the intervention took place. A thematic analysis, as suggested by Braun and Clarke (2006), was carried out to analyze parents' answers.

RESULTS

Preschoolers' Skills

Descriptive Statistics

Descriptive statistics were obtained to show the means and standard deviations of the control and experimental groups (**Table 2**), which revealed that pre-test means scores in both groups were similar prior to the intervention. Both groups of children's scores were assessed with a Mann-Whitney U-test (**Table 3**) in terms of equivalence before the intervention, since this test has been described as appropriate for use with small samples (Curtis and Marascuilo, 2004). The sum of the ranks for each group was calculated and then compared with that of the other group. A significant p-value ($p < 0.05$) indicates a significant difference between the two groups. Experimental and control groups did not differ in cognitive ($M = 1.30$, $SD = 0.923$; $M = 1.05$, $SD = 0.999$), social ($M = 1.60$, $SD = 0.754$; $M = 1.45$, $SD = 0.826$), and motor skills ($M = 1.60$, $SD = 0.681$; $M = 1.55$, $SD = 0.759$), respectively ($p > 05$). Therefore, both groups were similar in these skills before the intervention, suggesting that participants shared a similar development of cognitive, social and motor skills.

To analyze the effect of the intervention in the experimental group, a non-parametric Wilcoxon rank sum test (Coolican, 2009) was computed in both groups to explore statistical differences in scores (**Table 4**). The statistically significant difference was at the $p < 0.05$ level in all domains in the experimental group, as shown in **Table 4**. As can be observed, the experimental group increased cognitive ($M = 1.75$, $SD = 0.444$), $W = 0.007$, $p < 0.05$, social ($M = 1.90$, $SD = 0.308$), $W = 0.034$, $p < 0.05$, and motor skills ($M = 1.85$, $SD = 0.366$), $W = 0.025$, $p < 0.05$. However, the control group did not improve these skills on the cognitive ($M = 1.20$, $SD = 0.951$), $W = 0.083$, $p = 0.05$, social ($M = 1.60$, $SD = 0.681$), $W = 0.083$, $p = 0.05$, and motor measures ($M = 1.55$, $SD = 0.759$), $W = 1.000$, $p = 0.05$. As anticipated, statistically significant differences in the experimental group were found between the pre-test and post-test, suggesting that the intervention program did have an effect in the development of children's skills.

Teachers and Teaching Assistants' Transition Practices

Preschool teachers and TAs were asked to rate the use of transition practices in preparation for the transition to first grade based on a 3-point Likert-type scale with 40-items. Descriptive statistics for teachers and TAs for both groups are shown in **Table 5**. Additionally, a non-parametric Wilcoxon rank sum test was computed in order to analyze the differences in the means scores after the period of intervention in both groups (**Table 6**). Results indicated statistically significant differences between the pre-test and post-test in the experimental group; Teacher ($M = 1.73$, $SD = 0.506$) $W = 0.000$, $p < 0.001$; teaching assistant ($M = 1.55$, $SD = 0.714$) $W = 0.000$, $p < 0.001$, but no in the control group; teacher ($M = 0.53$, $SD = 0.877$) $W = 1.000$, $p = 0.05$; teaching assistant ($M = 0.40$, $SD = 0.778$) $W = 0.157$, $p = 0.05$, respectively. These results suggest that the preschool teacher and the teaching assistant of the experimental group reported a more frequent use of transition practices that promote literacy-related skills in children, compared to the control group.

Parents' Perspectives on Open-Ended Questions

Parents' perspectives were gathered by using three open-ended questions and analyzed following a thematic analysis (Braun and Clarke, 2006), which lead to the identification of key themes. Participants' answers were read thoroughly at least three times by the researcher to gain a full understanding of the way in which codes would emerge. Once codes and themes were identified, two external experts in preschool education independently reviewed the codes and themes generated by the main researcher to reach an agreement and thus enhance the trustworthiness of the results.

TABLE 2 | Descriptive statistics of children skills for both groups.

	Control Group						Experimental Group					
	Pre-test			Post-test			Pre-test			Post-test		
	N	Mean	SD	N	Mean	SD	N	Mean	SD	N	Mean	SD
Cognitive Skills	20	1.05	0.999	20	1.20	0.951	20	1.30	0.923	20	1.75	0.444
Social Skills	20	1.45	0.826	20	1.60	0.681	20	1.60	0.754	20	1.90	0.308
Motor Skills	20	1.55	0.759	20	1.55	0.759	20	1.60	0.681	20	1.85	0.366

TABLE 3 | Mann-Whitney U Test Computed with Pre-post-tests from both Groups.

	Cognitive Skills Pre-test	Social Skills Pre-test	Motor Skills Pre-test	Cognitive Skills Post-test	Social Skills Post-test	Motor-Skills Post-test
Mann-Whitney U	174.000	180.500	197.000	142.500	191.000	165.500
Wilcoxon W	384.000	390.500	407.000	352.500	401.000	375.500
Z	−0.796	−0.654	−0.101	−1.839	−0.311	−1.281
Asymp. Sig. (2-tailed)	0.426	0.513	0.920	0.066	0.756	0.200
Exact Sig. [2*(1-tailed Sig.)]	0.495[b]	0.602[b]	0.947[b]	0.121[b]	0.820[b]	0.355[b]

[b]*Not corrected for ties.*

TABLE 4 | Comparison of Pre and Post-tests Means Scores in both Groups.

	Control Group			Experimental Group		
	Cognitive Skills	Social Skills	Motor Skills	Cognitive Skills	Social Skills	Motor Skills
Z	−1.732[b]	−1.732[b]	0.000[c]	−2.714[b]	−2.121[b]	−2.236[b]
Asymp. Sig. (2-tailed)	0.083	0.083	1.000	0.007*	0.034*	0.025*

[a]*Compared through the Wilcoxon signed ranks test.*
[b]*Based on negative ranks.*
[c]*The sum of negative ranks equals the sum of positive ranks.*
**Results of the Wilcoxon signed ranks test significant at the $p < 0.05$ level.*

TABLE 5 | Descriptive statistics for teachers and teaching assistants from both groups.

	Pre-test				Post-test			
	Teacher		Teaching Assistant		Teacher		Teaching Assistant	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Control Group	0.53	0.877	0.40	0.778	0.53	0.816	0.45	0.783
Experimental Group	0.40	0.810	0.43	0.712	1.73	0.506	1.55	0.714

A consensual agreement was reached for the final version of the five themes identified. Regarding the question related to the factors parents have considered in order to choose the primary school that their children will attend, two main themes emerged from participants' answers:

School Quality

Parents mainly considered the quality of the primary school in terms of academic achievement. This is to say, they reported having asked schools directly and/or relied on what acquaintances told them regarding whether a primary school was good or bad, considering the academic level. Parents highlighted "…I mainly focus on whether the school has good reputation or not. If my neighbors say that they do not have smart students, then I will not choose it…" whilst others emphasized the information given by their family members "…my brother in law had his kids in that school and they obtained high grades. I will enroll my kid in that school because it has a good academic level."

School Close to Workplace

Parents emphasized that how close a school was to their workplace was an important factor to consider when choosing a primary school. Some parents mentioned: "I have found a primary school right on the back of the building where I work and that will be the school where my daughter will attend to because we can then get home together and quick." Other parents pointed out that given that the city is very big, they cannot spend hours in a traffic jam to pick their children from primary school "I have heard about a good school close to my friend's house, however I am enrolling him in a school which is two blocks away from my workplace, otherwise it will take me 2 h to pick him up." "This city is crazy and you cannot spend one and a half hours in the traffic jam. There is a school close to my house which is not a very good one, but what can I do?"

As for the second question regarding the way in which they support their child for this transition, one key theme emerged from parents' answers.

Sending Children to a "Real" School to Learn How to Read and Write

Parents reported that they were concerned about their children's lack of academic skills during the preschool-academic year, which will be essential once they enter primary school. As a result, one of the main ways in which they supported their children was by sending them to a "real school" because they teach children how to read and write. "I have enrolled my child in a good school where they focus on teaching children how to read and write." Other parents also pointed out that they support their children

TABLE 6 | Comparison of Means Scores of Pre-test and Post-test in both Groups of Teachers.

	Control Group		Experimental Group	
	Preschool Teacher	**Teaching Assistant**	**Preschool Teacher**	**Teaching Assistant**
Z	0.000[b]	−1.414[c]	−5.097[c]	−4.930[c]
Asymp, Sig. (2-tailed)	1.000	0.157	0.000**	0.000**

[a] *Compared through the Wilcoxon signed ranks test.*
[b] *The sum of negative ranks equals the sum of positive ranks.*
[c] *Based on negative ranks.*
** *Results of the Wilcoxon signed ranks test significant at the $p < 0.01$ level.*

by teaching them how to read and write, "…at home, I spend 2 h with my child teaching her the letters and numbers. We have even started to write words and his name." Other parents thought that a good way to prepare their child was by sending him/her to language schools: "I am concerned about the primary school and therefore my child is learning English language in a private school so he can be prepared for the primary school." Parents also thought that the current preschool center was not good enough and therefore, they send their child to private schools: "Well you know…in this school they [children] just play and do not learn anything. In April, my child will attend to a private school instead of this one so he can learn how to read and write."

Finally, parents shared what they have been talking about with their child in order to prepare them for the primary school, focusing on two main themes:

New Rules and Obedience

Parents highlighted that the main issues they talked about when leaving preschool and entering primary school were the need to follow teachers' directions and obey the new rules: "I have told my boy that he will have to behave and do whatever his teacher will tell him. He cannot play anymore and must behave well." Another parent mentioned: "…you know, my child likes playing and talking to her peers, however, she will not be able to do that anymore. She must focus on the academic tasks the teacher requires her to do. She must be very obedient." Another parent highlighted the challenges that this change brings to her child: "My son is very mischievous and therefore he will struggle behaving in the new school. I am teaching him that he must follow the rules and obey his new teacher or he will have problems with me."

The Need to Do "Homework"

Parents reported that they were aware of the differences between preschool and primary school and thus focused on the need for their child to complete everyday homework: "I have told my child that in the primary school she will have to finish every task required by her teacher. At home, she will not play until she finishes her homework." Other parents highlighted that having "homework" from the primary school will also require them to spend additional time with their child: "In primary school my daughter will do lots of homework and I will have to spend more time helping her. I have told her that she must be fast to finish whatever she is asked to do." Finally, parents also thought that learning a new language will help their child in this transition: "…his English language homework is making him aware of the importance of doing homework. I tell my son that he will have to do both homework(s) [English language and Primary school] if he wants to play Xbox."

Parents' Satisfaction Survey

Twenty parents who participated in the preschool transition-intervention programme, completed the satisfaction survey at the end of the intervention. Mean scores were computed and revealed that, based on a 5-point scale, 95% (19) of parents felt very satisfied ($M = 4.95$ $SD = 0.22$) with the intervention programme.

DISCUSSION

Overall, findings provide evidence of the positive impact of the preschool transition-intervention programme on children's cognitive, social and fine motor skills, as well as in the frequency with which PTs and TAs use transition practices that promote literacy in preparation in the transition to first grade. Parents reported that the quality of the primary school and closeness of the school were the main factors to consider when choosing the primary school to which their child will attend. Parents reported that promoting academic skills in their child is essential to prepare them for this transition. Following rules and being obedient were the main topics on which parents focused when talking with their preschool child about the primary school, and they also reported being very satisfied with the implementation of the programme. This intervention was research-informed, being the first of its kind to be implemented in a Latin American context, since most of the preschool transition research has been carried out in developed economies such as Australia, Iceland, the UK, Italy, Greece and the US.

Results revealed that, after the intervention programme, there were statistically significant differences in children's skills in the experimental group, suggesting that children benefited from the various activities implemented throughout the intervention. However, caution must be taken when interpreting the results, since there could be a number of confounding variables influencing these results. Findings from this study confirm the usefulness of a range of activities which can be implemented in preschool classrooms to help pre-schoolers develop cognitive, social and fine-motor skills grounded in collaborative work between preschool teachers, teaching assistants and parents, which is indeed very much in line with some of the principles

of the Ecological and Dynamic Model of Transition (Rimm-Kauffman et al., 2000). The results of this study seem to add evidence to the usefulness of one of the principles of the Ecological and Dynamic Model -that of promoting a constant interaction among contexts (i.e., preschool center, home, primary school). This could be observed when the activities implemented in our programme, promoted a constant interaction and exchange of information among the members of such contexts namely parents, teachers, children and headteachers. Such interaction seemed to have contributed to the development of a strong sense of community to support children during this change which has been observed in previous studies (Wildenger and McIntyre, 2011). Modeling key developmental aspects and transition practices (i.e., new knowledge for teachers), improving classroom-areas, implementing literacy-related activities and promoting visits to the primary school (considering the socio-cultural context and curriculum) seemed to be an effective strategy to support teachers and parents to acquire new knowledge and develop practices to support pre-schoolers during this transition. These results are consistent with previous studies (e.g., Berlin et al., 2011; Brotherson et al., 2015) which have shown significant effects of interventions in children's skills. Moreover, significant improvements in children's skills have also been observed in large-scale studies where a number of transition practices have also been implemented by teachers (Schulting et al., 2005). Whilst the lack of a randomized allocation of preschoolers in the experimental and control groups could represent a limitation in the present study, statistical analyses still revealed a positive impact in the development of children's skills. Nevertheless, other factors such as children's extra-curricular activities and the number of older siblings at home, were not controlled. Future studies should consider a randomized allocation of participants for both groups. Whilst results suggest that children in the experimental group developed more skills after the intervention, this study did not follow up on pre-schoolers during the first year of primary school, which could have allowed us to explore the long-term effects of this intervention. Future studies should focus on a more rigorous experimental and longitudinal design to be able to investigate the long-term impact of transition interventions. Furthermore, skills developed by children must be further analyzed to understand whether they contribute to a smooth transition to the first grade classroom.

This intervention helped preschool teachers and TAs significantly improve the use of transition practices. Whilst these transition practices were shown to be relevant for the support of the development of cognitive, social and fine motor skills in children, there is the need to focus on additional developmental domains (i.e., emotional). Although this intervention showed positive outcomes with teachers, other confounding variables (e.g., peer-to-peer support, exchange of ideas with other teachers) could have had an impact on teachers, which were not controlled and which need to be considered in future research.

Teachers seem to have promoted important parental involvement, which has also been observed in other studies as a result of interventions (Stormshak et al., 2002). Whilst family involvement was not measured in this study, it was clear that parents' engagement in classroom activities provided preschoolers with joyful experiences by seeing their parents coming to their classroom. Findings from family engagement activities in this study are similar to those found previous studies (Wildenger and McIntyre, 2011). This intervention helped the preschool teacher and TA carry out helpful activities (Stormshak et al., 2002; Dockett and Perry, 2007; Urbina-Garcia, 2019) to promote school-school links. However, future research is needed to explore the prevalence of such practices in teachers' repertoire. The constant teacher-parent interactions and visits to the primary school (i.e., "bridging") led to a more frequent exchange of information among adults, which also allowed preschoolers to get to see—in a concrete way—what a primary school looked like.

Parents seemed to be aware of the differences between the preschool and primary school. However, they mainly focussed on their child's academic skills, leaving out other aspects (i.e., social, emotional). This is not surprising, since previous studies have shown that parents usually consider early literacy skills as essential to start first grade (Lee and Gogh, 2012), given that one of the key aspects of this transition is the change from a played-based to a more academic-led curriculum, which suggests a "curriculum discontinuity" (Turunen and Maatta, 2012; Alatalo et al., 2017). As a result, parents' main supporting strategies focused on helping their child learn how to read and write. Parents believed that enrolling their child in "actual schools," where they will learn how to read, in addition to learning another language (i.e., English) was essential. Similarly, parents reported that the main issues they focussed on when talking to their child about their imminent entry to primary school were following new rules, carrying out classroom activities as required, doing homework and being obedient, which is consistent with previous findings (Chun, 2003; Fabian and Dunlop, 2007; Eskelä-Haapanen et al., 2017). Parents also reported how these "new challenges" would have an impact on their daily routine, since they would have to spend more hours with their child helping him/her with "homework," which is consistent with other studies where a change in parents' routines has been importantly highlighted (Margetts and Kienig, 2013). Interestingly, parents' main criteria for choosing the primary school focused on the school's academic level and closeness to parents' workplace.

To summarize, this study has addressed an important gap in the literature whereby most of the preschool transition has been carried out in developed economies such as Australia, Iceland, the US and broadly in Europe, overlooking developing economies such as those found in Latin America. Worryingly, this region has shown some of the lowest academic performances based on international assessment exercises (OECD, 2018), and yet little is known as to the way in which the context, cultural practices, values, educational policies or curriculum, shape the preschool transition. This study represents one of the first attempts to explore a specific and adapted intervention programme to aid the preschool transition, including teachers, TAs, children and parents in a single intervention. This study adds to the international literature by providing empirical evidence regarding the implementation of a transition intervention programme in a developing economy, such as Mexico, contributing to what is already known from developed economies. Findings suggests that

by implementing intervention programmes of this nature, significant improvement can be observed in preschoolers' skills, teachers' practices, and parents' involvement, which could facilitate preschoolers' transition to first grade. These findings must be replicated in order to broaden the extent to which these results can be generalized to other developing economies. We encourage the implementation of this type of intervention in similar contexts, with a view to gathering empirical evidence that could inform educational policies in near future.

DATA AVAILABILITY STATEMENT

The datasets generated for this study are available on request to the corresponding author.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Ethics Committee of the Faculty of Psychology. National Autonomous University of Mexico. Written informed consent to participate in this study was provided by the participants' legal guardian/next of kin.

AUTHOR CONTRIBUTIONS

The author confirms being the sole contributor of this work and has approved it for publication.

FUNDING

The budget for this study was administered by CONACYT-Mexico (National Council of Science and Technology). I would like to thank to all the participants for their valuable time invested in this study and to all Mexican citizens whose taxes, made possible this study.

REFERENCES

Ahtola, A., Silinskas, G., Poikonen, P.-L., Kontoniemi, M., Niemi, P., and Nurmi, J.-E. (2011). Transition to formal schooling: do transition practices matter for academic performance? *Early Child. Res. Q.* 26, 295–302. doi: 10.1016/j.ecresq.2010.12.002

Alatalo, T., Meier, J., and Frank, E. (2017). Information sharing on children's literacy learning in the transition from Swedish preschool to school. *J. Res. Childh. Educ.* 31, 240–254. doi: 10.1080/02568543.2016.1274926

Berlin, L. J., Dunning, R. D., and Dodge, K. A. (2011). Enhancing the transition to kindergarten: a randomized trial to test the efficacy of the "Stars" summer kindergarten orientation program. *Early Child. Res. Q.* 26, 247–254. doi: 10.1016/j.ecresq.2010.07.004

Braun, V., and Clarke, V. (2006). Using thematic analysis in psychology. *Qual. Res. Psychol.* 3, 77–101. doi: 10.1191/1478088706qp063oa

Bricker, Betty, and Pretti-Frontnczak, K. (2002). *Assessment, Evaluation, and Programming System for Infants and Children (AEPS®)*, 2nd Edn. Administration Guide. (AEPS). Baltimore: Paul H. Brookes Publishing Co.

Brotherson, S. E., Hektner, J. M., Hill, B. D., and Saxena, D. (2015). "Targeting the transition to kindergarten: academic and social outcomes for children in the gearing up for kindergarten program," in *Conference Proceedings: of Learning Curves: Creating and Sustaining Gains from Early Childhood through Adulthood* (Washington, DC: Society for Research on Educational Effectiveness).

Brownell, M. T., Yeager, E., Rennells, M. S., and Riley, T. (1997). Teachers working together: what teacher educators and researchers should know. *Teach. Educ. Spec. Educ.* 20, 340–359. doi: 10.1177/088840649702000405

Cadigan, K., and Missall, K. N. (2007). Measuring expressive language growth in young children with autism spectrum disorders. *Topics Early Child. Spec. Educ.* 27, 110–118. doi: 10.1177/02711214070270020101

Carida, H. C. (2011). Planning and implementing an educational programme for the smooth transition from kindergarten to primary school: the Greek project in all-day kindergartens. *Curric. J.* 22, 77–92. doi: 10.1080/09585176.2011.550800

Chun, W. N. (2003). A study of children's difficulties in transition to school in Hong Kong. *Early Child Dev. Care* 173, 83–96. doi: 10.1080/0300443022000022440

Claes, B. (2010). *Transition to kindergarten: the impact of preschool on kindergarten adjustment* (Ph.D. dissertation). Retrieved from ProQuest. Alfred University, Alfred, NY, United States.

Coolican, H. (2009). *Research Methods and Statistics in Psychology*, 5th Edn. London, UK: Hodder Education, An Hachette UK Company.

Curtis, D. A., and Marascuilo, L. A. (2004). Point estimates and confidence intervals for the parameters of the two-sample and matched pair combined test for ranks and normal scores. *J. Exp. Educ.* 60, 243–269. doi: 10.1080/00220973.1992.9943879

Dockett, S., and Perry, B. (2007). *Transitions to School: Perceptions, Expectations, Experiences*. Sydney: UNSW Press.

Eskelä-Haapanen, S., Lerkkanen, M. K., Rasku-Puttonen, H., and Poikkeus, A. M. (2017). Children's beliefs concerning school transition. *Early Child Dev. Care* 187, 1446–1459. doi: 10.1080/03004430.2016.1177041

Fabian, H., and Dunlop, A. W. (2007). "Outcomes of good practice in transition processes for children entering primary school," *Working Papers in Early Childhood Development, No. 42* (The Hague: Bernard van Leer Foundation).

Fabian, H., and Dunlop, W. (2005). "The importance of play in the transition to school," in *The Excellence of Play,* 2nd Edn, ed J. R. Moyles (Berkshire: Open University Press/McGraw-Hill).

Gao, X., and Grisham-Brown, J. (2011). The use of authentic assessment to report accountability data on young children's language, literacy and pre-math competency. *Int. Educ. Stud.* 4, 41–53. doi: 10.5539/ies.v4n2p41

García, F. J., and Ruiz-Higueras, L. (eds.). (2011). "Modifying teachers' practices: the case of a European training course on modelling and applications," in *Trends in Teaching and Learning of Mathematical Modelling*, eds F. Javier and L. Ruiz-Higueras (Dordrecht: Springer), 569–578.

Giallo, R., Treyvaud, K., Matthews, J., and Kienhuis, M. (2010). Making the transition to primary school: an evaluation for a transition program for parents. *Austr. J. Educ. Dev. Psychol.* 10, 1–17.

Haciibrahimoglu, B. Y., and Kargin, T. (2017). Determining the difficulties children with special needs experience during the transition to primary school. *Educ. Sci. Theory Pract.* 17, 1487–1524. doi: 10.12738/estp.2017.5.0135

Hart, K. C. (2012). *Promoting successful transitions to kindergarten: an early intervention for behaviourally at risk children from head start presschools* (Ph.D. dissertation). Retrieved from ProQuest. State University of New York at Buffalo, Buffalo, NY, United States.

Haslam, S. A., and McGarty, C. (2014). *Research Methods and Statistics in Psychology*. London, UK: Sage.

Hedegaard, M., and Fleer, M. (2013). *Play, Learning, and Children's Development: Everyday Life in Families and Transition to School*. Cambridge, UK: Cambridge University Press.

Kagan, S. L., and Tarrant, K. (2010). *Transitions for Young Children: Creating Connections across Early Childhood Systems*. Baltimore, MD: Brookes Publishing Co.

Lee, S., and Gogh, G. (2012). Action research to address the transition to kindergarten to primary school: children's authentic learning, construction play and pretend play. *Early Child. Res. Pract.* 14, 1–16.

Lemire, C., Dionne, C., and McKinnon, S. (2014). Validité de contenu du nouveau domaine de la littératie de l'AEPS®/EIS. *Rev. Francoph. Défic. Intellect.* 25, 116–130. doi: 10.7202/1028217ar

Li, H. C. W., Mak, Y. W., Chan, S. S., Chu, A. K., Lee, E. Y., and Lam, T. H. (2013). Effectiveness of a play-integrated primary one preparatory programme to enhance a smooth transition for children. *J. Health Psychol.* 18, 10–25. doi: 10.1177/1359105311434052

Loughran, J. J. (2002). *Developing Reflective Practice: Learning About Teaching and Learning Through Modelling*. Abingdon; Oxon New York, NY: Routledge.

Malsch, A. M., Green, B. L., and Kothari, B. H. (2011). Understanding parents' perspectives on the transition to kindergarten: what early childhood settings and schools can do for At-risk families. *Best Pract. Mental Health* 7, 47–66.

Margetts, K., and Kienig, A. (2013). *International Perspectives on Transition to School: Reconceptualising Beliefs, Policy and Practice*. Melbourne, VIC: Routledge.

Morrison, F. J., Ponitz, C. C., and McClelland, M. M. (2010). "Self-regulation and academic achievement in the transition to school," in *Child Development at the Intersection of Emotion and Cognition* (Washington, DC: American Psychological Association), 203–224.

Neuman, S. B., Bredekamp, S., and Copple, C. (2000). *Learning to Read and Write: Developmentally Appropriate Practice*. Washington, DC: NAEYC.

Noh, J. (2005). *Examining the psychometric properties of the second edition of the assessment, evaluation, and programming system for three to six years: AEPS test,* 2nd Edn. (Ph.D. thesis). University of Oregon, Eugene, OR, United States.

OECD (2018). *Education at a Glance 2018: OECD Indicators*. Paris: OECD.

Perry, B., Dockett, S., and Petriwskyj, A. (2014). *Transitions to School-International Research, Policy and Practice*. New York, NY: Springer.

Peters, S. (2010). *Literature Review: Transition from Early Childhood Education to School*. Report to the Ministry of Education, New Zealand. Retrieved from: http://ece.manukau.ac.nz/__data/assets/pdf_file/0008/85841/956_ECELitReview.pdf

Rimm-Kauffman, S., Pianta, R., and Cox, M. (2000). Teachers' judgements problems in the transition to kindergarten. *Early Child. Res. Q.* 15, 147–166. doi: 10.1016/S0885-2006(00)00049-1

Salmi, S., and Kumpulainen, K. (2019). Children's experiencing of their transition from preschool to first grade: a visual narrative study. *Learn. Cult. Soc. Interact.* 20, *58–67*. doi: 10.1016/j.lcsi.2017.10.007

Schulting, A. B., Malone, P. S., and Dodge, K. A. (2005). The effect of school-based kindergarten transition policies and practices on child academic outcomes. *Dev. Psychol.* 41, 860–871. doi: 10.1037/0012-1649.41.6.860

Stormshak, E. A., Kaminski, R. A., and Goodman, M. R. (2002). Enhancing the parenting skills of Head Start families during the transition to kindergarten. *Prevent. Sci.* 3, 223–234. doi: 10.1023/A:1019998601210

Taylor, S. J., Bogdan, R., and DeVault, M. (2015). *Introduction to Qualitative Research Methods: A Guidebook and Resource*. New York, NY: John Wiley & Sons.

Turunen, A., and Maatta, K. (2012). What constitutes the pre-school curricula? Discourses of core curricula for pre-school education in Finland in 1972-2000. *Eur. Early Childh. Educ. Res. J.* 20, 205–2015. doi: 10.1080/1350293X.2012.681135

Urbina-Garcia, A. (2019). Preschool transition in Mexico: exploring teachers' perceptions and practices. *Teach. Teach. Educ.* 85, 226–234. doi: 10.1016/j.tate.2019.06.012

Wildenger, L., and McIntyre, L. (2011). Family concerns and involvement during kindergarten transition. *J. Child Fam. Stud.* 20, 387–396. doi: 10.1007/s10826-010-9403-6

Conflict of Interest: The author declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

APPENDIX A

General Structure of the Intervention Programme

Aim

To plan, design and facilitate an intervention programme to promote children's cognitive, social and fine motor skills as well as teachers practices that promote children's early literacy skills with a view to facilitating children's transition to primary school

Objectives

a) to promote children's cognitive, social and fine motor skills to facilitate children's transition to primary school
b) to promote school-school and home-school links to facilitate children's transition to primary school

Methodology

This intervention followed a pre-post research design making use of a mixed-methods approach considering different activities
Collaborative work between PT, TAS and researchers leading to planning sessions for the intervention
Planning family involvement
Planning school visits
Planning pedagogical activities
Weekly monitoring meetings
in situ modeling by researchers
Promoting PT and TAS *in situ* reflections on practice
Weekly discussion meetings
Supporting the development of new material for students

Evaluation

The programme was evaluated following a pre-post research design. The effectiveness of the programme was assessed based on the outcomes in children's skills, teachers' practices and parent's perceptions after the intervention
Children's skills were evaluated with the AEPS (Bricker et al., 2002) to measure cognitive, social and fine motors skills
Teachers' practices that promote early literacy were evaluated by an adapted version of the "Inventory of Early Literacy Practices" (Neuman et al., 2000)
Parents' views were gathered with three open-ended questions.

frontiers in Psychology

ORIGINAL RESEARCH
published: 04 September 2020
doi: 10.3389/fpsyg.2020.02150

Interplay Between Reading and Writing Under Different Teaching Models: A Study Based on Chinese Learning by China's Ethnic Minorities

*Ying Zhang[1], Hengli Peng[2] and Yufang Bian[1]**

[1] Collaborative Innovation Center of Assessment Toward Basic Education Quality, Beijing Normal University, Beijing, China,
[2] Faculty of Linguistic Sciences, Beijing Language and Culture University, Beijing, China

Introduction: The relationship between reading and writing has been comprehensively explored from different perspectives. The following three theories and hypothesis could elucidate the relationship: reading→writing, writing→reading; and reading↔writing. In China, the teaching models of school influence the Chinese language learning of students in ethnic minority areas. Although language teaching can take various forms, this study selects two teaching models (S1: the traditional teaching model; S2: the complete Chinese teaching model) that can broadly represent Chinese minority schools. Primarily, this study aims to investigate the impact of different teaching models on the interplay between Chinese reading and writing ability of China's minority students. Second, this study aims to explore gender differences in the relationship between reading and writing in two different teaching models.

Methods: As the cross-lagged model is suitable for a longitudinal study of the data collected from multiple time waves and explore the causal relationship between variables. We enrolled 3869 Chinese ethnic minority fourth- to sixth- grade students from 126 schools and collected data for three waves. This study mainly achieves the two aims mentioned above through the cross-lagged design.

Results: Results reveal that: (1) the complete Chinese teaching model is more effective than the mixed teaching model in stimulating the interaction relationship between reading and writing; (2) in the mixed teaching model, boys did not exhibit a significant effect of reading on writing, but only the effect of writing on reading, whereas girls exhibited the interaction between reading and writing; in the complete teaching model, there are gender differences in the relationship between reading and writing, however, with the development of time, the interaction between boys and girls in reading and writing becomes more robust, demonstrating that similar development trend in boys' and girls' interaction between reading and writing.

Conclusion: The implication of these results is that: (1) the interactive relationship between reading and writing is developed in both teaching models; (2) there are some gender differences in the relationship between reading and writing in each teaching model.

Keywords: reading, writing, teaching model, Chinese learning, gender difference

OPEN ACCESS

Edited by:
Małgorzata Lipowska, University of Gdańsk, Poland

Reviewed by:
Grazyna Maria Krasowicz-Kupis, Maria Curie-Skłodowska University, Poland
Hu Jian, Jiangxi University of Finance and Economics, China

***Correspondence:**
Yufang Bian
bianyufang66@126.com

Specialty section:
This article was submitted to Educational Psychology, a section of the journal Frontiers in Psychology

Received: *13 May 2020*
Accepted: *31 July 2020*
Published: *04 September 2020*

Citation:
Zhang Y, Peng H and Bian Y (2020) Interplay Between Reading and Writing Under Different Teaching Models: A Study Based on Chinese Learning by China's Ethnic Minorities. Front. Psychol. 11:2150. doi: 10.3389/fpsyg.2020.02150

INTRODUCTION

It is commonly acknowledged that the four abilities of language (speaking, listening, reading, and writing) are interrelated. To date, several studies have comprehensively explored those relationships, especially the relationship between the two literacy skills, reading and writing (Berninger et al., 2002; Shanahan, 2009). Reading is the ability to extract, interpret, and use information from a print or digital text (Jonathan et al., 2018). We use a broad range of cognitive skills and language knowledge resources while engaging in reading comprehension activities (Perfetti and Adlof, 2012; Geva and Ramírez, 2015). Typically, the processes of reading require the abilities or language resources: accurate word recognition (i.e., lexical access), syntactic knowledge of the language, text structure and organizational patterns, and formulation of major ideas from text processing (Jonathan et al., 2018). Regarding the development of writing ability, increasing standards in children's writing is a current educational priority (Department for Education, 2012, 2013). Writers could be influenced by their formal schema, which denotes knowledge about ways in which text types or genres are structured (Jonathan et al., 2018). Hence, writing in combination with students' life experience or under the guidance of certain familiar topics is more likely to effectively develop real writing ability.

The relationship between reading and writing has been comprehensively investigated from various perspectives (Chapelle et al., 2011). Indeed, some studies extensively explored the relationship between reading and writing (Berninger et al., 1994, 2002; Abbott et al., 2010; Berninger and Abbott, 2010). However, whether the reading development led to the writing development or whether the writing development preceded the reading development remains unclear. Of note, three theories and hypothesis could help explain the relationship (Shanahan and Lomax, 1988; Schoonen, 2018).

The first theory proposes that reading ability contributes to the development of writing ability, corroborating the idea that the development of reading ability precedes writing. Some meta-analysis studies revealed that students from fourth to twelfth grade experienced the massive impact of the reading-to-writing teaching model or intervention on average (Scammacca et al., 2007, 2015). The second theory highlights that writing ability increases the development of reading ability. Such perspective holds that the development of writing skills is adequate, as its development comprises the development of reading ability and, consequently, promotes the development of reading skills. In addition, studies have demonstrated that the writing-to-reading model better explains the learning of beginners (Schoonen, 2018). The third theory integrates the most reasonable statements of the first two schools, that is, reading and writing mutually facilitate each other in their development. Abbott et al. (2010) examined the development of reading and writing skills of two groups of primary school students from the first to seventh grade and found that the reading and writing level had a strong autoregression for the same reading or writing level in the previous year, but a weak regression to overlapping skills, that is, the effect of reading on writing level was weak, and so was the effect of writing on reading level.

The research targets of previous studies were relatively small children in the early stage development of their reading and writing skills because children in this stage had strong plasticity and opportunities to receive reading and writing teaching and guidance. The majority of studies shed light on language education and usually involved the efficacy of language curriculum design in augmenting reading and writing skills (Shanahan, 2009). The relationship between different language teaching models and the development and relationship of reading and writing has also been a hot topic for research and the key to driving language education practice over the years.

Nevertheless, the equivocality of the research has suggested that the impact of different teaching models on the development of student reading and writing skills merits further research (Hall and Burns, 2018). In the field of writing research, teaching must cater to their abilities to make students learn effectively (Kamps and Greenwood, 2005; Al Otaiba and Fuchs, 2006). Reportedly, integration of the enhancement in reading and writing skills with teaching could decrease the incidence of language learning difficulties (Wanzek et al., 2010). In reading education, numerous successful reading instruction and intervention practices suggest that providing clear instructions to senior students was the key to obtaining a positive reading effect (Edmonds et al., 2009). Furthermore, providing appropriate practical opportunities and receiving valuable feedback in the teaching process correlated with enhanced academic performance (Hattie and Timperley, 2007; Shute, 2008).

As China is a multi-ethnic country, learning Chinese by Chinese minority students differs from learning their native languages. To a certain extent, learning Chinese for them is like learning a second language altogether. Hence, it is worth exploring the interplay between reading and writing ability for Chinese minority students during the development of reading and writing skills in Chinese at school. In addition, we focused on the role of Chinese teaching models on the development of reading and writing skills in minority students. This study was primarily based on the education project designed to teach Chinese to Chinese minority students and promote minority students to learn Chinese as a second language. We included the long-term and overall planning of reading and writing in teaching in the implementation process of the project to examine the effects of different bilingual teaching models on the development of students' reading and writing skills in Chinese. Of note, fluent reading and writing training during Chinese teaching could promote the final formation and development of reading and writing abilities and the interplay between them. Moreover, the impact of long-term teaching model could be responsible for a unique interplay between Chinese reading and writing for Chinese minority students. Notably, discussion on this issue is conducive to determine the long-term effect model between teaching and language development in the teaching process and, subsequently, offer a basis to explore the impact of bilingual teaching models and some reference for the subsequent bilingual education planning in China's minority areas.

Bilingual teaching is a vital component of the overall social, economic, cultural, and political environment. Different countries have different understandings of bilingual teaching and different models derived from practice (Baker, 2001, 2002). Typically, bilingual teaching denotes teaching activities with the mother tongue and second language as the media; however, its definition varies from country to country and from place to place. Internationally, bilingual teaching has had some broadly accepted definitions. The most authoritative definition of bilingual teaching, as defined in Longman Dictionary of Language Teaching and Applied Linguistics, is "the use of a second language or a foreign language in school for the teaching of content subjects" (1998). Owing to different cultural backgrounds of different countries, bilingual teaching differs in terms of concept, standard, objective, strategy, procedure, and models. Baker (1993) once categorized bilingual education models into 10 types; however, the popular models still widely used mainly include the following four types: transitional bilingual model; two-way bilingual model; immersion model; and maintenance bilingual education model.

The transitional bilingual model pertains to the education model in which the mother tongue is used partly or entirely after students enter the school, and later only the target language (second language) is adopted (Stern, 1999). The fundamental aim of the transitional bilingual model is to integrate minority students into the mainstream education (Baker, 2006). Specifically, in China, the transitional bilingual model aims to help students adapt to the second language classroom. Bilingual teachers teach children natural science, math, social science, and other subjects in students' native language, while the second language is only used in the second language classroom, the and knowledge of other subjects can be used to communicate in the said classroom. Nevertheless, the theoretical advantages of this teaching model are challenging to be experienced in practice, mainly because students cannot quickly and accurately acquire the L2 words needed to communicate in other subjects, and, thus, it is difficult to realize a smooth transition to the second language classroom.

Cummins (2000) highlighted that the two-way bilingual model started in the United States and was gaining popularity. Baker (2001) argued that in a typical two-way bilingual model, students augmented their proficiency in both mother tongue and second language through learning, as well as used both languages equally in classroom teaching, that is, using the mother tongue and second language together. The two-way bilingual model accommodated two language groups together to promote the learning of a second language while sustaining the mother tongue. In addition, the two-way bilingual model promoted the academic accomplishment and language ability of both students whose language is used by the majority and the minority in the same classroom; this has triggered considerable interest in the United States. However, the focus should be on the limitation of using this model in China's minority areas, that is, a limited number of minority schools with Chinese as a second language cannot fulfill the objective conditions of this bilingual environment and can only fulfill the requirements of Chinese teaching through the placement of corresponding teachers. Thus, the essential conditions of attending the same class for students of both Chinese nationality and ethnic minorities are not implemented yet in practice. Hence, it is challenging to put this bilingual teaching model into practice in China's minority schools.

Longman Dictionary of Language Teaching and Applied Linguistics (1998) reported that the immersion bilingual model uses a single target language (second language) in teaching, rather than the child's mother tongue. As a new type of second language education, the immersion bilingual model stemmed from the bilingual education model in Canada, particularly Quebec. After years of teaching practice in Canada, this bilingual model has been established to be effective and broadly recognized by the global bilingual society. Students learn scientific knowledge in a second language and receive an all-round development in the learning process. Indeed, students in China's minority areas can learn Chinese using the Chinese immersion bilingual model through the placement of teachers whose mother tongue is Chinese, namely, adopting the complete Chinese teaching model examined in this study. Of note, teachers whose mother tongue is Chinese are qualified to teach Chinese in China's minority areas. Besides using the unified Chinese textbook in the classroom, they mostly provide instructions and feedback to students in Chinese.

Baker (2002) reported that the essence of maintaining bilingual model is to educate minority students using both the minority and majority languages (second language). Notably, the maintenance bilingual model is also called bilingual teaching oriented to the traditional language of minority students. In this teaching model, the minority language is the dominant language in the majority of teaching, or, at least, takes up half of the course time (Dicker, 2003); this model is present in the traditional Chinese teaching model in schools in China's minority areas, that is, the mixed teaching model, including the integration of the minority language and Chinese in this study. Chinese teachers in this model are primarily minority teachers who can speak Chinese in the minority areas; they have the qualifications needed to teach Chinese and have attained corresponding certifications. In addition, they usually use the unified textbook in Chinese teaching, while mainly relying on the minority language to provide guidance and feedback to minority students.

Previous research revealed that among students aged 9–10 years, girls scored higher than boys in writing ability (Babayiğit, 2015). Likewise, Midgette et al. (2008) found differences in the writing ability of the fifth- and eighth-grade students. The writing ability presents a consistency in terms of gender differences across different grades (Reynolds et al., 2015; Cordeiro et al., 2018). In addition, studies on reading abilities of primary school students revealed differences between boys and girls (Gao et al., 2019), and considerable literature showed that girls performed better in reading than boys (Voyer and Voyer, 2014; Nalipay et al., 2019). However, most studies focused on gender differences in writing or reading abilities. Some studies explored the relationship between writing and reading and their functions, with limited focus on gender differences, let alone exploring the impact of different teaching models on their relationship and gender differences. Yet, it is imperative to investigate the impact of different teaching models on the

interplay between writing and reading abilities and their mutual promotion for students of different genders, which triggered our great concern in this study.

This Study

As China is a multi-ethnic country, Chinese is one of the crucial subjects for students in China's minority areas. In addition, Chinese is an essential instrument for minority students to secure better development and more opportunities in China in the future. Since 2002, "the Chinese Proficiency Test for Minorities in China" has been in practice to explore and adapt to the needs of Chinese teaching and testing in minority areas. The continuous maturity of the test has furthered our understanding of Chinese learning by minority students. Moreover, minority education has increasingly accentuated the need to adapt to the reading and writing development rules of minority students, as well as design teaching methods suitable for Chinese learning by minority students. Unlike learning their native languages, Chinese minority students learn Chinese as a second language, which is quite different from minority languages, as well as from alphabetic languages like English. Thus, proficient reading and writing ability is a crucial aspect of language ability to fulfill the needs of examination or actual communication. In addition, the teaching content needs to cater to the demand of students' language development (Gao et al., 2019) to harness Chinese reading and writing skills.

In this study, among the teaching models described above, we adapted two models mainly for teaching Chinese in China's minority areas—S1: mixed minority language-Chinese teaching model and S2: complete Chinese teaching model/Chinese immersion model. In addition, two different teaching models were adopted in the implementation of this study—mixed minority language-Chinese teaching model (S1) and complete Chinese model (S2). Besides, this study explores the roles of the models in the development of students' reading and writing skills. Gender differences in both reading and writing have been frequently reported (Pajares and Valiante, 2001; McGeown et al., 2012; McGeown, 2013). Moreover, excellent reading and writing performance have been identified more closely with girls than boys (Millard, 1997; Marsh and Yeung, 1998; Guimond and Roussel, 2001; Pajares and Valiante, 2001; McGeown et al., 2012; McGeown, 2013). What are the differences in the way girls and boys develop their relationships between reading and writing? How do they develop differently in different teaching models? These questions provoked the interest of this study. This study further explores and examines the interplay between reading and writing abilities for boy and girl students under different teaching models. As the cross-lagged model facilitated exploring the longitudinal relationship between different variables across time, this study adopts it to examine the collected data, and then discover the development of writing and reading abilities for students of different genders and their interaction under different teaching models.

As overall planning in this study project, we attempt to compare the impact of different teaching models in teaching practice. To further examine the effect of each teaching model, we also examine gender differences using a 3-year longitudinal design to explore the relationship between reading and writing and examine whether this relationship depends on gender under each teaching model. This study could provide a basis for a comprehensive exploration of future similar studies and some reference for the choice of teaching models in the future.

MATERIALS AND METHODS

Procedure

Since the implementation of this study, we randomly selected different schools in Xinjiang ethnic minority areas for teaching design and arrangement of textbook use. We matched schools in terms of school socioeconomic status, facilities, teacher training, and Chinese textbook selection. We executed the teaching intervention in peer groups with the implementation of different teaching models in these peer groups. Hence, we established two groups differing only in the teaching model—S1: mixed minority language-Chinese group (traditional bilingual teaching group) and S2: complete Chinese teaching group (Chinese immersion teaching group). Teachers' teaching methods were provided according to the research requirement and textbook use. In addition, differences in the impact of textbooks and teaching on students constituted different impacts of two teaching models in this study. Besides, teacher training for each group was provided regularly per the requirements of textbook and corresponding syllabus. Teachers in the S1 and S2 groups used the same Chinese Textbook (Fang, 2004). The major differences in Chinese teaching methods between these two groups are as follows (**Figure 1**): (i) *Composition of teachers*. Teachers in the S1 group were primarily comprised non-native Chinese teachers who were qualified for teaching Chinese in minority areas, whereas teachers in the S2 group mainly included native Chinese teachers who were qualified for teaching Chinese in minority areas. (ii) *Teaching materials*. The S1 group mostly used Chinese teaching materials in the teaching process to guide students to understand and master the teaching materials per the requirements of the syllabus, whereas the S2 group mainly relied on Chinese teaching materials, supplemented by plenty of Chinese materials, to guide students to understand and master the contents of teaching materials and Chinese materials per the syllabus and the content of teacher training, and used Chinese to guide students at ordinary times. (iii) *Arrangement of the Chinese course/Curriculum*. Schools assigned to the S1 and S2 groups participated in the uniform curriculum arrangement, respectively. Schools in the S1 group offered three class hours of Chinese lesson every week, whereas other courses in minority languages. Schools in the S2 group provided two Chinese interest classes in the afternoon every week besides three class hours of Chinese lesson every week. Students could choose to attend the interest classes for Chinese communication depending on their interests (all the lessons were offered in small class size, usually comprising 10–15 students). Native Chinese teachers performed various activities in the interest classes in Chinese (e.g., learning to sing Chinese songs and recite in Chinese). In training, both groups of Chinese teachers were encouraged to give students assignments of writing Chinese diaries, and every

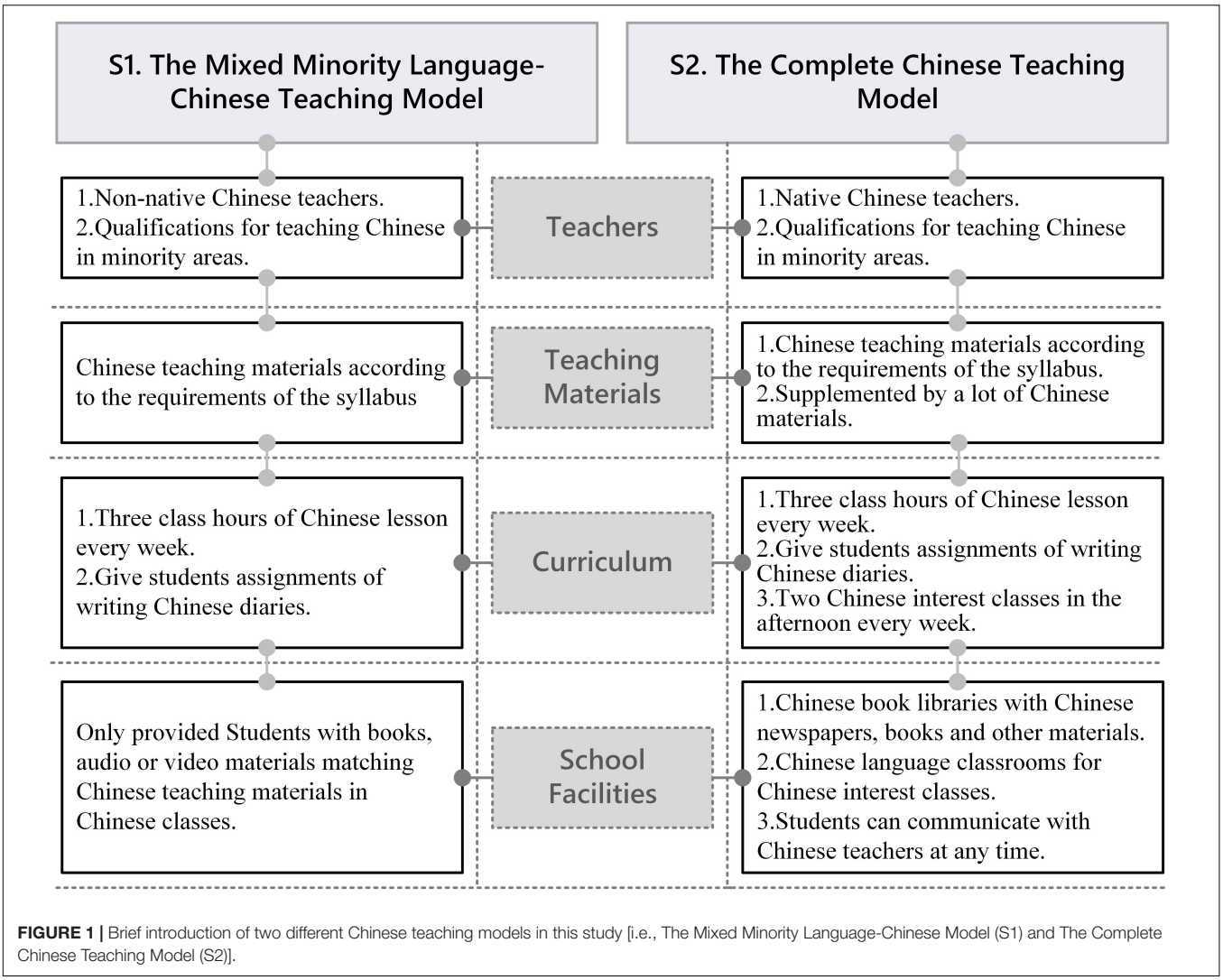

FIGURE 1 | Brief introduction of two different Chinese teaching models in this study [i.e., The Mixed Minority Language-Chinese Model (S1) and The Complete Chinese Teaching Model (S2)].

2 weeks, students were required to write a composition regularly in class, for which, teachers provided written feedback. (iv) *School facilities*. Schools in the S1 group were primarily equipped with books, videos, and audio in the minority language traditionally, and only provided students with books, audio, or video materials matching Chinese teaching materials in Chinese classes. Schools in the S2 group were equipped with Chinese book libraries and Chinese language classrooms for Chinese interest classes in teaching buildings to provide students with an overall Chinese learning environment. Thus, students in the S2 group could read Chinese newspapers, books, and refer to Chinese materials at any time in the Chinese library located in their teaching building after class, as well as communicate with Chinese teachers at any time. Moreover, schools could use the school broadcast station to play Chinese programs for a certain length of time every day to provide students with a Chinese learning environment. Furthermore, teachers would play Chinese videos for students in class or in interest class.

The time for reading and writing test was 60 min in total. The chief examiners were uniformly trained by the education department in the minority areas, and the tests were invigilated uniformly. Finally, the objective questions were uniformly graded by the computer, and the subjective questions were graded by scorers who were engaged in Chinese examination for Chinese ethnic minorities for, at least, 3 years and received the uniform test and training.

Participants

In this study, the data were primarily obtained from the stage data (2011−2013) of a longitudinal tracking project called "Studies on Chinese Communicative Competence Standards and Assessment System," which was designed to take fourth to sixth graders (age: 9−12.5 years) learning Chinese in China's minority areas as subjects (as this project study was a preliminary attempt, it only involved Xinjiang area where the Chinese Proficiency Test for Minorities in China has been in place for a relatively long period). Beijing Normal University and Beijing Language and Culture University and other units designed and implemented this study. As Chinese was a second language for students in minority areas, the main goal of a series of studies related to this project was to

elucidate the current situation and regularity of Chinese learning for students in minority areas in China and offer better methods for future Chinese learning. Of note, this study was one of the series of studies in this project. The students participating in this study, as well as their schools, were subject to research follow-up and educational monitoring between 2011 and 2013, and relevant data were collected. Notably, the study participants involved in the span of 3 years in this study were all from the same batch. A total of 3869 primary school students (boys accounted for 46.7% of the total) from 126 schools participated in this study.

All the subjects were in the same grade and categorized into two groups (S1: mixed minority language-Chinese teaching method; S2: complete Chinese teaching method) based on the teaching methods (a total of 4803 students participated in the study). Students in both groups learned Chinese under two different teaching models and, finally, received the same test at the same time. Subjects started to engage in the study in the fourth grade, and tests were conducted for 3 consecutive years during the project research. Specifically, the first test time (T1) was the autumn semester in the fourth grade, the second test time (T2) was precisely at the same time in the second year, that is, the autumn semester in the fifth grade, for the same batch of subjects, and the same for the third test time (T3). A total of 4541 students participated in the first test, and some of them failed to participate in the second test because of transfer to another school, personal leave, sick leave, or other reasons. A total of 4201 students participated in the second test (with a loss rate of 7.49%) and 4128 students in the third test (with a loss rate of 9.09% compared with the first test). The analyses of the lost subjects, χ^2 test, and variance analysis revealed no significant difference between the subjects participating in the second and third tests and the lost subjects in terms of gender ($x_2^2 = 2.41$, $p = 0.19$; $\chi_1^2 = 2.33$, $p = 0.17$), age [$F_1(1, 4538) = 1.03$, $p = 0.30$; $F_2(1, 4538) = 1.34$, $p = 0.28$], reading [$F_1(1, 4538) = 0.94$, $p = 0.45$; $F_2(1, 4538) = 1.16$, $p = 0.31$], and writing [$F_1(1, 4538) = 1.05$, $p = 0.44$; $F_2(1, 4538) = 1.34$, $p = 0.28$] in the first test, suggesting that sample loss was random. Overall, 3869 subjects participated in all the three tests, of whom, 43.8% were boys.

All school principals, students, and their guardians participating in this study provided a signed letter of consent to voluntarily participate in this study before the commencement of this study. We focused on assessing the impact of different bilingual teaching models implemented by schools to enhance students' reading and writing abilities during the study process.

Measures

The following measurement tools in this study were from the Collaborative Innovation Center of Assessment toward Basic Education Quality and the Faculty of Linguistic Sciences (FLS); these were mainly developed and used by the Beijing Normal University and Beijing Language and Culture University. This study aims to examine the language development of minority students and the relationship between individual development and educational factors in school. Of note, FLS, Beijing Language and Culture University [mainly accountable for the research and development of the Chinese Proficiency Test for Minorities in China (MHK) in ethnic minority areas] compiled numerous questionnaires on the standardized language test implemented in minority areas, which had been established to have both good reliability and validity (Peng, 2005).

School Questionnaire

The principals had to complete several multiple-choice questions related to the school environment of Chinese learning, including "Are the textbooks used in your school the uniformly compiled edition or self-selected ones?" (uniformly compiled by the Division of Ethnic Education, Ministry of Education/self-selected); "What is the current teaching model of the Chinese course in the bilingual class?". Of note, questions of this part were used for grouping before the intervention of the teaching model so that schools participating in the experiment of two teaching models (S1: mixed minority language-Chinese/traditional bilingual teaching; S2: complete Chinese teaching group/Chinese immersion teaching) were assigned to equivalent groups. Before the formal survey, students randomly assigned to the S1 and S2 groups were given an initial test (i.e., reading and writing test for the fourth graders). However, no statistically significant difference was observed in terms of reading and writing scores between both groups of students under two teaching models, that is, the differences in subsequent research were mainly caused by differences in teaching models.

Reading Evaluation

The scores in this part were obtained from the read scores of the final-term Chinese examination (Yuan and Peng, 2014). There were 30 questions overall, of which, Questions 1−10 focused on language understanding in the discourse from the perspective of vocabulary knowledge, syntax, and comprehension. (1) Vocabulary knowledge examined in the first part signifies the knowledge pertaining to lexical meaning used by an individual to understand others' speech and thoughts, and interpret the reading text (Moats, 2005), which is primarily tested using lexical definition and interpretation provided by students. The lexical quality hypothesis proposes that the quality of reading comprehension correlates with the quality of lexical knowledge (Perfetti, 2007). Thus, when studying the relationship between reading and writing development, vocabulary knowledge was placed in the first part of our study to test students' reading level. In the test, we tested students' interpretation of the lexical items appearing in the examination question (Li et al., 2009), and students' vocabulary knowledge was examined by synonymous substitution or interpretation of a lexical item in a sentence in the form of multiple choices. The lexical items in the multiple-choice questions were subject to the Chinese syllabus. A total of 10 questions were set up in the study, with 1 point scored for each question, 0 point for an error or no answer. The highest score was 10 points and the lowest 0 point. A higher score suggested a higher quality for vocabulary knowledge. [For example, "with the joint efforts of the whole class, we can surely complete the task. A. fixedly; B. regularly; C. definitely; D. decidedly." Making a correct choice warrants accurate understanding of the meaning of a word in a sentence. Another example is, "Unlike my sister, I am not interested in drawing. This meaning of the sentence

is: A. I love painting; B. My sister can't draw; C. My sister and I often draw; D. My sister likes drawing." The difficulty in understanding this sentence lies in grasping the meaning of the negation word to choose from similar words a word that is most appropriate for the sentence; this question item tested students' understanding of the meaning of a negation word in the context of a sentence]. (2) The second part examined syntax knowledge and mainly examined students' use of words in sentences; this part included 10 questions, with 1 point for each correct answer, and 0 point for a wrong answer or no answer. The highest score was 10 points and the lowest 0 point. A higher score implied a higher syntactical level. In addition, this part focused on the students' flexible application of vocabulary and grammar in a sentence [For example, "Each of us should carefully _____ the traffic rules." As "尊" in the option "尊重" (respect), and "遵" in the option "遵守" share the same pronunciation and similar word form, this question examined students' ability to distinguish words of the same pronunciation and similar forms. Another example, "Mom _____ herself very beautiful today. A. clothes; B. dressed up; C. expressed; D. image." This question primarily examined students' choice of words by considering its meaning expressed in the whole sentence, including choosing whether a verb or a noun, collocation of words, and overall application of syntactic rule)]. (3) Questions 21−30 in the third part mostly focused on examining students' understanding of passages. There were four passages in total, with each passage containing about 100–150 Chinese characters, and there were 2 or 3 questions for each passage. Students answered questions about the meaning of words and sentences or the general idea of the passage by reading it, with 1 point scored for each correct answer, and 0 point for a wrong answer or no answer. The highest score was 10 points, and the lowest 0 point. A higher score implied a higher level for the comprehension of the passage.

The difficulty level of examinations in 3 years was adjusted per the curriculum standards and syllabus of each year. In addition, reading scores for comprehension questions were processed according to the equivalence method to form a longitudinal scale, allowing for comparison among different ages (among them, 5 questions were same in the questionnaire for the fourth to sixth graders, used for the longitudinal equivalence). As there was one correct answer to each question, so "1" point was scored for a correct answer or "0" for a wrong answer or no answer. The total score for each part (vocabulary, syntax, and comprehension) was 10 points. A higher score suggested a better mastery and a better competence in this part, and *vice versa*. As the overall reading scores were measured and equalized, the 3-year scores were comparable. Cronbach's α was 0.88, the internal consistency was 0.87–0.94 in the study.

Writing Evaluation

The scores in this part primarily came from the assessment results of writing in the final-term Chinese examination. The assessment was obtained from the comprehensive evaluation of FLS. Notably, testing in the writing part was divided into spelling, the picture composition and composition. (1) the first part included 10 objective questions on spelling for Chinese phonetic alphabet (i.e., Chinese pinyin, Yuan and Peng, 2014). The objective questions were mainly set in accordance with the characteristics of Chinese, that is, each syllable of Chinese pinyin corresponded to a different Chinese character/word, and participants were required to write the correct Chinese character or word according to different contexts [e.g., "This performance is especially 精 cai (彩) (精彩 means *wonderful* in Chinese): I really want to watch another one."] [an overall evaluation (0−6 points) was given by the scorer for this part]. A total of 10 questions were examined in the survey, in which 1 point was scored for a correct answer, and 0 point for a wrong answer or no answer. The highest score was 10 points and the lowest 0 point. A higher score implied a stronger ability in sentence spelling. The internal consistency coefficient of this part was 0.85–0.93 for the 3-year tests. (2) The following short composition was a short essay requiring students to write over 50 words. Students had to write a short essay corresponding to the situation shown in a picture and hinted through keywords (as shown in **Figure 2**) [an overall evaluation (0−6 points) was given by the scorer for this part]; (3) The second part was semi-guided writing (e.g., the semi-guided writing was "During our growth, we are grateful to many people, who may be our father, mother, teacher, or our classmates and friends.Write down what you want to say to him/her, and why you are thankful to him/her and your personal story. Please write a thank-you letter titled 'A letter of thank you to XX' according to the requirements of the letter format. Please complete the topic before writing. Write no less than 150 words in the genres other than poetry" [an overall evaluation (0−6 points) was given by the scorer for this part].

Based on the equivalence method, scores for objective questions were processed and converted into a longitudinal scale, enabling comparison among different ages (among them, 3 questions were same in the questionnaire for the fourth to sixth graders, used for the longitudinal equivalence). As there was one correct answer to each question, so "1" point was scored for a correct answer or "0" for a wrong answer or no answer. The total

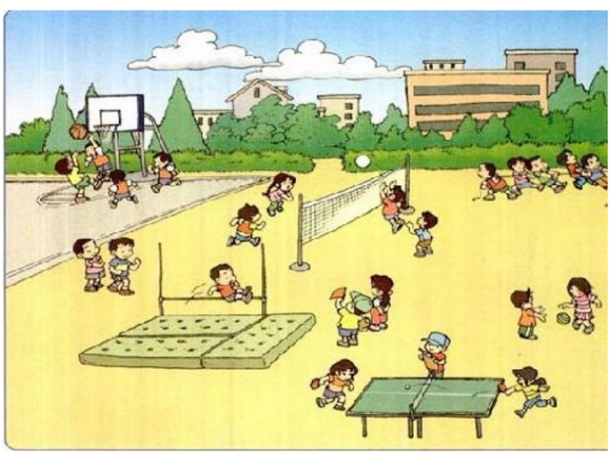

FIGURE 2 | Situation prompt: On the playground, students, do sports, some. . . some. . . in high spirits (used in the second part of the writing test). (*Permissions have been obtained from Faculty of Linguistic Sciences, Beijing Language and Culture University, Beijing, China*).

score for the first part was 10 points, and the second and third were writing (0–6 points). A higher score implied a better mastery in this part, and a lower score a poorer competence. As the overall writing scores were measured and equalized, the 3-year scores were comparable. Cronbach's α was 0.85, the internal consistency was 0.86–0.92 in the study.

Statistical Analysis

We performed measurement equivalence processing on the 3-year data to render the reading and writing assessment results over the 3 years comparable in time. For convenience, we used an IRT model for vertical scaling. To develop a vertical scale, achievement growth between a pair of grades was defined as the change in scores over the content. We used BILOG 3.09 for the conversion of scale scores based on the subsequent reading and writing score comparison. We adopted a classic three-wave, cross-lagged panel design. We hypothesized that the development of reading and writing skills of Chinese minority students could facilitate each other in Chinese learning. Besides, different teaching models could further impact this type of mutual facilitation. We used Mplus8.0 for modeling and analysis of the cross-lagged panel structural model and SPSS19.0 for the primary analysis and processing of the data.

Ethics Statement

In this study, the core variables were the students' reading and writing scores over 3 years, which were graded by Chinese experts based on the reading and writing evaluation criteria, respectively. We surveyed students in the classroom at every wave of the timeline. The Institutional Review Committee, comprising the Collaborative Innovation Center of Assessment toward Basic Education Quality, Beijing Normal University and Faculty of Linguistic Sciences, Beijing Language and Culture University, approved all the questionnaires and procedures used in this study. In addition, written informed consent was obtained from all principals, students and their parents in this study.

RESULTS

Descriptive Statistics

The multivariate analysis of variance (MANOVA) revealed that different class models [0 = parallel teaching model adopting the mixed minority language and Chinese (S1); 1 = complete Chinese teaching model (S2)] exerted a significant effect on reading at three waves [$F(2,3866) = 74.81$, $p < 0.01$, partial $\eta^2 = 0.41$]. Then, the univariate analysis revealed that students in the complete Chinese teaching model exhibited a higher reading level in each time period. Moreover, MANOVA suggested that the class model exert a significant effect on writing at three waves of measurement [$F(2,3866) = 42.46$, $p < 0.05$, partial $\eta^2 = 0.27$], and follow-up univariate analysis also suggested that the complete teaching model had higher levels of writing ability at each interval (**Table 1**).

Correlation Analysis

In this study, we performed a correlation analysis of subjects' reading and writing abilities and corresponding control variables in the three tests under two different teaching models (**Table 2**). We observed a significant correlation between students' reading and writing, whether at the same time-point or at different time-points ($ps < 0.01$). Overall, the correlation coefficient between reading and writing at different time-points ranged 0.302–0.583.

Relationship Between Writing and Reading: Test Based on the Cross-Lagged Panel Structural Model

Before exploring the teaching model effects in the relationship between reading and writing, a series of nested CFAs were conducted to obtain evidence of measurement invariance across girls and boys. The measurement structure of latent factors was freely estimated across girls and boys in the unconstrained model, and the factors and factor loading patterns were constrained to be equal across two groups in the constrained model. Next, the x^2 difference test was used to assess significant differences in the models across gender groups (**Table 3**). All x^2 differences were significant for reading and writing, while other fit indices did not substantially decrease (ΔCFI < 0.01, ΔTLI < 0.01, ΔRMSEA < 0.005). These findings suggested that reading and writing display factorial invariance across teaching model groups.

We performed a comparative analysis of multiple groups to test the path difference between the two teaching models after controlled vocabulary knowledge and phonological awareness. (1) We established two groups of cross-lagged baseline models (primarily denoting reading and writing at three waves). All paths allowed free estimation according to the teaching model and attained a good fit ($x^2 = 1154.398$, $df = 630$, $p < 0.001$, CFI = 0.97, TLI = 0.94, RMSEA = 0.030 with 90% CI = [0.015, 0.043]). (2) We established a constrained cross-lagged model, setting the structural load weight between writing and reading to be equal between paths corresponding to different teaching models, and enabled the measurement model to change freely at three waves ($x^2 = 1365.622$, $df = 557$, $p < 0.001$, CFI = 0.92, TLI = 0.90, RMSEA = 0.036 with 90% CI = [0.029, 0.054]). (3) The χ^2 difference test suggested that compared with the unconstrained model, the fitting degree of the constrained model decreased marginally ($\Delta\chi^2_{(73)} = 211.224$, $p < 0.001$), and other suitable indexes also worsened (ΔCFI > 0.02, ΔTLI > 0.02, ΔRMSEA > 0.005), suggesting that the constraint model was rejected, that is, the relationships between reading and writing skills varied with the teaching model.

As shown in **Figure 3**, in the mixed minority language-Chinese teaching model, students' writing and reading skills interacted with each other and progressed, mostly in that students' writing facilitated the development of reading, while reading played a relatively weak role in enabling the development of writing. In the complete Chinese teaching model, students' reading and writing mutually facilitated each other, exhibiting an even stronger promoting effect. Specifically, under the mixed minority language-Chinese teaching model (S1), reading at T1 and T2 could significantly predict reading at T2 and T3 ($\beta_1 = 0.30$, $p_1 < 0.001$; $\beta_2 = 0.33$, $p_2 < 0.001$), and writing at T1 and T2 could significantly predict writing at T2 and T3 ($\beta_1 = 0.32$, $p_1 < 0.001$; $\beta_2 = 0.37$, $p_2 < 0.001$). Reading at T1/T2 could significantly predict writing at T2/T3 ($\beta_1 = 0.14$,

TABLE 1 | Mean score (*M*), standard deviation (*SD*) and MANOVA results.

TM	Variable	Evaluation	*M(SD)*			$F_{(T1-T3)}$	η_p^2
			T1	T2	T3		
S1	Reading	*Vocabulary knowledge (0-10)*	4.01(0.97)	4.79(1.18)	6.68(1.98)		
		Syntax (0-10)	4.18(1.03)	5.27(1.19)	6.95(1.23)	74.81**	
		Comprehension (0-10)	4.88(1.22)	5.75(1.43)	7.27(1.35)		0.41
	Writing	*Sentence spelling (0-10)*	5.77(1.22)	6.04(1.31)	7.56(1.27)		
		Short composition (0-6)	2.94(1.15)	3.18(1.22)	4.33(1.19)		
		Semi-guided Writing (0-6)	2.06(1.13)	3.29(1.31)	4.51(1.28)		
S2	Reading	*Vocabulary knowledge (0-10)*	4.09(1.01)	4.96(1.92)	6.79(1.53)		
		Syntax (0-10)	4.30(1.19)	5.58(1.33)	7.05(1.35)		
		Comprehension (0-10)	4.84(1.58)	6.64(1.75)	9.07(1.46)	42.46*	0.27
	Writing	*Sentence spelling (0-10)*	6.12(1.21)	7.47(1.28)	8.13(1.19)		
		Short composition (0-6)	3.03(1.13)	3.99(1.08)	4.97(1.23)		
		Semi-guided writing (0-6)	2.29(1.56)	4.08(1.68)	5.77(1.49)		

*TM, teaching model; S1, the mixed minority-Chinese teaching model; S2, the complete Chinese teaching model. T1 denotes the survey data in the first year; T2 denotes the survey data in the second year; and T3 denotes the survey data in the third year. *p < 0.05 and **p < 0.01.*

$p_1 < 0.05$; $\beta_2 = 0.17$, $p_2 < 0.05$), and writing at T1/T2 could significantly predict reading at T2/T3 ($\beta_1 = 0.16$, $p_1 < 0.05$; $\beta_2 = 0.21$, $p_2 < 0.01$). Under the complete Chinese teaching model (S2), reading at T1/T2 could significantly predict reading at T2/T3 ($\beta_1 = 0.32$, $p_1 < 0.001$; $\beta_2 = 0.37$, $p_2 < 0.001$), and writing at T1/T2 could significantly predict writing at T2/T3 ($\beta_1 = 0.35$, $p_1 < 0.001$; $\beta_2 = 0.39$, $p_2 < 0.001$). Reading at T1/T2 could significantly predict writing at T2/T3 ($\beta_1 = 0.20$, $p_1 < 0.01$; $\beta_2 = 0.30$, $p_2 < 0.001$), and writing at T1/T2 could significantly predict reading at T2/T3 ($\beta_1 = 0.23$, $p_1 < 0.01$; $\beta_2 = 0.34$, $p_2 < 0.001$).

TABLE 2 | Correlation coefficient of all students, mean score (*M*) and standard deviation (*SD*) of boys and girls in different teaching models about reading and writing.

Variable	1	2	3	4	5	6
(1) Reading (T1)	1	0.443***	0.375***	0.444***	0.323***	0.324***
(2) Reading (T2)	0.583***	1	0.487***	0.375***	0.427***	0.404***
(3) Reading (T3)	0.527***	0.490***	1	0.327***	0.382***	0.378***
(4) Writing (T1)	0.410***	0.417***	0.361***	1	0.412***	0.421***
(5) Writing (T2)	0.302**	0.507***	0.370***	0.435***	1	0.437***
(6) Writing (T3)	0.305**	0.462***	0.332***	0.391***	0.415***	1
S1						
Girls (M/SD)						
M	13.13	15.90	21.07	7.79	11.28	14.54
SD	4.59	4.26	4.85	1.98	2.05	2.06
Boys						
M	13.01	15.72	20.33	7.98	7.71	10.80
SD	5.01	4.44	4.33	2.23	2.16	2.39
S2						
Girls						
M	13.47	18.35	24.07	8.49	8.82	15.65
SD	4.39	4.19	4.76	2.11	2.23	2.19
Boys						
M	12.99	16.01	21.95	8.27	7.32	13.29
SD	4.63	4.22	4.65	1.99	2.17	2.24

*The table is divided into three parts, the first part of the table is the correlation coefficient of all the students, the correlation coefficient in the mixed minority language-Chinese teaching model (S1) is presented in the upper triangle, while the correlation coefficient of the complete Chinese teaching model (S2) is presented in the lower triangle. T1, the survey data in the first year; T2, the survey data in the second year; and T3, the survey data in the third year. **p < 0.01 and ***p < 0.001.*

Gender Differences in the Relationship Between Reading and Writing Under Different Teaching Model Groups

We analyzed teaching activities performed in the two teaching models to understand the specific influence of each teaching model on the interplay between reading and writing for boy and girl students. Before examining the gender effects in the relationship between reading and writing, a series of nested CFAs were conducted to obtain evidence of measurement invariance across boys and girls. The measurement structure of latent factors were freely estimated across boys and girls in the unconstrained model, and the factors and factor loading patterns were constrained to be equal across two groups in the constrained model. Then, the x^2 difference test was used to assess significant differences in the models across gender groups, and the results were shown at **Table 4**. The results suggested that under the S1/S2 teaching model, both reading and writing exhibited a factorial invariance across gender groups.

In this study, multigroup comparisons were conducted to test differences in paths across gender in the S1 and S2 teaching models separately. We established two groups of cross-lagged baseline models (primarily denoting reading and writing at three waves). (1) A two-group cross-lagged model as the baseline model (including reading and writing over the three waves), in which all of the paths were left free to vary by gender, achieved reasonable fit ($x^2 = 1889.253$, $df_{(S1)} = 630$, $p_{(S1)} < 0.001$, $CFI_{(S1)} = 0.95$, $TLI_{(S1)} = 0.93$, $RMSEA_{(S1)} = 0.041$ with 90% CI = [0.034–0.052]; $x^2 = 1902.253$, $df_{(S2)} = 630$, $p_{(S2)} < 0.001$, $CFI_{(S2)} = 0.96$, $TLI_{(S2)} = 0.95$, $RMSEA_{(S2)} = 0.038$ with 90% CI = [0.032–0.050]). (2) A constrained cross-lagged model was conducted, in which

TABLE 3 | Goodness-of-fit of measurement invariance confirmatory structural equation model between S1 and S2 for reading and writing.

Variable	Model	χ^2	*df*	CFI	TLI	RMSEA [90% CI]	$\Delta\chi^2$	Δdf	ΔCFI	ΔTLI	ΔRMSEA	*p*
Reading	U	72.554	48	0.984	0.976	0.047[0.032, 0.058]	2.697	6	+0.002	+0.003	−0.002	<0.001
	C	75.251	54	0.986	0.979	0.045[0.033, 0.057]						
Writing	U	98.495	48	0.974	0.961	0.051[0.039, 0.062]	4.674	6	+0.001	+0.003	+0.002	<0.001
	C	103.169	54	0.975	0.964	0.053[0.041, 0.061]						

U (unconstrained) means the unconstrained model that measurement structure of latent factors is freely estimated between the mixed minority language-Chinese teaching model (S1) and the complete Chinese teaching model (S2), C (constrained) means the constrained model that the factors and factor loading patterns were constrained to be equal across two groups.

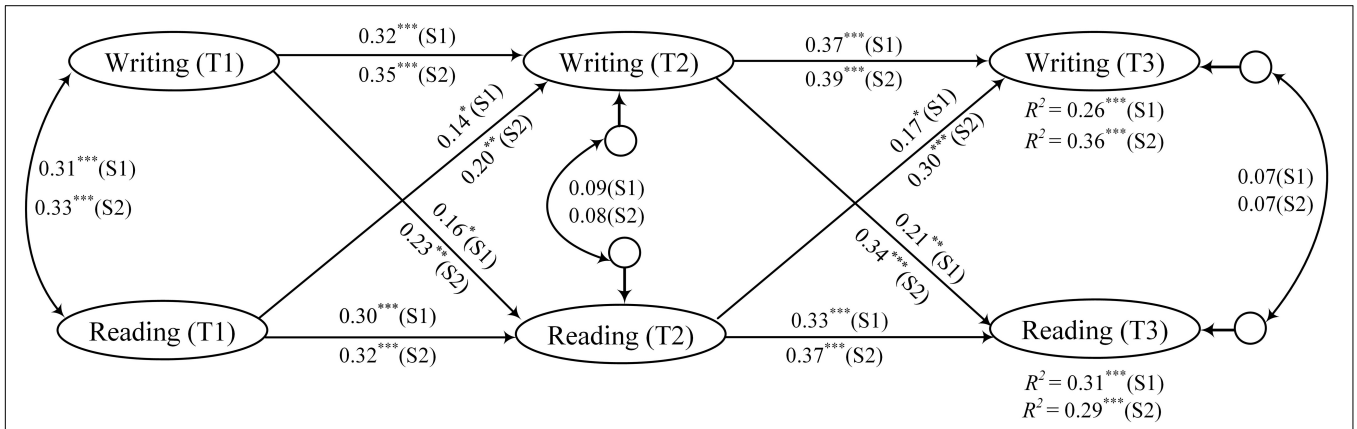

FIGURE 3 | Standardized regression coefficients in cross-lagged panel structural model in the mixed minority language-Chinese teaching model (S1) and the complete Chinese teaching model (S2). ***$p < 0.001$; **$p < 0.01$; and *$p < 0.05$.

TABLE 4 | Goodness-of-Fit of measurement invariance confirmatory structural equation model between boys and girls for reading and writing under each teaching model (S1 and S2).

TMM	Variable	Model	χ^2	*df*	CFI	TLI	RMSEA [90% CI]	$\Delta\chi^2$	Δdf	ΔCFI	ΔTLI	ΔRMSEA	*p*
	Reading	U	84.374	48	0.967	0.961	0.046[0.040, 0.058]	3.475	6	−0.002	+0.002	+0.001	<0.001
S1		C	87.849	54	0.965	0.963	0.047[0.041, 0.058]						
	Writing	U	80.610	48	0.973	0.968	0.049[0.043, 0.061]	4.445	6	+0.002	−0.002	+0.001	<0.001
		C	85.055	54	0.975	0.966	0.050[0.043, 0.061]						
	Reading	U	99.930	48	0.956	0.941	0.041[0.033, 0.052]	2.035	6	−0.002	−0.003	−0.002	<0.001
S2		C	101.965	54	0.954	0.938	0.039[0.033, 0.049]						
	Writing	U	76.595	48	0.969	0.953	0.043[0.036, 0.057]	6.358	6	−0.001	+0.002	+0.001	<0.001
		C	82.953	54	0.968	0.955	0.044[0.036, 0.057]						

TM, teaching model (including S1, the mixed minority language-Chinese teaching model; S2, the complete Chinese teaching model); U (unconstrained), the unconstrained model that measurement structure of latent factors is freely estimated between boys and girls; C (constrained), the constrained model that the factors and factor loading patterns were constrained to be equal across two groups.

structural weights between reading and writing were set to be equal to corresponding paths across gender, and the measure model were left free to vary across three waves (x^2 = 964.908, $df_{(S1)}$ = 553, $p_{(S1)} < 0.001$, $CFI_{(S1)}$ = 0.92, $TLI_{(S1)}$ = 0.90, $RMSEA_{(S1)}$ = 0.052 with 90% CI = [0.045–0.063]; x^2 = 982.473, $df_{(S2)}$ = 630, $p_{(S2)} < 0.001$, $CFI_{(S2)}$ = 0.93, $TLI_{(S2)}$ = 0.90, $RMSEA_{(S2)}$ = 0.042 with 90% CI = [0.036–0.054]). (3) The χ^2 difference test suggested that compared with the unconstrained model, the fitting degree of the constrained model decreased marginally ($\Delta\chi^2_{(s1)}$ = 924.345, $p_{(S1)} < 0.001$; $\Delta\chi^2_{(s2)}$ = 919.780, $p_{(S2)} < 0.001$), and other suitable indexes also worsened ($\Delta CFI_{(S1)} > 0.02$, $\Delta TLI_{(S1)} > 0.02$, $\Delta RMSEA_{(S1)} > 0.005$; $\Delta CFI_{(S2)} > 0.02$, $\Delta TLI_{(S2)} > 0.02$, $\Delta RMSEA_{(S2)} > 0.005$), suggesting that the two models were rejected, that is, the relationship between reading and writing skills varied by gender under S1 (and S2) teaching model.

In the mixed minority language-Chinese teaching model (**Figure 4**), the results revealed that girls' reading at T1/T2 could significantly predict their reading at T2/T3 ($\beta_1 = 0.28$, $p_1 < 0.001$; $\beta_2 = 0.31$, $p_2 < 0.001$). Similarly, boys' reading at T1/T2 could also significantly predict their reading at T2/T3($\beta_1 = 0.34$, $p_1 < 0.001$; $\beta_2 = 0.40$, $p_2 < 0.001$). Girls' writing at T1/T2

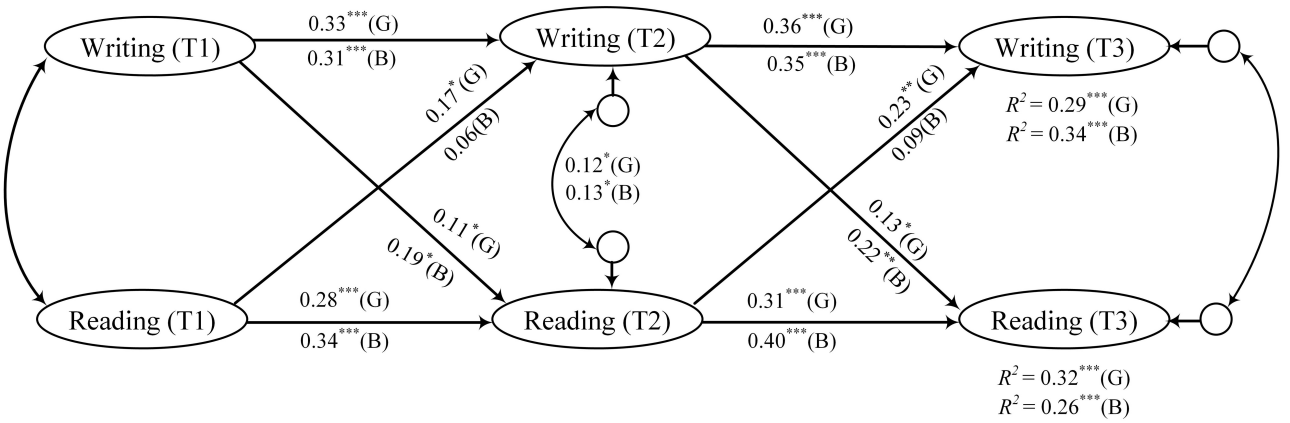

FIGURE 4 | Mixed minority language-Chinese teaching model. Standardized regression coefficients in cross-lagged panel structural model in boys (B) and girls (G) under the mixed minority language-Chinese teaching model. ***$p < 0.001$; **$p < 0.01$; and *$p < 0.05$.

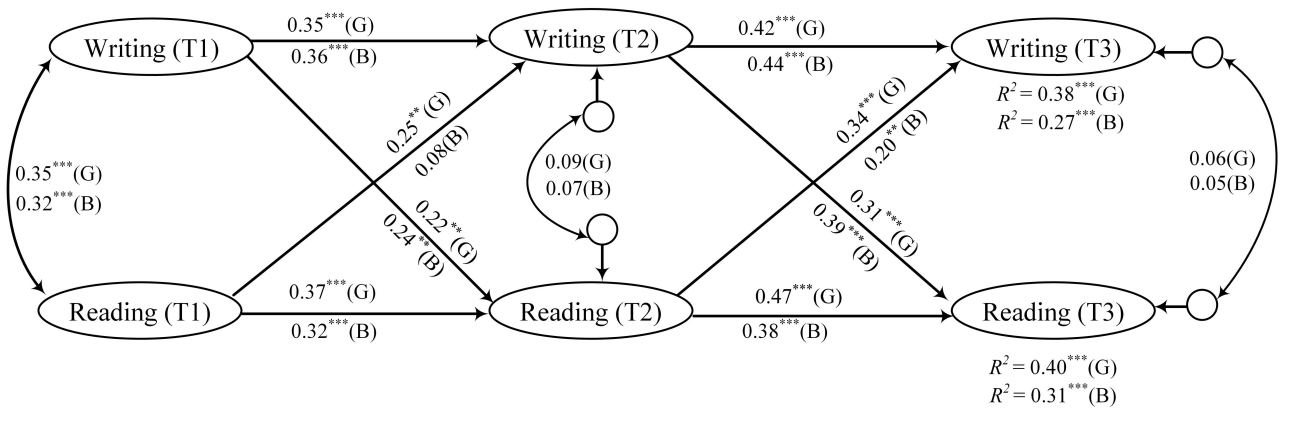

FIGURE 5 | Complete Chinese teaching model. Standardized regression coefficients in cross-lagged panel structural model in boys (B) and girls (G) under the complete Chinese teaching model. ***$p < 0.001$ and **$p < 0.01$.

could significantly predict their writing T2/T3 (β_1 = 0.33, $p_1 < 0.001$; β_2 = 0.36, $p_2 < 0.001$). Likewise, boys' writing at T1 and T2 could significantly predict T2/T3 writing (β_1 = 0.31, $p_1 < 0.01$; β_2 = 0.35, $p_2 < 0.001$). Girls' reading at T1/T2 could significantly predict their writing at T2/T3 (β_1 = 0.17, $p_1 < 0.05$; β_2 = 0.23, $p_2 < 0.01$). However, boys' reading at T1/T2 fails to significantly predict their writing at T2/T3 ($ps > 0.05$). Girls' writing at T1/T2 could significantly predict their reading at T2/T3 (β_1 = 0.11, $p_1 < 0.05$; β_2 = 0.13, $p_2 < 0.05$). In addition, boys' writing at T1/T2 could significantly predict their reading at T2/T3 (β_1 = 0.19, $p_1 < 0.05$; β_2 = 0.22, $p_2 < 0.01$). The model-fitting results revealed that in the interaction relationship between reading and writing embodied in the mixed minority language-Chinese teaching model, boys' reading exerted little effect on writing, and this relationship was not changed over time. Their writing could promote reading somewhat; this effect was marginally strengthened with development. The interplay trend between the reading and writing development under this teaching model was significant for girls, and this effect was marginally strengthened with development. Briefly, in the traditional mixed minority language-Chinese teaching model, students' reading and writing relied more on their own accumulation and promotion, and the interaction between the two was not prominent. As teachers in traditional teaching used their native language to guide students, and students mostly relied on test-taking skills to enhance their Chinese grades, it was challenging for students to really improve their reading and writing abilities. Hence, it was difficult for students to promote their learning effects and achieve mutual promotion between reading and writing.

As shown in **Figure 5**, in the complete Chinese teaching model, the results revealed that girls' reading at T1/T2 could significantly predict their reading at T2/T3 (β_1 = 0.37, $p_1 < 0.001$; β_2 = 0.47, $p_2 < 0.001$). Similarly, boys' reading at T1/T2 could also significantly predict their reading at T2/T3 (β_1 = 0.32, $p_1 < 0.001$; β_2 = 0.38, $p_2 < 0.001$). Girls' writing at T1/T2

could significantly predict their writing at T2/T3 (β_1 = 0.35, $p_1 < 0.001$; β_2 = 0.42, $p_2 < 0.001$). Likewise, boys' writing at T1/T2 could significantly predict their writing at T2/T3 (β_1 = 0.36, $p_1 < 0.001$; β_2 = 0.44, $p_2 < 0.001$). Girls' reading at T1/T2 could significantly predict their writing at T2/T3 (β_1 = 0.25, $p_1 < 0.01$; β_2 = 0.34, $p_2 < 0.001$). However, boys' reading at T1/T2 failed to significantly predict their writing at T2/T3 (β = 0.08, $p > 0.05$), while boys' reading at T2 could significantly predict T3 writing (β = 0.20, $p < 0.01$). Girls' writing at T1/T2 could significantly predict their reading at T2/T3 (β_1 = 0.22, $p_1 < 0.01$; β_2 = 0.31, $p_2 < 0.001$). Likewise, boys' reading at T1/T2 could also significantly predict their reading at T2/T3 (β_1 = 0.24, $p_1 < 0.01$; β_2 = 0.39, $p_2 < 0.001$). From the perspective of the model fitting results, girls' reading exhibited an increasingly stronger promotion on writing with the implementation of the complete Chinese teaching model. In addition, girls' writing exhibited an increasingly promoting effect on reading. Moreover, the interplay between girls' writing and reading abilities exerted a significant impact at various stages. Although boys also exhibited a trend that writing exerted an increasingly stronger impact on reading than the other way around, at first, boys' reading did not have a significant impact on writing, and it is only in the second year that the trend that reading promoted writing began to emerge, which shows the promoting effect of teaching model. We observed a similar trend between boys and girls in the way that writing affected reading. Under the complete Chinese teaching model, a mutual interplay was noted between reading and writing to varying degrees for boys and girls.

DISCUSSION

Research on the application of certain educational models or intervention means to efficiently promote the development of students' reading and writing skills has proliferated considerably (McKenna and Stahl, 2018; Treiman, 2018). In this study, we adopted a 3-year longitudinal design to elucidate the role played by different teaching models in promoting the relationship between reading and writing skills from the developmental perspective. The findings revealed that regardless of the teaching model adopted in the process of China's minority students learning Chinese, reading and writing could facilitate the development of each other to varying degrees. Schoonen (2018) argued that both reading and writing needed language learners to display a certain fluency in acquiring language knowledge resources. Furthermore, this study revealed that the relationship between reading and writing differed to varying degrees because of different teaching models. This study also reported gender differences in the interplay between Chinese reading and writing under different teaching models. All these provide some reference for the subsequent teaching design and method selection to implement Chinese teaching in minority areas in China.

First, this study constructs an overall model to explore the promotion of the S1 and S2 teaching models on the development of Chinese reading and writing ability, respectively. Under the minority language-Chinese teaching model (S1), writing and reading skills mutually facilitated each other, and the relationship between the two was relatively weak. Teachers who used this teaching model were from the said ethnic minority, with the minority language as their native language; their guidance on Chinese provided to students was mostly realized through their native language, and such guidance was depicted more in writing and examination skills. In Chinese teaching, besides Chinese textbooks, teachers did not have adequate Chinese materials to help children read sufficiently, and teachers whose native language was not Chinese were unable to provide students with insightful guidance in Chinese. Under the S1 teaching model, teachers often left assignment such as writing diaries in Chinese. The form of assignment, that is, writing in limited Chinese, was more familiar to students, and students often mobilized Chinese words already known to them in writing. In a writing task, students must complete a reading task and use their internal memory and language resources to complete the task (Hayes, 1996, 2012), under the S1 teaching model, students could also engage in Chinese reading in the assigned Chinese writing task, students had to further mobilize their reading ability (Flower and Hayes, 1981; Hayes, 1996), thus, students' high writing ability encouraged students to improve their reading ability. However, although reading needs induced by Chinese writing and Chinese accumulation could facilitate the development of Chinese reading to a certain degree, this type of facilitation was limited because of insufficient materials, which was reflected in the path coefficient of model fitting.

For the complete Chinese teaching model (S2), writing and reading ability displayed more robust mutual facilitation, and the mutual interplay, that is, writing ability on reading ability, and *vice versa*, was nearly the same. Some previous studies proposed that reading ability favors the writing process and writing output (McCutchen, 2000). Considerable Chinese language materials and language teachers provide significant guided communication, enabling students obtain higher quality of Chinese reading at ordinary times. Students have to do daily Chinese writing exercises (e.g., Chinese diary), which would be useful at ordinary times reading material content in the application of Chinese writing. Reading and feedback occasionally play a prominent role in reading comprehension and writing revision, including weighing the role of vocabulary and characteristics of the writing style, and grasping of sentence structure (Deane et al., 2008). Usually, students must write according to the written materials they read and must create a mental model for the writing task (Nicola's-Conesa, 2012), which itself could warrant careful reading of the instructions or the original materials. To better complete the writing task, students mobilize their internal mental model to read articles till the time of writing (Hayes et al., 1987).

In addition, we found gender differences in the developmental relationship between Chinese reading and writing under each teaching model. Several studies on reading and writing have reported differences in reading and writing abilities between boys and girls. Though most studies suggested that girls perform better

in reading and writing than boys (Reynolds et al., 2015; Cordeiro et al., 2018), some studies reported that girls do not always enjoy advantages in terms of reading or writing ability compared with boys (Jewell and Malecki, 2005; Beard and Burrell, 2010; Scheiber et al., 2015). Despite divergent conclusions drawn for gender differences in reading and writing, the relationship between reading and writing is more complicated. This study focused on the effect of different teaching models on the relationship between reading and writing. Specifically, under the S1 teaching model, boys' reading ability only affected its own development, and its development hardly contribute to the development of writing ability. However, the development of boys' writing ability markedly facilitated the development of reading ability. Similarly, the development of girls' reading ability exerted a significant impact on the development of their writing ability. Under the S2 teaching model, the development of reading and writing for boys and girls exhibited mutual facilitation. Obviously, under the teaching model with abundant Chinese resources and in-depth guidance for Chinese learning, both boys and girls could achieve integrated development of reading and writing, thereby exhibiting a more significant interplay between each other.

This study has a certain theoretical significance. Different theories have been used to elucidate the interplay between reading and writing. For example, a one-way interaction (i.e., reading influences writing, or *vice versa*) could exist between reading ability and writing ability, or a two-way interaction (Shanahan and Lomax, 1988; Schoonen, 2018). In this study, we set up different teaching models to compare the interplay between the development of reading ability and that of writing ability under different teaching models. In the process of Chinese minority students learning Chinese, the traditional S2 teaching model could better promote the interaction between reading and writing compared with the S1 teaching model. Thus, we found gender differences between boys and girls. In addition, a mutual promotion was present between reading and writing for girls under these two teaching models. However, boys' reading and writing could facilitate each other to a certain extent under the S2 teaching model. One-way facilitation, that is, writing facilitating reading, was observed in the S1 teaching model; that is, reading did not significantly impact writing in this model, suggesting that in the future research on the relationship between reading and writing, we should not only take the overall development relationship between reading and writing into account but also comprehensively weigh teaching models and individual factors (such as gender in this study) that can promote the development of reading and writing to provide a detailed explanation. Moreover, this study has some practical significance. Our study demonstrates that the interplay between reading and writing is less significant for Chinese minority students learning Chinese under the traditional S1 teaching model compared with the S2 teaching model, and such differences are more viewed from the perspective of gender differences. It is crucial to provide students with sufficient Chinese reading materials, reading and writing guidance from native Chinese teachers, and more frequent activities organized for small Chinese interest classes. This study can inspire teachers and educational decision-makers to take more extensive measures, such as appropriately increasing teaching input based on the original teaching input, helping students gradually improve their reading and writing abilities by providing more reading materials and strengthening the training of native language teachers, and improving the interplay between reading and writing.

Limitations

This study has some limitations worth acknowledging. First, the study participants were students from the minority groups in Xinjiang, China, which was favorable to control the influence of students' native language. However, as China is a multi-ethnic country, the diversity of background languages should be considered when promoting a complete Chinese teaching model in other minority areas in China. Second, owing to the limitation of data collection and study design, we could not determine whether the differences in other aspects of the school environment are accountable for differences in reading and writing skills under different teaching models. Thus, a comprehensive influence mechanism of teaching models remains to be further examined. Finally, although this study aimed to investigate reading and writing skills, only a limited number of crucial variables were included in this study. Hence, future research should further control these variables or elucidate the impact of other variables on reading and writing skills.

CONCLUSION

This study establishes an interactive relationship between reading and writing in both teaching models. The complete Chinese teaching model is more effective than the mixed teaching model in promoting the interaction relationship between reading and writing. In the mixed teaching model, boys do not show a significant effect of reading on writing, but only the effect of writing on reading, whereas girls exhibit the interaction between reading and writing. In the complete teaching model, there are gender differences in the relationship between reading and writing, however, with the development of time, the interaction between boys and girls in reading and writing becomes more robust, demonstrating that similar development trend in boys' and girls' interaction between reading and writing.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

The Institutional Review Committee, comprising the Collaborative Innovation Center of Assessment toward Basic Education Quality, Beijing Normal University and Faculty of Linguistic Sciences, Beijing Language and Culture University, approved all the questionnaires and procedures used

in this study. In addition, written informed consent was obtained from all principals, students and their parents in this study.

AUTHOR CONTRIBUTIONS

YZ designed and executed the study, analyzed the data, and wrote the manuscript. HP collaborated with editing of the manuscript. YB collaborated with the design of the study. All authors contributed to the article and approved the submitted version.

FUNDING

This study was major project of the National Social Science Fund Studies on Chinese Communicative Competence Standards and Assessment System (15ZDB101).

REFERENCES

Abbott, R. D., Berninger, V. W., and Fayol, M. (2010). Longitudinal relationships of levels of language in writing and between writing and reading in grades 1 to 7. *J. Educ. Psychol.* 102, 281–298. doi: 10.1037/a0019318

Al Otaiba, S., and Fuchs, D. (2006). Who are the young children for whom best practices in reading are ineffective? *J. Learn. Disabil.* 39, 414–431. doi: 10.1177/00222194060390050401

Babayiğit, S. (2015). The dimensions of written expression: language group and gender differences. *Learn. Instruct.* 35, 33–41. doi: 10.1016/j.learninstruc.2014.08.006

Baker, C. (1993). *Foundations of Bilingual Education and Bilingualism*. Clevedon: Multilingual Matters Ltd.

Baker, C. (2001). *Foundations of Bilingual Education and Bilingualism*. Bristol: Multilingual Matters.

Baker, C. (2002). *Foundations of Bilingual Education and Bilingualism*, 3rd Edn, Bristol: Multilingual Matters.

Baker, C. (2006). "Psycho-sociological analysis in language policy," in *An Introduction to Language Policy*, ed. T. Ricento (Oxford: Blackwell), 210–228.

Beard, R., and Burrell, A. (2010). Writing attainment in 9- to 11-year-olds: some differences between girls and boys in two genres. *Lang. Educ.* 24, 495–515. doi: 10.1080/09500782.2010.502968

Berninger, V. W., and Abbott, R. D. (2010). Listening comprehension, oral expression, reading comprehension, and written expression: related yet unique language systems in grades 1, 3, 5, and 7. *J. Educ. Psychol.* 102, 635–651. doi: 10.1037/a0019319

Berninger, V. W., Abbott, R. D., Abbott, S. P., Graham, S., and Richards, T. (2002). Writing and reading: connections between language by hand and language by eye. *J. Learn. Disabil.* 35, 39–56. doi: 10.1177/002221940203500104

Berninger, V. W., Cartwright, A. C., Yates, C. M., Swanson, H. L., and Abbott, R. D. (1994). Developmental skills related to writing and reading acquisition in the intermediate grades. Shared and unique functional systems. *Read. Writ. Interdiscipl. J.* 6, 161–196. doi: 10.1007/BF01026911

Chapelle, C. A., Enright, M. K., and Jamieson, J. M. (eds) (2011). *Building a Validity Argument for the Test of English as a Foreign LanguageTM*. New York, NY: Routledge.

Cordeiro, C., Castro, S. L., and Limpo, T. (2018). Examining potential sources of gender differences in writing: the role of handwriting fluency and self-efficacy beliefs. *Writ. Commun.* 35:074108831878884. doi: 10.1177/0741088318788843

Cummins, J. (2000). *Language, Power and Pedagogy: Bilingual Children in the Crossfire*. Bristol: Multilingual Matters LTD.

Deane, P., Odendahl, N., Quinlan, T., Fowles, M., Welsh, C., and Bivens-Tatum, J. (2008). *Cognitive Models of Writing: Writing Proficiency as a Complex Integrated Skill*. Princeton, NJ: ETS.

Department for Education (2012). *What is the Research Evidence on Writing? RR238*. Available at: https://www.gov.uk/government/publications/what-is-the-research-evidence-on-writing (accessed May 11, 2018).

Department for Education (2013). *The National Curriculum in England Framework document. September 2013, Ref: DFE-00178-2013*. Available at: https://www.gov.uk/government/publications/nationalcurriculum-in-england-primary-curriculum#history (accessed May 11, 2018).

Dicker, S. J. (2003). *Language in America: A Pluralist View*, 2nd Edn, Clevedon: Multilingual Matters.

Edmonds, M. S., Vaughn, S., Wexler, J., Reutebuch, C. K., Cable, A., Tackett, K. K., et al. (2009). A synthesis of reading interventions and effects on reading outcomes for older struggling readers. *Rev. Educ. Res.* 79, 262–300.

Fang, X. (2004). *Chinese Textbooks*. Xinjiang1: Xinjiang Education Press.

Flower, L., and Hayes, J. R. (1981). A cognitive process theory of writing. *Coll. Composit. Commun.* 32, 365–387. doi: 10.2307/356600

Gao, T., Zhao, J., Li, X., Mao, Y., Chen, Q., and Harrison, S. E. (2019). Impact of rapid reading skills training on reading rate and reading achievement among primary school students in China. *Educ. Psychol.* 40, 42–61. doi: 10.1080/01443410.2019.1607257

Geva, E., and Ramírez, G. (2015). *Focus on Reading*. New York, NY: Cambridge University Press.

Guimond, S., and Roussel, L. (2001). Bragging about one s school grades: gender stereotyping and students perception of their abilities in science, mathematics, and language. *Soc. Psychol. Educ.* 4, 275–293. doi: 10.1023/A:1011332704215

Hall, M. S., and Burns, M. K. (2018). Meta-analysis of targeted small-group reading interventions. *J. Sch. Psychol.* 66, 54–66. doi: 10.1016/j.jsp.2017.11.002

Hattie, J., and Timperley, H. (2007). The power of feedback. *Rev. Educ. Res.* 77, 81–112.

Hayes, J. R. (1996). "A new framework for understanding cognition and affect in writing," in *The Science of Writing: Theories, Methods, Individual Differences and Applications*, eds C. M. Levy, and S. Ransdell (Mahwah, NJ: Lawrence Erlbaum), 1–27.

Hayes, J. R. (2012). Modeling and remodeling writing. *Writ. Commun.* 29, 369–388. doi: 10.1177/0741088312451260

Hayes, J. R., Flower, L., Schriver, K. A., Stratman, J. F., and Carey, L. (1987). "Cognitive processes in revision," in *Advances in Applied Psycholinguistics: Volume 2, Reading, Writing, and Language Learning*, ed. S. Rosenberg (Cambridge: Cambridge University Press), 176–240.

Jewell, J., and Malecki, C. K. (2005). The utility of CBM written language indices: an investigation of production-dependent, production-independent, and accurateproduction scores. *Sch. Psychol. Rev.* 34, 27–44.

Jonathan, M. N., Dana, R. F., Christine, C. M., William, G. G., Fredricka, L. S., and Vandergrift, L. (2018). *Teaching English to Second Language Learners in Academic Contexts-Reading, Writing, Listening and Speaking*. New York, NY: Routledge.

Kamps, D., and Greenwood, C. (2005). Formulating secondary level reading interventions. *J. Learn. Disabil.* 38, 500–509. doi: 10.1177/00222194050380060501

Li, H., Dong, Q., Zhu, J., Liu, J. P., and Wu, X. C. (2009). The role of morphological awarence in kindergarteners linguistic skill development. *Journal of Psychological Science* 32, 1291–1294.

Marsh, H. W., and Yeung, A. S. (1998). Longitudinal structural equation models of academic selfconcept and achievement: gender differences in the development of math and English constructs. *Am. Educ. Res. J.* 35, 705–738. doi: 10.3102/00028312035004705

McCutchen, D. (2000). Knowledge, processing, and working memory: implications for a theory of writing. *Educ. Psychol.* 35, 13–23. doi: 10.1207/S15326985EP3501_3

McGeown, S., Goodwin, H., Henderson, N., and Wright, P. (2012). Gender differences in reading motivation: does sex or gender identity provide a better account? *J. Res. Read.* 35, 328–336. doi: 10.1111/j.1467-9817.2010.01481.x

McGeown, S. P. (2013). Sex or gender identity? Understanding children s reading choices and motivation. *J. Res. Read.* 38, 35–46. doi: 10.1111/j.1467-9817.2012.01546.x

McKenna, M. C., and Stahl, K. A. D. (2018). *Assessment for Reading Instruction*, 3rd Edn, New York, NY: The Guilford Press.

Midgette, E., Haria, P., and MacArthur, C. A. (2008). The effects of content and audience awareness goals for revision on the persuasive essays of fifth- and eighthgrade students. *Read. Writ. Interdiscipl. J.* 21, 131–151. doi: 10.1007/s11145-007-9067-9

Millard, E. (1997). *Differently Literate: Boys, Girls and the Schooling of Literacy*. London: Falmer Press.

Moats, L. C. (2005). How spelling supports reading. *American Educator* 29, 4–12.

Nalipay, M. J. N., Cai, Y., and King, R. B. (2019). Why do girls do better in reading than boys? How parental emotional contagion explains gender differences in reading achievement. *Psychol. Sch.* 57, 310–319. doi: 10.1002/pits.22330

Nicola's-Conesa, F. (2012). *Development of Mental Models of Writing in a Foreign Language Context: Dynamics of Goals and Beliefs*. Doctoral thesis, University of Murcia, Murcia.

Pajares, F., and Valiante, G. (2001). Gender differences in writing motivation and achievement of middle school students: a function of gender orientation? *Contemp. Educ. Psychol.* 26, 366–381. doi: 10.1006/ceps.2000.1069

Peng, H. (2005). Chinese proficiency test for minorities in china. *Chin. Exam.* 10, 57–59.

Perfetti, C. (2007). Reading ability: lexical quality to comprehension. *Sci. Stud. Read.* 11, 357–383. doi: 10.1080/10888430701530730

Perfetti, C., and Adlof, S. M. (2012). "Reading comprehension: a conceptual framework from word meaning to text meaning," in *Measuring Up: Advances in How to Assess Reading Ability*, eds J. P. Sabatini, E. A. Albro, and T. O. Reilly (Lanham, MD: Rowman & Littlefield Education), 3–20.

Reynolds, M. R., Scheiber, C., Hajovsky, D. B., Schwartz, B., and Kaufman, A. S. (2015). Gender differences in academic achievement: is writing an exception to the gender similarities hypothesis? *J. Genet. Psychol.* 176, 211–234. doi: 10.1080/00221325.2015.1036833

Scammacca, N., Roberts, G., Vaughn, S., Edmonds, M., Wexler, J., Reutebuch, C. K., et al. (2007). *Interventions for Adolescent Struggling Readers: A Metanalysis With Implications for Practice*. Portsmouth, NH: RMC Research Corporation.

Scammacca, N. K., Roberts, G., Vaughn, S., and Stuebing, K. K. (2015). A meta-analysis of interventions for struggling readers in grades 4-12: 1980-2011. *J. Learn. Disabil.* 48, 369–390. doi: 10.1177/0022219413504995

Scheiber, C., Reynolds, M. R., Hajovsky, D. B., and Kaufman, A. S. (2015). Gender differences in achievement in a large, nationally representative sample of children and adolescents. *Psychology in the Schools* 52, 335–348. doi: 10.1002/pits.21827

Schoonen, R. (2018). Are reading and writing building on the same skills? The relationship between reading and writing in L1 and EFL. *Read. Writ.* 32, 511–535. doi: 10.1007/s11145-018-9874-1

Shanahan, T. (2009). "Connecting reading and writing instruction for struggling learners," in *Instruction and Assessment for Struggling Writers: Evidence-Based Practices*, ed. G. A. Troia (New York, NY: The Guilford Press), 113–131.

Shanahan, T., and Lomax, R. G. (1988). A developmental comparison of three theoretical models of the reading-writing relationship. *Res. Teach. Eng.* 22, 196–212.

Shute, V. J. (2008). Focus on formative feedback. *Rev. Educ. Res.* 78, 153–189. doi: 10.3102/0034654307313795

Stern, H. H. (1999). *Fundamental Concepts of Language Teaching*. Shanghai: Shanghai Foreign Language Education Press.

Treiman, R. (2018). What research tells us about reading instruction. *Psychol. Sci. Public Interest* 19:14. doi: 10.1177/1529100618772272

Voyer, D., and Voyer, S. D. (2014). Gender differences in scholastic achievement: a meta analysis. *Psychol. Bull.* 140, 1174–1204. doi: 10.1037/a0036620

Wanzek, J., Wexler, J., Vaughn, S., and Ciullo, S. (2010). Reading interventions for struggling readers in the upper elementary grades: a synthesis of 20 years of research. *Read. Writ.* 23, 889–912. doi: 10.1007/s11145-009-9179-5

Yuan, S., and Peng, H. L. (2014). An empirical study on the longitudinal scale of chinese test paper in Xinjiang province. *The Chinese Testing*. doi: 10.3969/j.issn.1005-8427.2014.07.001

Conflict of Interest: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

frontiers in Psychology

ORIGINAL RESEARCH
published: 23 November 2020
doi: 10.3389/fpsyg.2020.593995

Math Is for Me: A Field Intervention to Strengthen Math Self-Concepts in Spanish-Speaking 3rd Grade Children

Dario Cvencek[1], Jesús Paz-Albo[2], Allison Master[1,3], Cristina V. Herranz Llácer[2], Aránzazu Hervás-Escobar[2] and Andrew N. Meltzoff[1]*

[1] Institute for Learning and Brain Sciences, University of Washington, Seattle, WA, United States, [2] Departamento de Ciencias de la Educación, Lenguaje, Cultura y Artes, Ciencias Histórico-Jurídicas y Humanísticas y Lenguas Modernas, Facultad de Ciencias Jurídicas y Sociales, Universidad Rey Juan Carlos, Madrid, Spain, [3] Department of Psychological, Health, and Learning Sciences, University of Houston, Houston, TX, United States

OPEN ACCESS

Edited by:
Edgar Galindo, University of Évora, Portugal

Reviewed by:
Leanne Elliott, University of Pittsburgh, United States
Martín-Lobo Pilar, Universidad Internacional De La Rioja, Spain
Óscar Conceição De Sousa, Universidade Lusófona, Portugal

***Correspondence:**
Dario Cvencek
dario1@uw.edu

Specialty section:
This article was submitted to Educational Psychology, a section of the journal Frontiers in Psychology

Received: *12 August 2020*
Accepted: *14 October 2020*
Published: *23 November 2020*

Citation:
Cvencek D, Paz-Albo J, Master A, Herranz Llácer CV, Hervás-Escobar A and Meltzoff AN (2020) Math Is for Me: A Field Intervention to Strengthen Math Self-Concepts in Spanish-Speaking 3rd Grade Children. Front. Psychol. 11:593995. doi: 10.3389/fpsyg.2020.593995

Children's math self-concepts—their beliefs about themselves and math—are important for teachers, parents, and students, because they are linked to academic motivation, choices, and outcomes. There have been several attempts at improving math achievement based on the training of math skills. Here we took a complementary approach and conducted an intervention study to boost children's math self-concepts. Our primary objective was to assess the feasibility of whether a novel multicomponent intervention—one that combines explicit and implicit approaches to help children form more positive beliefs linking themselves and math—can be administered in an authentic school setting. The intervention was conducted in Spain, a country in which math achievement is below the average of other OECD countries. We tested third grade students (N = 180; M_{age} = 8.79 years; 96 girls), using treatment and comparison groups and pre- and posttest assessments. A novelty of this study is that we used both implicit and explicit measures of children's math self-concepts. For a subsample of students, we also obtained an assessment of year-end math achievement. Math self-concepts in the treatment and comparison groups did not significantly differ at pretest. Students in the treatment group demonstrated a significant increase in math self-concepts from pretest to posttest; students in the comparison group did not. In the treatment group, implicit math self-concepts at posttest were associated with higher year-end math achievement, assessed approximately 3 months after the completion of the intervention. Taken together, the results suggest that math self-concepts are malleable and that social–cognitive interventions can boost children's beliefs about themselves and math. Based on the favorable results of this feasibility study, it is appropriate to formally test this novel multicomponent approach for improving math self-concepts using randomized controlled trial (RCT) design.

Keywords: math self-concept, intervention, implicit cognition, math achievement, Spanish-speaking children, elementary school

INTRODUCTION

Improving the quality of education during the elementary-school years is a goal of global initiatives concerned with transforming schools. There has been increasing attention to enhancing not only children's academic skills, but also students' beliefs and attitudes about school and learning. Research has shown that students' thoughts and feelings about mathematics contribute to their academic motivation, choices, and achievement. The present study examined the malleability of students' *math self-concepts*—how children think of themselves in relation to mathematics. We designed an intervention to enhance children's math self-concepts with the long-term goal, after further study, of designing broader intervention programs to help improve mathematics outcomes in young children.

At the broadest level, math self-concepts refer to how children think of themselves in relation to math. A substantive body of empirical work in the traditions of Reciprocal Effects Model (REM; Marsh, 1990) and Expectancy Value Theory (EVT; Eccles et al., 1983) provides ample evidence that the relation between a self-concept in a particular subject (e.g., math self-concept) and achievement in that subject (e.g., math achievement) is positive and often reciprocal (see Arens et al., 2020; Jiang et al., 2020). For example, a large, longitudinal study from the end of Grade 4 through the end of Grade 9 (N = 3,370 German students across 42 schools) found that math self-concepts were both predictive of (as well as predicted by) math test scores and school grades over the 6-year-period (Marsh et al., 2018). Another study involving 241 Shanghai children from Grades 2, 4, and 7 showed, using path analyses, that math self-concepts were positively related to calculation fluency in Grade 7 and math problem solving in Grades 4 and 7 (Cai et al., 2018). Finally, a study of United States preschoolers showed that early math self-concepts predicted math achievement 5 months later, controlling for initial self-concepts/interest in math (Fisher et al., 2012). Taken together, these studies show that the links between math self-concepts and math achievement are robust, reciprocal, evident cross-sectionally and longitudinally, and across different countries and age groups.

Math self-concepts can be measured in many ways and at many levels (Gunderson et al., 2012). At the simpler level are straightforward self-representations and identities such as students' judgments of their own personal ability in math (Harter, 2006) or a strong psychological link between *self* and *math* (Cvencek et al., 2011). At higher levels of complexity are multidimensional, self-reflective views of math self-concepts that involve social comparison, perceptions of the self in math learning situations, and future expectancies about one's competence in math (Bong and Skaalvik, 2003; Eccles, 2005; Marsh et al., 2019). The identity association of *me* = *math* corresponds to the "simpler level" of the math self-concept, and is what we sought to tap in the tests used in this paper (**Supplementary Material Section 1** provides a more detailed analysis of this conception of "levels," as well as measurement methods).

Young children's math self-concepts have been assessed with both *explicit* measures using intentional, verbalizable self-report (e.g., Harter and Pike, 1984), as well as *implicit* measures using automatic and non-reflective responding (Cvencek et al., 2011). Explicit processes are controlled and deliberative with mental contents accessible to introspection. Implicit processes are typically fast, non-deliberative, and not available to introspection. Both are recognized to be of psychological importance (e.g., Kahneman, 2011). Some studies have shown that, although implicit and explicit math self-concepts can be dissociated in children, both are useful for predicting math-related outcomes. Explicit math self-concepts may be more strongly linked to children's conscious choices and future aspirations, while implicit math self-concepts may be more strongly linked to achievement on timed, high-stakes standardized tests (Steffens et al., 2010; Cvencek et al., 2015).

In research with adult participants, the explicit system is considered to be malleable and changed with "one-shot" intervention strategies, whereas the implicit system is often considered to be relatively rigid (Devine et al., 2012). To date, little research has examined whether the difficulties in changing implicit cognition in *adult* participants also apply for children. Interventions on children could potentially be more effective in changing implicit beliefs than in adults because children's implicit cognition is based on fewer experiences and therefore may be less crystallized and more malleable than the adult case (Gonzalez et al., 2017). It is currently unknown whether interventions targeting implicit math beliefs can be designed in age-appropriate ways during elementary school, or whether a combination of interventions that draw on both implicit and explicit measurement approaches might be especially effective.

Elementary school is a desirable time for designing interventions to change math self-concepts. First, math self-concepts are still developing during this age period. While there is a substantial body of work demonstrating the stable relations between math self-concepts and math achievement by middle school (Muenks et al., 2018; Marsh et al., 2019), the math self-concepts in elementary-school children undergo substantial change (Ehm et al., 2019). Specifically, the magnitude (how positive or negative one's math self-concept is), structure (what types of beliefs and self-evaluations factor into the "content" of one's math self-concept), and the relation of math self-concepts to math achievement all undergo change during elementary school (Weidinger et al., 2018). Second, the ages tested here may represent the optimal time to influence children's implicit beliefs in particular (Gonzalez et al., 2017; Qian et al., 2019); it may be a time during which math begins to be incorporated into one's self-concept (Lei et al., 2019). The age group in this study (Grade 3; 8 to 9 years of age) was chosen based on dual reasons: (i) it seems to be a time of developmental change and (ii) previous findings show that math self-concepts can be measured reliably with both implicit and explicit measures at this age (Meltzoff and Cvencek, 2019).

To our knowledge, only one study attempted to intervene on both math achievement, as well as children's thoughts and feelings about mathematics (math self-concept, math anxiety, and self-regulation) in elementary-school children (Collingwood and Dewey, 2018). This multi-component intervention was delivered by trained teaching assistants in small groups for

4 weeks and consisted of 12 45-minute long sessions. The intervention involved: (i) self-regulated learning, (ii) mindful breathing, (iii) humor and comic strips, and (iv) use of self-coping statements when solving math problems. The intervention was found to improve math achievement and self-regulation, but had no measurable effect on math self-concept or math anxiety. It is currently unknown how to effectively enhance students' math self-concepts during elementary-school years.

The interventions used in the current study consisted of multiple components. The use of multi-component interventions is considered desirable in this age group, particularly when trying to establish larger effect sizes for constructs (such as math self-concepts) which are multi-dimensional themselves (Martin, 2008; and see **Supplementary Material, Section 1**). We designed and used age-appropriate interventions on *both* explicit and implicit self-concepts: The two "explicit" interventions required children to process information and engage in reflective thinking; the two "implicit" interventions allowed children to process information in a less deliberate manner and engage in automatic responding. A novel feature of the current work is that we combined *both* types of strategies in a single intervention session, because we believe that this increases the likelihood of success, as opposed to focusing on one type of approach alone.

The interventions targeting explicit cognitions drew on previous research showing that students benefit from feeling that they are valued and can succeed in school. It may be important for students to have these feelings both as individuals and in relation to the social-identity groupings to which they feel a sense of belonging (such as race/ethnicity, gender, or regional identity). In one previous study, children were most successful on a math test when they were reminded of a social identity that was linked to positive stereotypes in math, such as being Asian (Ambady et al., 2001). In another study, middle-school students of color achieved higher grades when their sense of personal adequacy was affirmed in school (Cohen et al., 2006). If children feel that they and their groups are successful in math, this should boost their explicit math self-concepts (Master and Meltzoff, 2020).

The interventions targeting implicit cognitions drew on previous successful interventions used in adults showing that mental associations between "me" and certain attributes can be strengthened using motor acts and auditory cues. In one study (Kawakami et al., 2008), college women who were low in implicit math identification (defined as the "strength of association between *self* and *math* versus *other* and *math*," p. 821) showed greater math identification and persistence after a training that involved pulling a joystick toward themselves when they viewed images related to math. In another study, adults heard particular sounds after attending and responding to counter-stereotypical pairings between images and words, such as a female face with the word "math" (Hu et al., 2015). These sound cues were designed to reinforce the counter-stereotypical pairings in contrast to stereotypical pairings. We reasoned that in the case of children, similar physical and audio procedures could help reinforce the link between *me* and *math*, boosting children's implicit math self-concepts.

The primary goal of this study was to assess the *feasibility* of whether a novel multicomponent intervention that combines explicit and implicit approaches to help children form more positive beliefs about themselves and math can be administered in an authentic school setting. Implementation research in education typically begins with an exploration of malleable factors that provides the initial empirical basis for refining a particular intervention. An overarching goal during this phase of research is to determine: (i) whether there is evidence of the promise of the intervention for achieving its intended outcomes, and (ii) whether the theorized intervention approaches are feasible for use (e.g., not too time consuming) within the intended authentic delivery setting (Institute of Education Sciences, 2012). Evidence of promise at this phase will usually lead to further research using randomized controlled trial (RCT) design to provide rigorous experimental data about the efficacy of the intervention.

Following this general model, we used a repeated-measures, quasi-experimental design to establish feasibility and provide guidance for future designs. We acknowledge that the authentic school settings imposed certain limitations on the study, which can, and should, be improved in future work. These issues are articulated and addressed in the section "Limitations, Lessons Learned, and Future Research." At the same time, we think that this study, which is a first attempt at combining both implicit and explicit measures in an intervention on math self-concepts at this early age, advances our knowledge with potential downstream benefits in the design of broader educational interventions.

This study involved an international consortium of researchers from the United States and Spain and took place in Madrid. We chose Madrid as the test site for several reasons. First, the math achievement of students from Spain, as measured by PISA, is below the OECD average (Organisation for Economic Co-operation and Development, 2015). This below-average achievement provides an opportunity for testing new interventions because a successful intervention, after sufficient instrument development, may be able to be used in this same setting to enhance students' math outcomes before students fall behind on standardized math achievement on international tests. Second, Madrid is the only region in Spain that makes each school's average results on standardized tests available to the public (Anghel et al., 2015); and there is intense governmental and educational interest in boosting math performance in Spain in general and Madrid in particular. Indeed, we received considerable assistance from local policymakers, principals, and teachers in the conduct of this study. Third, by adapting the interventions for use in Madrid, this research has potential to provide tools in the Spanish language that can contribute to educational research not only in Europe but also in Latin America and an increasingly large Spanish-speaking population in the United States (Rivas-Drake et al., 2016; Bauman, 2017).

This study makes four novel contributions to the literature. First, to our knowledge, no previous study has examined the effectiveness of a multicomponent intervention targeting students' math self-concepts in early elementary school. Second, this study was the first to use both implicit and explicit math self-concepts as outcome measures in elementary school, and to combine these psychological constructs to predict year-end math achievement. Third, no previous study has used technology-based interventions to influence children's math self-concepts,

which provides preliminary groundwork toward broadly-useable interventions. Fourth, the current study responds to recent calls for reducing the oversampling of North American participants in educational research (Nielsen et al., 2017).

MATERIALS AND METHODS

Participants

The participants were 180 students (M = 8.79 years, SD = 0.40, range: 7.98–10.02 years); 96 were girls (M = 8.79 years, SD = 0.38, range: 8.04–9.95 years), and 84 were boys (M = 8.79 years, SD = 0.42, range: 7.98–10.02 years). Mean ages between girls and boys did not differ, p = 0.99. These participants were recruited from nine Madrid elementary schools (30 classrooms), with the cooperation of the Madrid Ministry of Education. The research team obtained permission from the school principals. Students were tested at schools either from (i) December to April during the 2015–2016 school year, or (ii) March to April during the 2016–2017 school year.

All nine schools shared the same regional department of education and educational policies, however, each school was free to design its own educational mission. All nine schools belonged to the same City of Madrid school district. On average, children attending the nine schools were primarily low- to upper-middle SES, but we did not specifically ask children about their individual family's SES. None of the classrooms were special education classrooms. Finally, according to the official results of the external assessment of all Madrid Grade 3 students (1,302 schools) in May 2016, the City of Madrid school district had the average score of 7.08 for the Math Assessment (on a scale from 0 to 10; 549 participating schools total), indicating that the nine schools were medium-achieving in math.

Due to institutional constraints in some of the schools, students could not be fully randomized into the treatment and control groups; thus, our study was what Shadish et al. (2002) have described as a quasi-experiment. Quasi-experiments done in real-world settings can be a very useful step toward more randomized controlled designs (Cook et al., 2020). Specifically, Shadish et al. (2002) argue that "the use of carefully selected comparison groups facilitates causal inference from quasi experiments (when) they are also accompanied by pretest measures on the same outcome variable as posttest" (p. 136). In line with this reasoning, students in the present study were assigned to treatment and comparison groups. As recommended by Shadish et al. (2002), we used a pretest/posttest design and used the same outcome variables in the pretest and posttest. As will be shown, the treatment and comparison groups did not differ in their pretest scores for either the implicit or the explicit measure. Finally, we oversampled for the treatment group (see Berkowitz et al., 2015, for a similar strategy).

The research team consisted of native Spanish-speaking researchers from the Universidad Rey Juan Carlos, which is located in proximity to the schools. The team members visited schools and held informational meetings to explain the study goals, procedures, and resolve any questions regarding the educational interventions. Families gave written consent for their children. The procedures of this research were approved by the relevant university Research Ethics Committee (Universidad Rey Juan Carlos approval numbers: 22/2015 and ENM 22/20150712201600317).

Materials

Students were tested individually in a separate room outside of his or her classroom by trained experimenters. For each measure, the student sat at a table facing a Lenovo ThinkPad Yoga 15 Ultrabook laptop computer with a pair of QuietComfort 25 Acoustic Noise Canceling headphones and an adapted keyboard (see Cvencek et al., 2015, pp. 3-4, for an illustration of such computerized implicit and explicit measures in educational research). The experimenter was seated next to the student and gave instructions orally. Each test session began with a 3–5-minute description of the study, during which students were told that they would "play a game on the computer" and were familiarized with the test apparatus. Students completed implicit and explicit tests of math self-concepts. No other tests pertaining to different school subjects other than the ones reported here were administered. The main characteristics of these tests are described in the sections below.

Pretest

Implicit Measure

The implicit measure was a Child Implicit Association Test (ChIAT) that has been successfully used with this age to measure math stereotypes and self-concepts (Cvencek et al., 2011). The underlying principle of the ChIAT is that it is easier to give the same response to items that are associated in memory (called "congruent") than to give the same response to pairs of items that are not associated in memory ("incongruent"). An example can illuminate this and help explain the general principles of the ChIAT. Imagine being presented with images of *spring* landscapes, *winter* landscapes, and also with faces of *young* people and faces of *old* people. You are asked to sort these images into two piles: one pile in which you are to place *spring* landscapes and *young* faces, and another pile in which you are instructed to place *winter* landscapes and *old* faces. Under these instructions, you will likely be very fast sorting the images: Your ease of sorting will be facilitated by a prior association of "spring goes with youth" and "winter goes with old age." However, if you are asked to sort the same images again, but now you have to place *spring* landscapes and *old* faces in one pile, and *winter* landscapes and *young* faces in the other pile, it will likely be more difficult. This is because you probably do not have memory links between "spring goes with old" or "winter goes with young." The underlying principle of the ChIAT is similar, and it has been found that both adults and children find certain associations to be more congruent, and they respond to them faster (which can be measured precisely on a computer machine). If children identify with math, they are expected to respond more quickly to *me* = *math* than to other control pairings (see Cvencek et al., 2011, for more complete details).

The math self-concept ChIAT assesses the degree to which individual participants link *me* with *math* more than with a

different academic subject such as reading. During the math self-concept ChIAT, students sorted the words belonging to four different categories: *me*, *not-me*, *math*, and *reading*. All stimuli were presented in Spanish. The stimuli for the *me* and *not-me* categories were four *me* pronouns (me, myself, I, mine) and four *not-me* pronouns (they, them, theirs, other). The stimuli for the *math* and *reading* categories were five *math* words (addition, count, math, graph, numbers) and five *reading* words (books, letters, read, sentence, story).

The ChIAT was scored using the *D*-score algorithm, which converts the raw response times into a standardized metric of association strength in line with previous successful uses with elementary-school children (Baron and Banaji, 2006; Cvencek et al., 2011). The ChIAT score (*D*) was scored so it had computational upper and lower bounds of +2 (which indicated a strong association of *me* = *math*) to −2 (which was a strong association of *me* = *reading*), with a rational value of 0 indicating an equally strong association of *me* with *math* and *reading*. The ChIAT score provides a continuous measure, good internal consistency, and exhibits great variability in responses across different participants, which allows educational researchers to assess stronger or weaker identification with math on an interval scale that is highly sensitive to individual differences. In the current study, the implicit measure was internally consistent ($\alpha = 0.70$). Using standard algorithms and procedures for eliminations for this age (Cvencek et al., 2011), four students (2.2%) were excluded for having excessively slow responses, and one (0.6%) was excluded for excessive errors, leaving $N = 175$ (94 girls, 81 boys) in the final reported sample.

Explicit Measure

The self-report measure was administered as two Likert-scale questions from the "Pictorial Scale of Perceived Competence and Acceptance for Young Children" (Harter and Pike, 1984). This measure used both pictures and verbal explanations. In the double binary response strategy used in the original scale, the experimenter first asked the student to select which of two same-gender characters, who were either engaged in math or reading, was more like the self. This was always followed by a follow-up question asking the student to point to a smaller or larger circle (1.1 and 2.3 cm in diameter, respectively) to indicate "a little" versus "a lot" of similarity. This two-step formulation of each question (known as "branching"; Krosnick and Presser, 2010) was done to keep the number of choices simple and age appropriate (Master et al., 2017a). Positive values indicated choice of the math character as more like the self.

The advantage of using the two-item explicit self-concept measure instead of a longer scale is that it is simple enough to be used in the age group tested. While using two-item measures may seem like an oversimplification of a multidimensional construct such as math self-concept, prior research suggest that such two-item measures are predictive of cognitive and behavioral outcomes in math contexts. For example, research has found that these math self-concept measures are predictive of standardized math test scores (Cvencek et al., 2015). There is also evidence showing that these measures demonstrated theoretically-expected evidence of cognitive–affective consistency or "balance" within child samples (Cvencek et al., 2014). This explicit measure typically exhibits similar internal consistency as six-item multidimensional math self-concept measures. In the current study, the explicit measure was internally consistent, as indicated by both satisfactory Cronbach's alpha ($\alpha = 0.71$) as well as a strong correlation between the two items, $r = 0.55$, $p < 0.001$.

Experimental Intervention Tasks

The interventions were administered individually immediately after the pretest. The order of implicit and explicit interventions was counterbalanced across participants. The entire intervention protocol took approximately 25 min. Each student was initially assigned to one of three groups: math-intervention (treatment), reading-intervention (reverse-treated comparison), or no-intervention group (untreated comparison). In the math-intervention group, students completed four tasks with math-related stimuli. In the reading-intervention comparison group, students completed the tasks with reading-related stimuli. In the no-intervention comparison group, students did not complete any intervention activities, and spent 5–10 min waiting in the same testing room before completing the posttest measures.

Intervention Task #1: Activating Positive In-Group Attributes

This intervention task was designed to highlight positive attributes about students' in-group's math performance. The rationale for this task was that reminding students about positive stereotypes about groups to which they belong can have positive effects on students' own identification with mathematics. This activity was designed to activate positive attributes about the math ability of students' in-group (Ambady et al., 2001). Findings of the Programme for International Student Assessment (PISA) study were used to create a short lesson that was shown to students. Students viewed a series of PowerPoint bar graphs that depicted Madrid students' math (or reading) performance relative to other Spanish and European students, and showed that Madrid children in general scored higher on math than students did on average in other regions of Spain (e.g., Catalonia, Navarre) or some countries in Europe (e.g., England, Germany).

In the math-intervention (treatment) group, the scores represented in bar charts were described as "scores on a test that measures how good at math you are." The scores presented were the actual average PISA math scores for Madrid. In the reading-intervention group, the scores represented in bar charts were described as "scores on a test that measures how good at reading you are." In the reading-intervention (comparison) group, the graphs used were the same ones used in the math-intervention group. Students in the no-intervention (comparison) group did not see any graphs.

Intervention Task #2: Expressing *Me* = *Math* Identity

This intervention task aimed to allow students to verbally express positive math self-concepts and reflect on why they are personally important to them. The principle underlying this task was that engaging in self-affirmations—such as seeing

oneself as efficacious—can alleviate the stress in achievement contexts by buttressing self-worth in that domain. Such self-affirmations are often induced by having students consciously reflect on personally important values, such as the importance of a self-defining skill. In the current study, the activity was designed to allow students to express and endorse their math (reading) identity and why these activities were important to them, in an adaptation of the intervention developed for older students by Cohen et al. (2006). Students in the math-intervention (treatment) group were asked to answer, "How good at math are you?" on a Likert scale ranging from 1 (*not good at all*) to 7 (*very good*). The experimenter reinforced their response ("It sounds like you are kind of/pretty good at math") and, most importantly, asked them to "Now write a few reasons why you think you are good at math." As reported below, children's ratings of their own math ability were highly positive (all ps < 0.001). (Although this adaptation highlighted students' ability in math, Mueller and Dweck, 1998, the ratings and explanations were all generated by students themselves, which protects against any possible threatening aspects of the evaluation, Yeager and Walton, 2011). The experimenter then discussed their answers with them.

Next, students in the math-intervention (treatment) group were asked, "How important is it for you to get good grades in math?" on a Likert scale ranging from 1 (*not at all important*) to 7 (*very important*). The experimenter reinforced their response ("It sounds like math is kind of/pretty important to you") and asked them to "Now write a few reasons why you think getting good grades in math is important." The experimenter then discussed their answers with them. This activity provided students with an opportunity to verbally express positive math self-concepts and self-affirm why being good at math was personally important to them (in line with Cohen et al., 2006). Students in the reading-intervention (comparison) group underwent the same procedures with questions about reading. Students in the no-intervention (comparison) group did not complete the affirmation activity. Responses from students in both the math-intervention and reading-intervention groups were highly positive on the 7-point Likert scale (good at math: $M = 5.91$, $SD = 1.11$; math important: $M = 6.67$, $SD = 0.99$; good at reading: $M = 5.66$, $SD = 1.17$; reading important: $M = 6.48$, $SD = 0.89$). Ratings of ability in math versus reading were not significantly different between groups, $p = 0.21$, nor were ratings of the importance of getting good grades, $p = 0.26$.

Intervention Task #3: Approaching Math

This intervention task was designed to allow students to physically "approach" math. The idea behind this task is that people generally evaluate objects and categories more favorably following the performance of approach, as opposed to avoidance, actions, especially when evaluations are measured at an implicit level. Consequently, giving students practice in responding to academic subjects by engaging in approach behaviors, which are known to be related—both semantically and behaviorally—with bringing categories closer to the self, can positively impact students' orientation to these subjects, at least at an implicit level. This activity was designed to have students associate math with approach ("positive") behaviors (following a procedure designed for adults by Kawakami et al., 2008). In the math-intervention (treatment) group, students were instructed to pull a joystick toward themselves when presented with math images (i.e., cartoons of children doing math or math objects such as calculators) and to push the joystick away when presented with reading images (i.e., cartoons of children reading or objects such as books). Students in the reading-intervention (comparison) group were instructed to pull the joystick toward themselves for reading images and push it away for math images. Students in the no-intervention (comparison) group did not complete any approach tasks. In both math-intervention and reading-intervention groups, students completed four blocks of 40 trials.

Intervention Task #4: Sound Cueing for Identification and Positivity

This intervention task was designed to allow students to hear interesting sound cues linked to math. Prior research has shown that pairing concepts (such as "mathematics") with subtle auditory cues—which participants have previously been trained to associate with self and positivity—can effectively enhance the implicit *me* = *math* and *math* = *good* linkages. This activity was designed to use sound cues in a task that has been used to reduce implicit gender biases in adults (Hu et al., 2015). Students engaged in two phases of training activities that rely on sound cues to strengthen the *me* = *math* and *math* = *good* associations.

During the first training phase, students viewed several types of image–word pairings but were required to attend and respond only to pairings that involved either (i) *me* pronouns and a *math* image, or (ii) a *good* word and a *math* image. Two attention-getting, frequency-modulated sounds were presented during the first training phase: one after correctly linking math and the self (*me* = *math*) and the other after linking math to something positive (*math* = *good*). Students in the reading-intervention comparison group were instructed to respond only to *me* and *reading* pairings and *good* and *reading* pairings. Students in the no-intervention comparison group did not complete any sound cueing trials. During the first training phase, students in the math-intervention (treatment) group and reading-intervention (comparison) group completed three blocks of 18 trials.

To underscore these associations, students also completed a second training phase. In each of the activities in the second training phase, the same two sounds from the first training phase prompted students to form a corresponding image–word pairing by using a computer mouse to drag the image to the appropriate target word. Students in the no-intervention (comparison) group did not complete any image dragging trials. During the second training phase, students in the math-intervention (treatment) group and reading-intervention (comparison) groups completed three blocks of 18 trials.

Posttest

Following the administration of the four intervention tasks, and an optional 5–10 min break, all students completed the same

implicit and explicit measures of math self-concept (i.e., posttest was administered in the same session as pretest, in the same location/test room, on the same laptop computer, and closely following the interventions, all as recommended by Shadish et al., 2002, for methodological reasons).

Treatment Fidelity

Three project coordinators supervised nine experimenters from the beginning to the end of the experiment. A 3-step plan for experimenter training was implemented prior to the start of the study. First, each experimenter was provided with the Treatment Manual in Spanish, which described the study protocol in detail. Second, project coordinators carried out training sessions in which they modeled the interventions with each experimenter prior to the start of the study. Third, project coordinators observed experimenters and provided training feedback in the form of group discussions with all experimenters over the course of several weeks, during which specifics of the interventions were repeatedly reviewed. These team meetings focused on evaluating the experimenters' adherence to the research protocol. The sessions highlighted experimenters' successes and failures, offered constructive feedback from project coordinators and other experimenters to increase the fidelity of interventions, and clarified procedures to minimize departures from protocol.

Once the study started, experimenters were also observed by their peers (i.e., other experimenters) during the interventions, which provided additional rounds of "real-time" feedback to correct any significant departures from protocol. Treatment fidelity is important to consider, because when interventions fail to produce expected effects, there is potential to conclude (erroneously) that observed results are due to the conceptual or methodological problems with a particular intervention, rather than the fact that it was not delivered as intended (Dusenbury et al., 2003).

In this study, treatment fidelity was quantified in two ways. First, by design, we kept track of intervention duration and compared the average duration for math-intervention (M = 23.75 min, SD = 2.47 min) and reading-intervention (M = 23.14 min, SD = 2.24 min) groups. These did not differ in temporal duration (p = 0.14), ruling out the possibility that students in the math-intervention group received "more" intervention than the students in the reading-intervention group. Second, any instances of "unforeseen events" that occurred were written down (e.g., school headmaster being present during interventions, bell ringing during intervention administration, student not following all of the instructions, etc.). This occurred for only 10.3% of the students. A Chi-square analysis was conducted to examine whether the number of these unforeseen events varied by experimental group and revealed no statistically significant effects, p = 0.46.

Year-End Math Achievement

We also wanted to examine the degree to which our math-intervention effects might be associated with long-term academic outcomes. We re-contacted the schools toward the end of the academic year (collected in June of both 2016 and 2017 school years) and requested measures of math achievement (i.e., grades in mathematics from the year-end report cards) for students in the math-intervention group (institutional constraints and costs prevented us from requesting year-end report cards from more than about 100 students). We achieved a 57% compliance rate for this aspect of the study, n = 56 out of 99 students. No other achievement data was provided by the schools.

RESULTS

Several preliminary analyses were conducted to check whether demographic factors (gender, age) and classrooms/schools from which children were recruited had significant effects on any of the pretest or posttest results. As expected, none of them did, all ps $>$ 0.10. Therefore, the analyses are reported by collapsing across these factors. The results are organized in sections: (i) preliminary analyses, (ii) pre–post change on math self-concepts for treatment versus comparison groups, followed by (iii) analyses evaluating long-term relations between treatment outcomes and end of year math achievement. **Table 1** displays correlations among study variables.

Main Analyses: Malleability of Self-Concepts

Preliminary Analyses

We first checked whether there was any difference in the pretest scores as a function of group. Two one-way analyses of variance (ANOVAs) were performed on math self-concept pretest scores (one for implicit, and one for explicit measures) with experimental group as a between-groups factor. As expected, neither the ChIAT measure of implicit math self-concept nor the students' verbal report of explicit math self-concept showed a pretest difference as a function of group (implicit, p = 0.70; explicit, p = 0.25). In addition, we examined whether the two comparison groups (reading-intervention group, n = 49, and no-intervention group, n = 27) differed on any of the implicit or explicit measures. There were no significant differences (see **Supplementary Material**). Thus, for the main analyses, we combined the reading-intervention and no-intervention groups into a combined comparison group (n = 76), which was compared to the math-intervention treatment group (n = 99).

Pre–Post Change

One-way analyses of covariance (ANCOVAs) were conducted to examine differences between the treatment and comparison groups on math self-concept posttest scores, controlling for

TABLE 1 | Correlations for all implicit and explicit measures.

Measure	1	2	3	4
(1) Implicit MSC (Pretest)	–			
(2) Implicit MSC (Posttest)	0.32***	–		
(3) Explicit MSC (Pretest)	0.21*	0.26**	–	
(4) Explicit MSC (Posttest)	0.23*	0.25**	0.76***	–

*MSC, Math Self-Concept; *p < 0.01; **p < 0.001; ***p < 0.0001.*

pretest scores. This approach ensures that posttest differences result from the treatment, and not leftover effects of random pretest differences between groups.

Implicit measures

The results for the implicit measures are displayed in **Figure 1A**. On both pre- and posttest implicit math self-concept measures, positive scores indicated *me = math* associations. As can be seen from the left two bars in **Figure 1A**, students in the math self-concept treatment group displayed stronger math self-concepts at posttest than at pretest. In contrast, and as shown in the right two bars in **Figure 1A**, students in the comparison group showed no significant gain in math self-concepts from pretest to posttest. The ANCOVA for the implicit measures revealed a significant effect of the math intervention on posttest math self-concept *after controlling for pretest*, $F(1,172) = 3.73$, $p = 0.05$, $d = 0.29$. Moreover, as shown in **Figure 1A**, paired-sample *t*-tests revealed that the pre–post change was significant in the treatment group, $t(98) = 2.36$, $p = 0.02$, $d = 0.28$, but not in the comparison group, $p = 0.65$. As expected, the pretest scores did not differ between the treatment and comparison group, $p = 0.55$; yet, the posttest scores in the treatment group were significantly higher in the *me = math* direction than in the comparison group, $t(173) = 2.03$, $p = 0.044$, $d = 0.31$. Finally, we compared the implicit scores to 0 (equally strong math and reading self-concepts), and only the scores in the treatment group at posttest were significantly different from 0, and they were in the *me = math* direction ($M = 0.17$, $SD = 0.38$), $t(98) = 4.41$, $p < 0.001$, $d = 0.44$.

Explicit measures

The results for the explicit measures are displayed in **Figure 1B**. On both pre- and posttest explicit math self-concept measures, positive scores indicated *me = math* associations (and negative scores indicated *not-me = math* associations). As can be seen from the left two bars in **Figure 1B**, students in the treatment group displayed stronger math self-concepts at posttest than at pretest. In contrast, and as shown in the right two bars in **Figure 1B**, students in the comparison group displayed no significant gain in math self-concepts from pretest to posttest. The ANCOVA for the explicit measures revealed a significant effect of the math intervention on posttest explicit math self-concept after controlling for pretest, $F(1,172) = 7.46$, $p = 0.01$, $d = 0.42$. Moreover, as shown in **Figure 1B**, paired-sample *t*-tests revealed that the pre–post change was significant in the treatment group, $t(98) = 2.46$, $p = 0.016$, $d = 0.15$, but not in the comparison group, $p = 0.53$. As expected, the pretest scores did not differ between the treatment and comparison groups, $p = 0.17$; and the posttest explicit scores in the treatment group were significantly higher in the *me = math* direction than in the comparison group, $t(173) = 2.82$, $p = 0.01$, $d = 0.43$. Finally, we compared the explicit scores to 0, and only the scores in the treatment group at posttest were significantly different from 0, and they were in the *me = math* direction ($M = 0.40$, $SD = 1.47$), $t(98) = 2.73$, $p = 0.01$, $d = 0.27$.

Analyses of Year-End Math Achievement

We also examined correlations between the pre- and posttest scores and year-end math achievement for the treatment participants (collected approximately 3 months following posttest). Neither the implicit pretest measure nor the explicit pretest measure was correlated with year-end achievement, $ps > 0.12$. For posttest scores, implicit math self-concepts were significantly correlated with year-end achievement, $r(54) = 0.42$, $p = 0.001$, but explicit math self-concepts were not, $p = 0.83$ (see Discussion). Moreover, a partial correlation of posttest implicit math self-concepts remained significant with achievement *after controlling for* pretest implicit math self-concepts, $r(53) = 0.38$, $p = 0.004$.

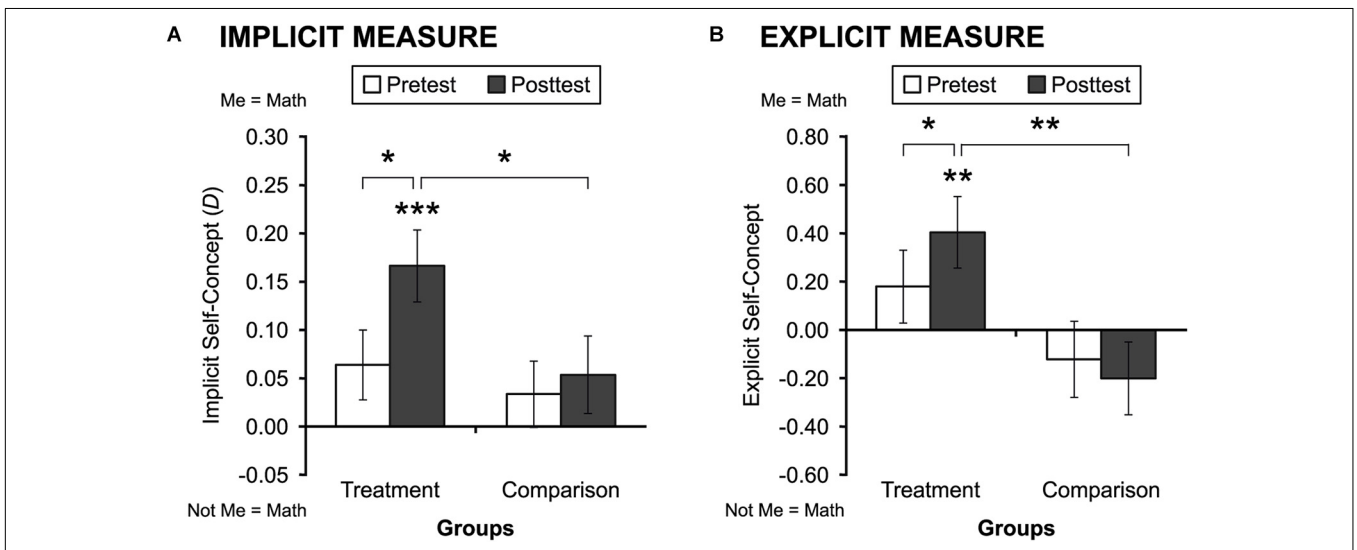

FIGURE 1 | Students' implicit **(A)** and explicit **(B)** math self-concepts at pre- and posttest, by treatment and comparison group. *Ns* are 99 and 76 for treatment and comparison groups, respectively. Error bars show ±1 *SE*. *$p < 0.05$; **$p < 0.01$; ***$p < 0.001$.

DISCUSSION

Third-grade students demonstrated significant gains on math self-concepts following a math self-concept field intervention that took place in a school setting. The intervention involved: (i) highlighting positive attributes about students' in-group's math performance, (ii) verbally expressing positive math self-concepts, (iii) physically "approaching" math, and (iv) hearing interesting sound cues linked to math. Students in the math-treatment group demonstrated stronger math self-concepts at posttest after controlling for pretest scores, and the comparison groups did not. This was true using *both* implicit and explicit measures. In addition, implicit math self-concepts in the intervention group at posttest were associated with higher year-end math achievement, assessed approximately 3 months later. This study suggests that a field intervention can be delivered one-on-one to elementary students during school hours.

The positive effect of the math intervention on both implicit and explicit measures is noteworthy, with implicit effects being particularly informative. A well-established criticism of studies that use only explicit, self-report outcome measures is that children may sometimes distort their true beliefs about math when verbally describing them based on what they think the adult wants to hear ("desirability effects"). For this reason, we used both implicit and explicit measures. As shown here, the measures of *implicit* math self-concepts can provide a valuable, even unique, window into investigating emerging beliefs about self and math in young children (see also Meltzoff and Cvencek, 2019).

A question of relevance to developmental and educational science is why this intervention with young children was successful when studies with *adults* have shown that implicit associations are difficult to change (Lai et al., 2014). Two factors might have played a role. First, our intervention was designed to incorporate several features that have been specifically linked to success in changing implicit associations, such as incorporating elements that are highly self-relevant (e.g., self-affirmation, activating positive stereotypes) and using multiple techniques (e.g., approach/avoid behaviors, sound cueing to call attention to positivity) to target self-concepts (Lai et al., 2014). Second, the age tested here may be a period during which these implicit associations are particularly malleable (Lai et al., 2016; Gonzalez et al., 2017; Meltzoff and Cvencek, 2019). Self-concepts in adults have been influenced by many prior experiences which may make them difficult to shift (Lai et al., 2016). In contrast, children's implicit cognition is based on fewer experiences and may therefore be more open to change (Gonzalez et al., 2017). Relatedly, preschool children or those substantially younger than studied here may be unable to integrate new experiences (Bigler and Liben, 2007). Thus, there may conceivably be a "Goldilocks period" in development (we speculate between ages 8–12; more research needed), in which children's implicit self-concepts about math are easier to change than adults' or substantially younger children's (Vezzali et al., 2012). We also note that we found no effects of gender on pretest or posttest measures. This pattern of results was unsurprising, given that this age group was selected intentionally to involve children before gender differences in math self-concepts have developed (see Cvencek et al., 2011; Master et al., 2017a).

The findings that posttest implicit math self-concept scores were associated with year-end math achievement raises two interesting theoretical questions. The first one involves why pretest math self-concepts were not associated with academic achievement. Math self-concepts of early elementary-school children are, on average, very positive and only weakly, if at all, associated with external indicators such as grades (Ehm et al., 2019). Here, we are able to demonstrate that the theoretically expected relations to academic achievement can be obtained following an intervention, lending further credence to the idea that math self-concepts are malleable and undergoing developmental change during elementary-school years (Cvencek et al., 2011; Weidinger et al., 2018).

A second question concerns why implicit self-concepts, but not explicit self-concepts, were linked to achievement. Several possibilities bear consideration. On the one hand, other research has also found that in many cases implicit measures predict behavior and achievement better than self-reports (Rudman, 2004; Cvencek et al., 2015; see also Greenwald et al., 2009), and it is possible that social desirability of giving the answer the experimenter wants may add noise to the results when using explicit measures alone as outcomes. On the other hand, there are measurement differences between implicit and explicit measures: The explicit self-concepts were measured on a Likert scale, and the implicit self-concepts were measured on a continuous scale. Previous research has shown that relatively coarse Likert scales can cause information loss and reduce the probability of detecting true effects (Russell and Bobko, 1992; see also Albaum et al., 1981, and Wu and Leung, 2017). Because implicit measures allowed for finer assessment of individual differences than the 4-step Likert scales used in the current study, they may have been more sensitive to pre–post treatment changes at an individual level.

These findings showing a positive association between the interventions and the year-end math outcomes also call for a discussion about possible mediating mechanisms. Based on the current feasibility study we speculate that experiences, such as those provided by the interventions used here, may enhance the implicit *me* = *math* linkages, which could have downstream, cascading consequences for motivation, such as putting in extra effort or persistence on math activities or approaching (rather than avoiding) math-related endeavors. These approach/persistence/motivation behaviors could in turn provide learning experiences that build math skills and thus affect year-end achievement through a positive recursive cycle (Cohen et al., 2006; Master and Meltzoff, 2020), in which stronger implicit math self-concepts lead to higher achievement, which then reinforces positive self-concepts. Based on the current findings, future research should examine how variations in frequency of such brief interventions (daily? weekly? quarterly?) map on to educational outcomes that matter for children, which will have implications for how these interventions could potentially be used in practice.

Limitations, Lessons Learned, and Future Research

The reported work has several strengths but is not without limitations. First, we acknowledge the nonrandom assignment of participants to treatment and comparison groups. Importantly, the treatment and comparison groups did not differ at pretest for either implicit or explicit measure, thus reducing concerns that the groups differed in important ways before the interventions were initiated. A critical direction for future research is to replicate this study with a large, pre-registered, randomized controlled trial (RCT) educational intervention.

A second limitation concerns the follow-up on math achievement. Math grades used in this research corresponded to the teachers' ratings. As such, they may be influenced by subjectivity, and also capture other aspects of student learning, such as effort, classroom behavior, or the relationship with the teacher (McMillan et al., 2002). The use of a standardized math test would be more informative insofar as it would permit testing directly whether the students with higher levels of math self-concept were those with the better mathematical performance. In addition, we were able to obtain year-end achievement data only for the treatment (math-intervention) group, and had 57% compliance in obtaining the year-end math achievement scores. This was due to the constraints of working with this particular school district. The use of a standardized math test with all students, especially at the school-level, would permit evaluating a direct effect of treatment condition on achievement by comparing the average achievement for the subsample that was intervened on to the average achievement of another sample of students in the same school and grade that was not intervened on. Future work should initiate randomized sampling from both treatment and comparison groups, coupled with procedures or compensation that might encourage higher compliance. However, even under our limited conditions, and with a modest sample size, we obtained a medium-sized relation between students' enhanced posttest implicit math self-concepts and their higher year-end math achievement (effect size of $r = 0.42$). A direction for future research is to examine the relations to math achievement with repeated assessments throughout the academic year. The current study's intervention was relatively brief, approximately 25 min total. What happened in a brief, one-shot intervention does not guarantee long-term effectiveness. Evaluating the effects of the intervention after a longer delay will allow for stronger inferences about the durability of the effects, which are important for both practical and theoretical concerns.

Third, this quasi-experimental study was primarily concerned with assessing the *feasibility* of whether an intervention combining explicit and implicit approaches has potential in authentic school settings. In doing so, we did not control for covariates that could account for differences between the treatment and comparison group. For example, family SES, parental education, math curriculum used in school, and teachers' experience could all contribute to the development of children's math self-concepts. Given that this study was not an RCT, we acknowledge that these factors were not necessarily random across conditions. Our hope is that the positive results from this feasibility study, including the lessons learned (see below), might spark future work using similar techniques and adopting a gold-standard, RCT methodology, which will deal effectively with unknown and unmeasured environmental covariates.

Fourth, implicit measures by design involve *relative* comparison between two contrasting target categories (Greenwald et al., 2009). Implicit measures that contrast math with reading/language are common in research about academic topics with adults (Nosek et al., 2002; Nosek and Smyth, 2011) and children (Cvencek et al., 2011, 2015). At the same time, the relative nature of implicit measures makes it difficult to conclude whether the current intervention: (i) only enhanced students' math self-concepts or (ii) enhanced math self-concepts while also weakening reading self-concepts (which would be in line with the so-called *ipsative self-concept hypothesis*, according to which, as self-concept in one domain goes up (e.g., math), self-concept in other domains (e.g., verbal) should go down; Parker et al., 2015; Umarji et al., 2018). While the relative implicit measures do not allow us to distinguish between these two alternatives, they are still useful in evaluating the effectiveness of interventions aimed at improving math outcomes, inasmuch as they have been found to be positively related to both absolute math achievement (e.g., performance on a standardized math test; Cvencek et al., 2015), as well as relative math achievement (e.g., SAT math minus verbal difference; Nosek and Smyth, 2011).

Fifth, this study used multiple components to target self-concepts (four tasks), and this limits our ability to specify the precise factor(s) that may be most important. Our rationale was that a multicomponent approach designed to boost both explicit and implicit math self-concepts might be more beneficial than a more narrowly designed intervention. But using multiple components does not allow us to determine which specific elements were necessary and/or sufficient, which would be needed to address mediating mechanisms. It would be useful for future interventions to test each intervention component separately.

Finally, more work is needed to make these math interventions culturally appropriate for other Spanish-speaking student groups, including Hispanic/Latinx students in the United States. Such students in the United States commonly experience a number of social, cultural, and economic barriers that affect their academic achievement, from poverty to issues of ethnic-racial discrimination. While these are not shared by Spanish children living in Madrid, the materials and activities adapted here provide a first step toward actionable practices in the Spanish language that can be used in future work with Spanish-speaking students in other countries beyond Spain. We acknowledge too that the cultural setting matters in this research, as in all work on the education of our children (e.g., Lee et al., 2020). Thus, "what works" in Madrid will not necessarily directly transfer to other cultures—even to other Spanish-speaking cultures inasmuch as different countries, regions, and school systems may well have different needs, practices, and

sociocultural norms. More broadly, future interventions aimed at enhancing students' math self-concepts should not only take into account the sociocultural character of students' math self-concepts, but also the dynamic character of students' self-concepts as well as how dominant sociocultural practices interact with students' self-concepts.

There were also three salient lessons learned from this study, which should be considered when designing future interventions to enhance students' math self-concepts. First, we demonstrated the feasibility of combining four tasks into one session in an age-appropriate manner. Children understood the directions and they were able to complete the protocol; but there would need to be adjustments to make the procedures developmentally appropriate at different ages. Second, we were able to implement the protocol within a school setting, asking the students to leave the classroom for an acceptable short duration, and we were able to monitor treatment fidelity quite closely, which standardized the protocol. We believe that monitoring treatment fidelity was an important aspect of this research. Third, we showed that the effects of multicomponent treatment can be measured using pre–post change in elementary school, and our procedures were enjoyable to the children at the age tested, which is important to ensure that children stay "on task" throughout the session.

Broader Educational Implications

The current results have potential implications for educational efforts aimed at promoting equity in math achievement. In Spain, mathematics is rated as an important educational area, but beyond Spain a growing number of educators are emphasizing the need to customize individual learning based on students' personal and academic readiness from Grade 3 onward (Gutiérrez and Rogoff, 2003; Paz-Albo, 2017; Nasir et al., 2020). After further development and formal RCT testing, the type of interventions developed here might prove useful in elementary education as a way to enhance students' interest and identification with math, and thus their interest and engagement in choosing STEM classes, after-school activities, and summer camps, and to influence their career aspirations. Moreover, the technology-based nature of the intervention provides the opportunity of expanding and refining this work so that it could be incorporated into online learning software.

The findings also have potential implications for the choices that administrators and researchers make about tutoring and interventions for math. Some interventions designed to improve children's counting competencies have been shown to be highly effective (Clements and Sarama, 2011), but they are also known to be somewhat time-consuming and costly. It has also been recognized that endeavoring to enhance students' beliefs and identifications with math (so-called "non-academic factors") is desirable because this may be less expensive and (possibly) more enjoyable for the students. Indeed, previous work with middle-school students has been able to show that non-academic interventions, such as mentoring students about the malleability of "intelligence," can boost standardized math test scores (Good et al., 2003; see also Dweck, 2006; Blackwell et al., 2007). Taking all this together, it would seem judicious for future work to *combine* programs aimed at improving math instruction and math skill development (e.g., Clements et al., 2020) with the types of social–cognitive interventions used in our current work as well as those of others (Yeager and Walton, 2011; Rhodes et al., 2019; Master and Meltzoff, 2020). This might allow us to assess whether a more comprehensive intervention strategy would be even more effective or longer lasting than any of the approaches listed above taken in isolation.

CONCLUSION

This study tested the feasibility of whether combining explicit and implicit approaches into a multicomponent intervention to help children form more positive beliefs about themselves and math can be administered in an authentic school setting. The results suggest that a field intervention can be delivered one-on-one to elementary students during school hours. The intervention was found to be effective insofar as third-grade students demonstrated significant gains on math self-concepts following the intervention. After further development, the novel intervention utilized here—or similar child-friendly ones—might have practical use for helping to spark young students' self-concepts, interest, and choices around mathematics. It is known, for example, that some elementary-school students decide that they are not "a math person," and thereafter dis-identify with math as they progress through school (Heyman, 2008; Musu-Gillette et al., 2015). Early interventions may hold promise for preventing or ameliorating this trajectory (Liben, 2015; Master et al., 2017b; Fredricks et al., 2018). More collaborative work between educators and researchers is needed to explore the ways in which interventions may enhance children's beliefs and attitudes about math over time and in school settings, and also to assess the feasibility of embedding these in the elementary-school curriculum. Well-timed interventions could help ensure that students stay identified with math and have a positive math self-concept very early in the pipeline. When students believe that "math is for me," it could potentially open the door to a positive relationship with math that will be helpful for broader academic success.

DATA AVAILABILITY STATEMENT

The dataset generated for this study is available on request to the corresponding author.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Universidad Rey Juan Carlos Ethics Committee, approval number 22/2015 and ENM 22/20150712201600317. Written informed consent to participate in this study was provided by the participants' legal guardian/next of kin.

AUTHOR CONTRIBUTIONS

DC, ANM, JP-A, CVHL, and AH-E designed the study and organized data collection. DC analyzed the data. DC, ANM, AM, and JP-A wrote the manuscript. All authors contributed to the article and approved the submitted version.

FUNDING

This research was supported by the Universidad Rey Juan Carlos and by grants from the National Science Foundation (SMA-1640889, HRD-1661285), and the Bezos Family Foundation.

ACKNOWLEDGMENTS

We thank the former Universidad Rey Juan Carlos President, Fernando Suárez Bilbao, and Spanish Honorary Consul, Luis Fernando Esteban Bernáldez, for facilitating this cross-institutional research collaboration. We also thank the school principals, teachers, parents, and students for their generous cooperation.

SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpsyg.2020.593995/full#supplementary-material

REFERENCES

Albaum, G., Best, R., and Hawkins, D. I. (1981). Continuous vs discrete semantic differential rating scales. *Psychol. Rep.* 49, 83–86. doi: 10.2466/pr0.1981.49.1.83

Ambady, N., Shih, M., Kim, A., and Pittinsky, T. L. (2001). Stereotype susceptibility in children: effects of identity activation on quantitative performance. *Psychol. Sci.* 12, 385–390. doi: 10.1111/1467-9280.00371

Anghel, B., Cabrales, A., Sainz, J., and Sanz, I. (2015). Publicizing the results of standardized external tests: does it have an effect on school outcomes? *IZA J. Eur. Lab. Stud.* 4:7. doi: 10.1186/s40174-014-0029-3

Arens, A. K., Frenzel, A. C., and Goetz, T. (2020). Self-concept and self-efficacy in math: longitudinal interrelations and reciprocal linkages with achievement. *J. Exp. Educ.* doi: 10.1080/00220973.2020.1786347 [Epub ahead of print],

Baron, A. S., and Banaji, M. R. (2006). The development or implicit attitudes: evidence of race evaluations from ages 6 and 10 and adulthood. *Psychol Sci.* 17, 53–58. doi: 10.1111/j.1467-9280.2005.01664.x

Bauman, K. (2017). *School Enrollment of the Hispanic Population: Two Decades of Growth*. Available online at: https://www.census.gov/newsroom/blogs/random-samplings/2017/08/school_enrollmentof.html (accessed April 4, 2019).

Berkowitz, T., Schaeffer, M. W., Maloney, E. A., Peterson, L., Gregor, C., Levine, S. C., et al. (2015). Math at home adds up to achievement in school. *Science* 350, 196–198. doi: 10.1126/science.aac7427

Bigler, R. S., and Liben, L. S. (2007). Developmental intergroup theory: explaining and reducing children's social stereotyping and prejudice. *Curr. Dir. Psychol. Sci.* 16, 162–166. doi: 10.1111/j.1467-8721.2007.00496.x

Blackwell, L. S., Trzesniewski, K. H., and Dweck, C. S. (2007). Implicit theories of intelligence predict achievement across an adolescent transition: a longitudinal study and an intervention. *Child Dev.* 78, 246–263. doi: 10.1111/j.1467-8624.2007.00995.x

Bong, M., and Skaalvik, E. M. (2003). Academic self-concept and self-efficacy: how different are they really? *Educ. Psychol. Rev.* 15, 1–40. doi: 10.1023/A:1021302408382

Cai, D., Viljaranta, J., and Georgiou, G. K. (2018). Direct and indirect effects of self-concept of ability on math skills. *Learn. Individ. Differ.* 61, 51–58. doi: 10.1016/j.lindif.2017.11.009

Clements, D. H., and Sarama, J. (2011). Early childhood mathematics intervention. *Science* 333, 968–970. doi: 10.1126/science.1204537

Clements, D. H., Sarama, J., Baroody, A. J., and Joswick, C. (2020). Efficacy of a learning trajectory approach compared to a teach-to-target approach for addition and subtraction. *ZDM* 52, 637–648. doi: 10.1007/s11858-019-01122-z

Cohen, G. L., Garcia, J., Apfel, N., and Master, A. (2006). Reducing the racial achievement gap: a social-psychological intervention. *Science* 313, 1307–1310. doi: 10.1126/science.1128317

Collingwood, N., and Dewey, J. (2018). 'Thinking your problems away': can maths interventions be developed to address both the academic and affective aspects of learning in primary aged children? *Educ. Child Psychol.* 35, 76–92.

Cook, T. D., Zhu, N., Klein, A., Starkey, P., and Thomas, J. (2020). How much bias results if a quasi-experimental design combines local comparison groups, a pretest outcome measure and other covariates: a within study comparison of preschool effects. *Psychol. Methods* doi: 10.1037/met0000260 [Epub ahead of print],

Cvencek, D., Kapur, M., and Meltzoff, A. N. (2015). Math achievement, stereotypes, and math self-concepts among elementary-school students in Singapore. *Learn. Instr.* 39, 1–10. doi: 10.1016/j.learninstruc.2015.04.002

Cvencek, D., Meltzoff, A. N., and Greenwald, A. G. (2011). Math–gender stereotypes in elementary school children. *Child Dev.* 82, 766–779. doi: 10.1111/j.1467-8624.2010.01529.x

Cvencek, D., Meltzoff, A. N., and Kapur, M. (2014). Cognitive consistency and math–gender stereotypes in Singaporean children. *J. Exp. Child Psychol.* 117, 73–91. doi: 10.1016/j.jecp.2013.07.018

Devine, P. G., Forscher, P. S., Austin, A. J., and Cox, W. T. L. (2012). Long-term reduction in implicit race bias: a prejudice habit-breaking intervention. *J. Exp. Soc. Psychol.* 48, 1267–1278. doi: 10.1016/j.jesp.2012.06.003

Dusenbury, L., Brannigan, R., Falco, M., and Hansen, W. B. (2003). A review of research on fidelity of implementation: implications for drug abuse prevention in school settings. *Health Educ. Res.* 18, 237–256. doi: 10.1093/her/18.2.237

Dweck, C. S. (2006). *Mindset: The New Psychology of Success*. New York, NY: Random House.

Eccles, J. S. (2005). "Subjective task value and the Eccles et al. Model of achievement-related choices," in *Handbook of Competence and Motivation*, eds A. J. Elliot and C. S. Dweck (New York, NY: Guilford), 105–121.

Eccles, J. S., Adler, T. F., Futterman, R., Goff, S. B., Kaczala, C. M., Meece, J. L., et al. (1983). "Expectations, values and academic behaviors," in *Achievement and Achievement Motivation*, ed. J. T. Spence (San Francisco, CA: W.H. Freeman), 75–146.

Ehm, J.-H., Hasselhorn, M., and Schmiedek, F. (2019). Analyzing the developmental relation of academic self-concept and achievement in elementary school children: alternative models point to different results. *Dev. Psychol.* 55, 2336–2351. doi: 10.1037/dev0000796

Fisher, P. H., Dobbs-Oates, J., Doctoroff, G. L., and Arnold, D. H. (2012). Early math interest and the development of math skills. *J. Educ. Psychol.* 104, 673–681. doi: 10.1037/a0027756

Fredricks, J. A., Hofkens, T., Wang, M.-T., Mortenson, E., and Scott, P. (2018). Supporting girls' and boys' engagement in math and science learning: a mixed methods study. *J. Res. Sci. Teach.* 55, 271–298. doi: 10.1002/tea.21419

Gonzalez, A. M., Dunlop, W. L., and Baron, A. S. (2017). Malleability of implicit associations across development. *Dev. Sci.* 20:e12481. doi: 10.1111/desc.12481

Good, C., Aronson, J., and Inzlicht, M. (2003). Improving adolescents' standardized test performance: an intervention to reduce the effects of stereotype threat. *Appl. Dev. Psychol.* 24, 645–662. doi: 10.1016/j.appdev.2003.09.002

Greenwald, A. G., Poehlman, T. A., Uhlmann, E. L., and Banaji, M. R. (2009). Understanding and using the implicit association test: III. Meta-analysis of predictive validity. *J. Pers. Soc. Psychol.* 97, 17–41. doi: 10.1037/a0015575

Gunderson, E. A., Ramirez, G., Levine, S. C., and Beilock, S. L. (2012). The role of parents and teachers in the development of gender-related math attitudes. *Sex Roles* 66, 153–166. doi: 10.1007/s11199-011-9996-2

Gutiérrez, K. D., and Rogoff, B. (2003). Cultural ways of learning: individual traits or repertoires of practice. *Educ. Res.* 32, 19–25. doi: 10.3102/0013189X032005019

Harter, S. (2006). "The self," in *Handbook of Child Psychology: Social, Emotional, and Personality development*, eds N. Eisenberg, W. Damon, and R. M. Lerner (Hoboken, NJ: Wiley), 505–570.

Harter, S., and Pike, R. (1984). The pictorial scale of perceived competence and social acceptance for young children. *Child Dev.* 55, 1969–1982. doi: 10.2307/1129772

Heyman, G. D. (2008). Talking about success: implications for achievement motivation. *J. Appl. Dev. Psychol.* 29, 361–370. doi: 10.1016/j.appdev.2008.06.003

Hu, X., Antony, J. W., Creery, J. D., Vargas, I. M., Bodenhausen, G. V., and Paller, K. A. (2015). Unlearning implicit social biases during sleep. *Science* 348, 1013–1015. doi: 10.1126/science.aaa3841

Institute of Education Sciences (2012). "The NCER goal structure," in *2012 National Board for Education Sciences Annual Report*. Available online at: https://ies.ed.gov/director/board/briefing/ncer_structure.asp (accessed February 20, 2020).

Jiang, S., Simpkins, S. D., and Eccles, J. S. (2020). Individuals' math and science motivation and their subsequent STEM choices and achievement in high school and college: a longitudinal study of gender and college generation status differences. *Dev. Psychol.* doi: 10.1037/dev0001110 [Epub ahead of print],

Kahneman, D. (2011). *Thinking, Fast and Slow*. New York, NY: Farrar, Straus and Giroux.

Kawakami, K., Steele, J. R., Cifa, C., Phills, C. E., and Dovidio, J. F. (2008). Approaching math increases math = me and math = pleasant. *J. Exp. Soc. Psychol.* 44, 818–825. doi: 10.1016/j.jesp.2007.07.009

Krosnick, J. A., and Presser, S. (2010). "Question and questionnaire design," in *Handbook of Survey Research*, eds P. V. Marsden and J. D. Wright (Bingley: Emerald Group), 263–313.

Lai, C. K., Marini, M., Lehr, S. A., Cerruti, C., Shin, J.-E. L., Joy-Gaba, J. A., et al. (2014). Reducing implicit racial preferences: I. A comparative investigation of 17 interventions. *J. Exp. Psychol. Gen.* 143, 1765–1785. doi: 10.1037/a0036260

Lai, C. K., Skinner, A. L., Cooley, E., Murrar, S., Brauer, M., Devos, T., et al. (2016). Reducing implicit racial preferences: II. Intervention effectiveness across time. *J. Exp. Psychol. Gen.* 145, 1001–1016. doi: 10.1037/xge0000179

Lee, C. D., Meltzoff, A. N., and Kuhl, P. K. (2020). "The braid of human learning and development: neuro-physiological processes and participation in cultural practices," in *Handbook of the Cultural Foundations of Learning*, eds N. S. Nasir, C. D. Lee, R. Pea, and M. K. de Royston (New York, NY: Routledge), 24–43.

Lei, R. F., Green, E. R., Leslie, S.-J., and Rhodes, M. (2019). Children lose confidence in their potential to "be scientists," but not in their capacity to do science. *Dev. Sci.* 22, e12837. doi: 10.1111/desc.12837

Liben, L. S. (2015). The STEM gender gap: the case for spatial interventions. *Int. J. Gen. Sci. Technol.* 7, 133–150.

Marsh, H. W. (1990). A multidimensional, hierarchical self-concept: theoretical and empirical justification. *Edu. Psychol. Rev.* 2, 77–171. doi: 10.1007/BF01322177

Marsh, H. W., Pekrun, R., Murayama, K., Arens, A. K., Parker, P. D., Guo, J., et al. (2018). An integrated model of academic self-concept development: academic self-concept, grades, test scores, and tracking over 6 years. *Dev. Psychol.* 54, 263–280. doi: 10.1037/dev0000393

Marsh, H. W., Pekrun, R., Parker, P. D., Murayama, K., Guo, J., Dicke, T., et al. (2019). The murky distinction between self-concept and self-efficacy: beware of lurking jingle-jangle fallacies. *J. Educ. Psychol.* 111, 331–353. doi: 10.1037/edu0000281

Martin, A. J. (2008). Enhancing student motivation and engagement: the effects of a multidimensional intervention. *Cont. Edu. Psychol.* 33, 239–269. doi: 10.1016/j.cedpsych.2006.11.003

Master, A., Cheryan, S., and Meltzoff, A. N. (2017a). Social group membership increases STEM engagement among preschoolers. *Dev. Psychol.* 53, 201–209. doi: 10.1037/dev0000195

Master, A., Cheryan, S., Moscatelli, A., and Meltzoff, A. N. (2017b). Programming experience promotes higher STEM motivation among first-grade girls. *J. Exp. Child Psychol.* 160, 92–106. doi: 10.1016/j.jecp.2017.03.013

Master, A., and Meltzoff, A. N. (2020). Cultural stereotypes and sense of belonging contribute to gender gaps in STEM. *Intern. J. of Gend. Sci. Tech.* 12, 152–198.

McMillan, J. H., Myran, S., and Workman, D. (2002). Elementary teachers' classroom assessment and grading practices. *J. Educ. Res.* 95, 203–213. doi: 10.1080/00220670209596593

Meltzoff, A. N., and Cvencek, D. (2019). "How stereotypes shape children's STEM identity and learning," in *Developing Minds in the Digital Age: Towards a Science of Learning for 21st Century Education*, eds P. K. Kuhl, S.-S. Lim, S. Guerriero, and D. van Damme (Paris: OECD), 37–47.

Mueller, C. M., and Dweck, C. S. (1998). Praise for intelligence can undermine children's motivation and performance. *J. Pers. Soc. Psychol.* 75, 33–52. doi: 10.1037/0022-3514.75.1.33

Muenks, K., Wigfield, A., and Eccles, J. S. (2018). I can do this! The development and calibration of children's expectations for success and competence beliefs. *Dev. Rev.* 48, 24–39. doi: 10.1016/j.dr.2018.04.001

Musu-Gillette, L. E., Wigfield, A., Harring, J. R., and Eccles, J. S. (2015). Trajectories of change in students' self-concepts of ability and values in math and college major choice. *Educ. Res. Eval.* 21, 343–370. doi: 10.1080/13803611.2015.1057161

Nasir, N. S., Lee, C. D., Pea, R., and de Royston, M. K. (2020). *Handbook of the Cultural Foundations of Learning*. New York, NY: Routledge.

Nielsen, M., Haun, D., Kärtner, J., and Legare, C. H. (2017). The persistent sampling bias in developmental psychology: a call to action. *J. Exp. Child Psychol.* 162, 31–38. doi: 10.1016/j.jecp.2017.04.017

Nosek, B. A., Banaji, M. R., and Greenwald, A. G. (2002). Math = male, me = female, therefore math ≠ me. *J. Pers. Soc. Psychol.* 83, 44–59. doi: 10.1037/0022-3514.83.1.44

Nosek, B. A., and Smyth, F. L. (2011). Implicit social cognitions predict sex differences in math engagement and achievement. *Am. Educ. Res. J.* 48, 1125–1156. doi: 10.3102/0002831211410683

Organisation for Economic Co-operation and Development (2015). *The ABC of Gender Equality in Education: Aptitude, Behavior, Confidence*. Paris: OECD.

Parker, P. D., Marsh, H. W., Morin, A. J. S., Seaton, M., and Van Zanden, B. (2015). If one goes up the other must come down: examining ipsative relationships between math and English self−concept trajectories across high school. *Brit. J. Educ. Psychol.* 85, 172–191. doi: 10.1111/bjep.12050

Paz-Albo, J. (2017). Is personalized learning the future of school? *Child. Educ.* 93, 295–299. doi: 10.1080/00094056.2017.1343581

Qian, M. K., Quinn, P. C., Heyman, G. D., Pascalis, O., Fu, G., and Lee, K. (2019). A long−term effect of perceptual individuation training on reducing implicit racial bias in preschool children. *Child Dev.* 90, e290–e305. doi: 10.1111/cdev.12971

Rhodes, M., Leslie, S.-J., Yee, K. M., and Saunders, K. (2019). Subtle linguistic cues increase girls' engagement in science. *Psychol. Sci.* 30, 455–466. doi: 10.1177/0956797618823670

Rivas-Drake, D., Camacho, T. C., and Guillaume, C. (2016). "Just good developmental science: trust, identity, and responsibility in ethnic minority recruitment and retention," in *Equity and Justice in Developmental Science: Theoretical and Methodological Issues*, eds S. S. Horn, M. D. Ruck, and L. S. Liben (San Diego, CA: Elsevier), 161–188.

Rudman, L. A. (2004). Sources of implicit attitudes. *Curr. Dir. Psychol. Sci.* 13, 79–82. doi: 10.1111/j.0963-7214.2004.00279.x

Russell, C. J., and Bobko, P. (1992). Moderated regression analysis and Likert scales: too coarse for comfort. *J. Appl. Psychol.* 77, 336–342. doi: 10.1037/0021-9010.77.3.336

Shadish, W. R., Cook, T. D., and Campbell, D. T. (2002). *Experimental and Quasi-Experimental Designs for Generalized Causal Inference*. Boston, MA: Houghton Mifflin.

Steffens, M. C., Jelenec, P., and Noack, P. (2010). On the leaky math pipeline: comparing implicit math–gender stereotypes and math withdrawal in female and male children and adolescents. *J. Educ. Psychol.* 102, 947–963. doi: 10.1037/a0019920

Umarji, O., McPartlan, P., and Eccles, J. (2018). Patterns of math and English self-concepts as motivation for college major selection. *Contemp. Educ. Psychol.* 53, 146–158. doi: 10.1016/j.cedpsych.2018.03.004

Vezzali, L., Capozza, D., Giovannini, D., and Stathi, S. (2012). Improving implicit and explicit intergroup attitudes using imagined contact: an experimental intervention with elementary school children. *Group Process. Intergr. Relat.* 15, 203–212. doi: 10.1177/1368430211424920

Weidinger, A. F., Steinmayr, R., and Spinath, B. (2018). Changes in the relation between competence beliefs and achievement in math across elementary school years. *Child Dev.* 89, 138–156. doi: 10.1111/cdev.12806

Wu, H., and Leung, S.-O. (2017). Can Likert scales be treated as interval scales?–A simulation study. *J. Soc. Serv. Res.* 43, 527–532. doi: 10.1080/01488376.2017.1329775

Yeager, D. S., and Walton, G. M. (2011). Social-psychological interventions in education: they're not magic. *Rev. Educ. Res.* 81, 267–301. doi: 10.3102/0034654311405999

Conflict of Interest: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

frontiers in Psychology

ORIGINAL RESEARCH
published: 13 January 2021
doi: 10.3389/fpsyg.2020.582805

A Constructivist Intervention Program for the Improvement of Mathematical Performance Based on Empiric Developmental Results (PEIM)

Vicente Bermejo[1,2], Pilar Ester[2]* and Isabel Morales[2]**

[1] Universidad Complutense de Madrid, Madrid, Spain, [2] Facultad de Educación, Universidad Camilo José Cela, Madrid, Spain

OPEN ACCESS

Edited by:
Edgar Galindo,
University of Evora, Portugal

Reviewed by:
Teresa Pozo-Rico,
University of Alicante, Spain
Heldemerina Samutelela Pires,
University of Evora, Portugal

***Correspondence:**
Vicente Bermejo
vbermejo@ucm.es
Pilar Ester
pester@ucjc.edu
Isabel Morales
imorales@ucjc.edu

Specialty section:
This article was submitted to Educational Psychology, a section of the journal Frontiers in Psychology

Received: 13 July 2020
Accepted: 07 December 2020
Published: 13 January 2021

Citation:
Bermejo V, Ester P and Morales I (2021) A Constructivist Intervention Program for the Improvement of Mathematical Performance Based on Empiric Developmental Results (PEIM). Front. Psychol. 11:582805. doi: 10.3389/fpsyg.2020.582805

Teaching mathematics and improving mathematics competence are pending subjects within our educational system. The PEIM (*Programa Evolutivo Instruccional para Matemáticas*), a constructivist intervention program for the improvement of mathematical performance, affects the different agents involved in math learning, guaranteeing a significant improvement in students' performance. The program is based on the following pillars: (a) students become the main agents of their learning by constructing their own knowledge; (b) the teacher must be the guide to facilitate and guarantee such a construction by being a great connoisseur of the fundamental aspects of the development of the child's mathematical thinking; (c) the mathematical contents must be sequenced in terms of the complexity and significance for the student as well as contextualized at all times; and (d) the classroom must have a constructivist climate highlighting cooperative work among students. The implementation of PEIM along with the empirical evaluation conducted in several centers in Madrid and Zaragoza (Spain) confirm how students improve their mathematical competence. Both first- and second-grade students in elementary education were far more effective in solving problems, highlighting the use of more advanced strategies in their resolution and a lower incidence of conceptual errors. Moreover, it was possible to verify how the students proving greater difficulty, experienced an evolution in learning similarly to those who did not present it. The program provides customized education to allow the teacher to know at all times how he should be more influential on the students' learning through mathematical profiles. Both teaching practice and teachers were observed, being that of the experimental group more prone to analyzing processes and allowing the construction of knowledge by students, due to their psycho-developmental training. As a result, we found several improvements through the implementation of the program that may serve, for upcoming years, as a basis for the necessary changes in the teaching of mathematics.

Keywords: PEIM, constructivism, developmental dimension, problem solving, mathematics teaching

INTRODUCTION

The emergence of research papers on the teaching-learning of mathematics is increasingly noticeable. The improvement of students' training is beginning to be a matter of state due to the high levels of school failure in international evaluations. Research results are frequently a long way from the classroom reality. In other words, it seems that research and educational practice are walking along different paths, and as a result, bridges should be built between the university and the school (Bermejo, 2018). However, improving mathematical competence does not imply making faster calculations, or obtaining a better resolution in activities only when they are presented to students more or less regularly. Instead, it implies that our students learn in a meaningful way, building their own knowledge to permit them directly apply what they have learned in their daily life, and always starting from their previous knowledge.

It is unacceptable the mathematical schizophrenia that comes out and is materialized in the child when the informal knowledge runs in parallel with the instruction received in the classroom. For many authors, such as Russell and Ginsburg (1984), those learnings the child obtains on a daily basis, and therefore, all students possess since they are first schooled, are the starting points to scaffold more precise and abstract concepts that will provide the learner with its straightforward application of what he has learnt in his upmost immediate environment.

On many occasions we can hear teachers speaking about the importance of calculus and the procedural mastery of arithmetic operations, relegating those activities that favor reasoning and problem solving.

We believe that it is important to disseminate research-based practices in which empirically contrasted positive results have been obtained, thus being able to obtain a number of evidence-based practices that allow improving the teaching-learning process and, therefore, the performance of students regarding mathematical competence. Educational practices that are research-validated can constitute a frame of reference to serve as a guide for knowledge transfer (Simplicio et al., 2020).

CONSTRUCTIVISM

The term "constructivism" comes from an artistic current that took place in present-day Russia around the year 1920 in the field of architecture and the plastic arts. However, the roots of this approach, as an epistemological proposal, go back even further than Plato with his innate ideas to justify knowledge. In fact, Gorgias (−380 BC) and the Greek sophists defended that we cannot know reality, but only have an opinion ("doxa") on things. More recently, Descartes' methodical doubt maintains that the only possible certainty is that of "cogito ergo sum." Berkeley (1685–1753) proposes his well-known "esse est percipi," to support that we only know our own ideas. In the same line, Giambattista Vico (1668–1744) affirms that man only understands what he does or builds. Likewise, Leibnitz's well-known quote (1646–1716) follows the same direction: "nihil est in intellectu quod prius non-fuerit in senso, nisi ipse intellectus." And finally, Kant (1724–1804) maintains that the mind is active and outlines experience (see Bermejo and Nieto, 2012).

Nevertheless, the father of cognitive constructivism is Jean Piaget with his work "La construction du reel chez l'enfant" published in Piaget (1937/1967), the second book of his well-known trilogy. As he concludes, accommodation and assimilation differ throughout the development of the child until they become increasingly complementary to each other: "True experience and deductive construction thus become both distinct and correlative" (p. 338). Therefore, constructivism takes up a room between empiricism and innatism or preformism, in an attempt to understand development as the result of an internal dimension formed by schemes, and another interactional dimension constituted by adaptation, being the result of the two above-mentioned functions: assimilation and accommodation. The former will help the subject adapt reality to his mental structures, whereas the latter will allow the adaptation of structures to reality. The equilibration of this process (equilibrium-disequilibrium-equilibrium) would be the fundamental cause of development, while factors such as social environment, physical environment and maturation become to play the facilitator roles (Piaget, 1937/1967). In this respect, the environment is not directly causing any development, but it can disturb or product disequilibrium. Therefore, equilibration, through a constructive process, would allow development to progress. However, equilibration is not understood as a static process, but a dynamic one, as Fosnot C. T. (1996) and Fosnot C. (1996b) highlights: "Equilibration is not a sequential process of assimilation, then conflict, then accommodation. Instead, it is a dynamic 'dance' of progressive equilibria, adaptation and organization, growth and change" (p. 14).

If the empiric learner is passive and relies upon effort and external motivation, and the maturing learner depends on an innate biological programming, the constructivist learner will evolve and develop via changes, equilibria and active constructions.

With some degree of frequency, different constructivist approaches are presented. Bermejo and Nieto (2012) talk about cognitive constructivism (Piaget), socio-cognitive constructivism (Vygotsky), biological constructivism (Maturana) and radical constructivism (Von Glaserfeld). Similarly, Castillo (2008) also proposes these four types of constructivism, although he classifies Maturana as a radical constructivist, along with Von Glaserfel. Nonetheless, in an attempt to analyze and coordinate them to pursue the main objective of the present paper, that is teaching-learning in the mathematics classroom, the following proposal presented by Cobb, seems to be accurate for us: "As was the case with the discussion of Rogoff's and von Glasersfeld's analyzes, this coordination of perspectives leads to the view that learning is both a process of self-organization and a process of enculturation that occurs while participating in cultural practices, frequently while interacting with others" (Cobb, 1996, p. 45).

In a few words, for Piaget "you only learn what you understand" and you only understand what you invent. This reminds us of the ideas of Giambattista Vico mentioned above.

In contrast, Vygotsky refers to two levels of development (current and potential) and the zone of proximal development, highlighting the adult's intervention in learning.

CONSTRUCTIVIST INTERVENTION PROGRAMS

Teaching mathematics have been approached from many different disciplines, i.e., cognitive psychology, neuroscience, biology, genetics, etc., although some, such as mathematics teaching, science teaching and educational psychology construct closer bridges between their results and daily practice in the classroom. It must be taken into account that each of the different disciplines focuses on different variables of the teaching-learning process, the student, the context, the teacher, etc. Since the teaching process is very complex, the intervention programs must try to respond to all the variables involved in the process, being aware that modifications may occur while being implemented in the classroom, due to the introduction of variables by the agents involved, the latter being the bases that will allow carrying out new studies (Simplicio et al., 2020).

According to Cobb (1998), there are two fundamental reasons why constructivism can be an alternative to more traditional methodologies. The first reason considers that students are capable of solving a wide variety of mathematical problems because they develop more complex and abstract structures. And, the second reason, through the construction of their own knowledge, looks at students changing their perspective because they are capable of creating and controlling mathematics, thus increasing students' motivation.

If we focus on learning mathematics, the interplay that occurs between the two approaches is the one that would allow the learning process to be balanced, since, as Bermejo et al. (2002) explains, the sociocultural part will focus on teacher-student and student-student interactions, and the participation of the individual to explain how the students take control of the teacher's contributions. Cognitive theorists, however, would analyze the student's processes of adaptation to the actions of others and would be more concerned with how deeply the individual interpretation is carried out. This implies that the construction of the individual mathematical concepts is influenced by the person's interpretations of others' activities and by his/her own.

In order to improve learners' mathematical performance, our intervention program known as PEIM aims to improve the understanding of mathematical contents, specifically in problem solving tasks. In order to do so, it will directly apply to four parameters: students, teachers, curricular contents and the social climate of the classroom.

With respect to students, the program assumes constructivist approaches so as not to receive passive mathematical knowledge, but rather, to construct it by themselves. Nevertheless, it is necessary to consider the knowledge prior to learning, since the student comes to the classroom with the knowledge that they have been acquiring within their context based on their daily life, as proposed by Resnick (1992). Since the child is born, regardless of his cultural background, he grows in a context with multiple stimuli that influence his mathematical learning (Ginsburg and Seo, 1999). For this reason, it is essential for the child to integrate what he is proposed to do in class together with his previous knowledge, which would entail more meaningful learning and, at the same time, would make him become a more active subject in the classroom. Assuming this premise, it would allow us to avoid any rote and decontextualized learning and move away from more directive teachings in which processes take on a special role. When children find themselves in new situations, they must adapt to them by restructuring the surrounding context so that they can negotiate it more easily. And, usually, it is necessary that they use creativity and apply alternative or unconventional thinking to those situations (Bagassi et al., 2020). By means of the implementation of a constructivist intervention, the student constructs significant learning allowing him to be more mathematically competent on a daily basis. In this respect, a longitudinal study conducted in England shows how students, who studied using very different approaches, despite having similar teachers and curriculum, learned differently, and obtained attitudes toward mathematics also differently (Boaler, 2002a,b, 2015).

When we refer to learning as a constructive process, not all authors attribute the same meaning to these words (see Bermejo et al., 2000b). Lampert (1989), for example, maintains that knowledge is constructed by the student in the same way as knowledge is constructed in the discipline of mathematics. Meanwhile, Carpenter et al. (1996, 2014) considers the process as an idiosyncratic construction by the student. And the NTCM (National Council of Teachers of Mathematics) proposes that "students should learn mathematics by comprehending, actively building new knowledge from experience and from their previous knowledge" (2000, p. 20).

From our point of view, and according to the National Council of Teachers of Mathematics (2000), an appropriate constructivist intervention would allow the student to interact with both the teacher and the rest of the students, using at all times different means to reason, relate, solve problems and communicate. It would also allow the student to anticipate and make conjectures of solutions based on mathematical arguments that validate what is stated. Furthermore, it will aid the learner to focus on solving problems that allow examples and counterexamples to be explored. Considering these aspects, it concludes by saying that the student, through reasoning, is capable of establishing conjectures and solutions, a process that will combine their prior knowledge with the concepts that they work collaboratively in the classroom by creating new knowledge structures.

The idea that we propose in the PEIM is that the teacher, through individual interviews, can define the student's mathematical profile in order to find out what developmental stage the student is at, what informal knowledge has been acquired and what type of proposals will allow the learner to progress adequately according to his rate of development.

Concerning teachers, they are a fundamental pillar in the teaching-learning process. It is essential for them to receive an extensive psycho-pedagogical training that enables them to get to know their students, so that they cannot only understand the

mathematical content in a deeper way, but also to be aware of how each student learns mathematics, that is, to anticipate the child's activity, their potential strategies and the mistakes committed in acquiring each content. It is, therefore, worth mentioning the importance that errors acquire as a source of learning. The understanding of the main mathematical concepts by the teachers will help them propose challenges to the student so that he/she can through meaningful learning, and construct more complex and abstract schemes that allow them to further develop their mathematical competence. Hence, it is important "to generate learning environments in which it makes sense both the approach and resolution of problems involving great mathematical ideas and those of other disciplines, and also the rules of the game used to deal with them" (Albarracín et al., 2018, p. 15).

From this perspective, it is essential that early childhood education teachers are aware of the most recent research findings in order to build bridges between research and classrooms, accommodating their own teaching to proven methods. With this respect, Koponen et al. (2016) proposes three priority areas in the development of the mathematical knowledge necessary for its teaching. The first area is concerned with a more coherent, comprehensive and shared understanding of what mathematics is, and how it should be taught. The second area calls for innovation and reflection on the research method. And finally, the third area involves carrying out studies on teaching, and deals with the nature of mathematical knowledge for a more equitable teaching.

For its part, the National Council of Teachers of Mathematics (2000) suggests taking into account several principles for teachers to design effective mathematics teaching: (a) to propose useful tasks that let them apply their knowledge to their daily life; (b) to analyze both the role of the teacher and the student in the educational practice, by using instruments that allow them to establish mathematical discussions to deepen their knowledge; and (c) to provide an adequate context previously analyzed adapting the teaching-learning process.

Cobb (1988, 1995) focuses on the idea that students construct their knowledge by restructuring their cognitive schemas and proposes that the teacher's task does not longer consist in helping to receive and acquire mathematical knowledge, but to organize and structure the activities to be carried out by the student. In this way, the teacher's role has substantially changed from the model presented by the traditional school. The teacher is no longer the instructor and becomes a guide to help students find their own way to solve the different activities proposed. This implies presenting situations where the student can look at different resolution strategies, making them do critical analyses and being able to justify how and why they did it in that way. For example, as Groen and Resnick (1977) put it, children are able to invent their own addition methods in the absence of adult instruction. This must let us think what, how and how much instruction is provided. Any connections between concepts as well as any applications provide a solid foundation for learning mathematics.

Likewise, the teacher's mathematical language is modified to model the explanations of the students in more adequate terms, distancing themselves from models in which the appropriate answers are rewarded and mistakes are corrected.

As Jacobson (2017) states, teachers have to face many challenges in the classroom, and these allow them to move forward in developing the contents and methodologies. In this respect, however, we should not forget how necessary ongoing training is, since it involves accepting the two principles of constructivism, those that must be implicit and present in the classroom. On one hand, children construct their own knowledge and, on the other, teaching must be organized to facilitate and guarantee such knowledge construction in the most efficient way possible. Therefore, this training must be a priority issue in educational centers and holding seminars with a certain frequency will help improve teachers' attitudes toward mathematics, and subsequently influence the instructional process in a positive way. Carpenter et al. (1998) show the existence of a close relationship between the change of beliefs in teachers and the way of teaching, as well as the performance of students (Yurekli et al., 2020). Furthermore, as Valentine and Bolyard (2019) write: "Negative attitudes toward mathematics are common among the general adult population, including prospective elementary teachers" (p. 437). So is this Philipp (2007), and the same belief is shared by students in terms of mathematics (Bermejo et al., 2000a). As some researchers have shown, there is a consistent relationship between math anxiety and performance (a medium to weak range, from −0.11 to −0.36), and they observe that those students who show higher in levels of MA tend to show poorer mathematics performance (Primi et al., 2020). None of these aspects are facilitators in the teaching-learning process.

We can then affirm that the learning process becomes a communicative process in which students are listened to, thereby understanding their goals and assuming their logical reasoning. The teacher in his role as a guide must ask students to clarify and justify their ideas both orally and in writing, which will allow him to influence and deepen into those aspects that he gauges more relevant, deciding when to relate language to mathematical notation. In order to do so, he will have to raise questions and provide assignments, provoke, compromise and challenge each student's mind. "In order for the teacher to manage the discussion in class correctly and efficiently, he needs have not only extensive knowledge on the topic being discussed, but also, and above all, he needs to know how the child learns that specific topic, that is, the levels of development in understanding the topic or content, the difficulties and typical errors that usually arise" (Bermejo et al., 2002, p. 40). Hence the weight of the program falls on the teacher's work before entering the classroom, because this, among other variables, will guarantee its success.

Another basic pillar of the program is school content. Quite a few studies show that the time spent on the subject, the parents and the content set by the government determine the educational practice (Anderson et al., 2005; Cross Francis, 2015; Yurekli et al., 2020). Therefore, it is necessary for the contents to be appropriately selected and sequenced. Such a selection does not largely affect the curriculum designed by the authorities, but what each teacher instructs on a daily basis. The selected activities should be aimed at facilitating comprehension, reasoning, solving

verbal problems, preparing mental representations, making decisions, etc., and devoting less time to routine and mechanical activities. The contents that are worked on must be meaningful for the students and connected to their daily life. Bermejo et al. (2002) states that what is really important is that learning takes place in a real context for students, since it fosters self-confidence and makes their learning more significant. The sequencing of contents must be up to their difficulty criteria (Bermejo et al., 1998). In this way, the PEIM proposes micro-genetic studies that allow the teacher to know the child's developmental steps regarding how each mathematical content is learned. In other words, it definitely suggests personalizing teaching.

Finally, the classroom context is another basic pillar making up the PEIM. In this respect, we understand that the context is the class dynamics and the multiple range of factors that facilitate and make learning possible. Some authors (see Saxe, 1991; Saxe and Guberman, 1998) understand learning as the individual achievement of goals through the development of collective activities. For this reason, Hatano and Inagaki (1991) believe that raising discussion among students would offer good opportunities for the construction of knowledge, due to socio-motivational factors. Likewise, cooperative work, in general, seems to have positive effects on learning. Cooperative learning helps students adopt different roles, from tutoring to being tutorized, and vice versa (Youde, 2020). Numerous studies (Johnson et al., 1983; Slavin, 1983a,b; Kagan, 1988; Johnson and Johnson, 1989; Sharan, 1990; Nelson-Le Gall, 1995) affirm that students who work cooperatively during their learning process, obtain global benefits at three levels: academic, social and personal. These benefits affect all students equally, from those whose profile is close to a proficient student to those who have learning difficulties (Huber and Carter, 2019; Moliner and Alegre, 2020; Sarid et al., 2020).

Authors such as Webb and Weeb and Farivar (1994) have studied this methodology in solving mathematical problems, although it must be said that it turns out difficult to identify the learning factors that influence on both the cognitive functions and the emotional sphere. Concerning these aspects, some authors conclude that peer interaction improves learning, because quite often does the child know his peers' difficulties better than does the teacher himself. Cooperation leads them to share the way they think, acting as mediators in the way others think (Presseisen, 1992). For their part, Palincsar and Brown (1998) affirm that the dialogue between students leads them to understand the strategic aspects of learning, appreciating their own thoughts as tools to address problems, therefore, through such a dynamic exchange, they learn powerful dimensions of thought.

THE PRESENT STUDY

The general objective of this study is to show the efficiency of the PEIM in learning mathematics, and, more specifically, in solving elementary verbal problems that require a single operation, either addition or subtraction, in the first years of elementary education. It is important to empirically demonstrate how likely it is to streamline the teaching-learning process by making methodological changes led by constructivist principles so as to improve students' mathematical performance. We want to emphasize the importance of the developmental dimension of the program that will facilitate the teacher to be aware of the constructive process the child follows in the acquisition of new mathematical contents.

There are two fundamental reasons why a constructivist perspective can be an alternative to transmission-based teaching methodologies. On one hand, it allows students to create more complex and abstract strategies, thus strengthening the ability to solve problems in a significant way. And on the other, it provides students with a sense of control that motivates and makes them be conscious that they are capable of learning and construct mathematics through problem solving.

This study presents two empirical works that were implemented in two discrete autonomous communities in Spain. The first study took place in public state schools in the community of Madrid, and the second in charter schools in the community of Aragon. The first study was carried out in the 1st grade of elementary education, whereas the second study was carried out in the 1st and 2nd grades. All schools belong to an upper-middle sociocultural group. In the first study, three different teachers were in charge of the experimental groups, and in the second study only one teacher implemented the PEIM in both groups. In both cases, we studied the influence of the program in solving verbal problems. However, in the second work, with the aim of studying the development of students depending on their ability, we also used other complementary tests so as to check their mathematical competence and IQ.

MATERIALS AND METHODS

Participants

Experiment 1

In order to empirically verify the PEIM's effectiveness, we randomly chose five groups in 1st grade of elementary education in Madrid's Public Schools, in upper middle-class residential areas. Two of these groups were used as control groups, whereas the three remaining classes, the experimental groups, followed the PEIM throughout the school year.

Experiment 2

The sample is made up of a group of 92 students from 1st and 2nd grade of elementary education in a charter school of Zaragoza. They were divided into four large groups of 23 children each. Two of them were from 1st grade and the other two were from 2nd grade: totaling 46 in 1st and 46 in 2nd grade. We established a control group and an experimental group in the 1st graders, as we also did in 2nd graders. At the beginning of the research, 1st graders had an age range between 5.9 and 6.8 years ($X = 6.34$), and 2nd graders belonged to the age range between 6.10 and 7.7 ($X = 7.42$). Along the study, three experimental deaths occurred, a fact that is not already considered for the sample participants.

Stimuli

Experiment 1

Six of the simplest verbal problems fall into the four main categories according to the ranking established in the Bermejo et al. (1998). These problems were formulated in both their additive and subtractive forms, except in the latter case for combination problems. Likewise, numerical expressions of addition and subtraction were applied with the unknown quantity both in the result and in the second term. The teachers of the experimental groups passed three questionnaires. Questionnaire I was used to examine the knowledge that these teachers had on the specific development of the mathematical content in these students. Questionnaire II based on checking teachers' beliefs and attitudes toward teaching-learning mathematics. And questionnaire III was used to look for information on self-evaluation about the impact that PEIM had had on their teaching. Eventually, we prepared an observation guide to register classroom dynamics.

Experiment 2

The students carried out several mathematical tests to evaluate their mathematical competence and a test to evaluate the groups' homogeneity. The tests we used were the following:

(1) The BADyG E1 test to have an estimate of each participant's general intelligence.
(2) For solving verbal problems, we presented the students a total of eighteen verbal problems, following Bermejo's classification (1990).
(3) Tedi-Math to measure the mathematical competence to assess the different areas: counting, numbering, understanding the number system, doing operations and solving verbal problems.

Procedure

Experiment 1

Firstly, we carried out an individual evaluation of all the students from both experimental and control groups to diagnose the previous mathematical knowledge and elaborate their mathematical profile. It consisted of an individual testing of the verbal problems and the numerical expressions mentioned above. The same tests were applied equally in the middle of the course to the experimental group (second evaluation), and at the end of the course they were applied to both control and experimental groups (third evaluation). All evaluations were recorded to facilitate a thoroughly detailed analysis. When the first evaluation was completed, questionnaire I was given to the teachers of the experimental group. Subsequently, all teachers also took questionnaire II. And finally, the teachers of the experimental group attended a 10 h seminar for several days, in which they were offered information about general child development and especially about specific mathematical development: addition, subtraction, verbal problems, strategies, errors, etc. In order to contextualize and specify all this information, we frequently offered them videos made by the same researchers to observe how different children solved the problems and the tasks proposed. At the end of the seminar, each teacher was provided with the "mathematical profile" of each of their students, made from the first evaluation we did at the beginning of the course. At the end of the course, questionnaire II was passed again to the teachers of the experimental groups to compare the results with those obtained in the first testing, as well as with the results obtained by the students in the groups in the last evaluation.

To evaluate the dynamics of the classroom, we maintained monthly meetings with the teachers of the experimental group and prepared an observation guide that included, among other things, the teachers' interventions, the students' initiatives, the type of activity of the students, etc. This record was carried out twice a month from February to April. Finally, we ended up passing questionnaire III for self-assessment on the impact that the PEIM had had on the teachers' instructional activity of the experimental groups.

Experiment 2

We carried out the classic experimental design where two groups participated, one control group and one experimental group. The distribution of the subjects in the different groups was randomly carried out in a stratified way in order to have a similar number of boys and girls both in the experimental and in the control groups. The TEDI-MATH test for checking mathematical knowledge was given to all the groups individually before the educational intervention was performed, as well as the measurement of eighteen verbal problems to assess their resolution. The problems presented fall into five different types of addition problems: change, combination, comparison, equalization and referential, and four types of subtraction: change, comparison, equalization and referential. Each problem was presented according to two variables in terms of the place of the unknown, either at the beginning or at the end. The numbers used in the measurements were modified in accordance with the grades (1st and 2nd graders) to soften or increase the difficulty. The result that the students had to provide did not have to exceed numbers 10 and 20, respectively, since our interest was not in testing their ability in operating with larger numbers, but in the reasoning applied to the different situations. These measurements were repeated at the end of the intervention (post-test).

The BADyG E1 intelligence test was also applied to the entire sample in groups.

The educational intervention was carried out in the mathematics classes throughout the school year. In one of the classes the teacher applied the constructivist program PEIM, while the control group continued working with a traditional methodology, that is, using calculation procedures and the textbook. The most outstanding tasks in the implementation of the PEIM were the verbal problems close to their immediate surroundings, because these allowed introducing other mathematical concepts as well as reasoning activities. They were proposed through the use of ICTs (e.g., power point, Prezi, etc.), and students worked on expendable materials that we handed them out (e.g., stickers, multi-cubes, jellybeans, etc.). The procedure applied to the development of the activities responded to Bruner's representation (1964, 1973). The problem was, in first place, proposed to work orally and avoid difficulties in reading and writing, which could condition problem resolution; and

then, it was actively developed in the different groups through the manipulation of objects. Once the students had exchanged either their methods of resolution or their mathematical opinions about the concepts, they proposed other activities that were carried out in an iconic way, that is, making a graphic representation. The last step in concept forming was to translate it into mathematical language, that is, doing a symbolic representation. For all the activities, they were provided with the time to share their proposal with the rest of the class.

These activities were supplemented with supermarkets, bingos and sessions in which students invented their own problems based on the conditions provided, giving them time to reflect on their knowledge, manage relationships about the corresponding operations and become aware of the errors committed in the relationships established, so that they could correct them.

RESULTS

Experiment 1

Bearing PEIM in mind, we first selected the main mathematical contents of addition and subtraction. In order to do so, the best way to teach these contents is to propose familiar and contextual verbal problems in difficulty order, as proposed in Bermejo et al. (1998). Additionally, we collected information on the use of numerical expressions.

In the first evaluation, the results obtained in the ANOVA show that the *Task* is the only significant factor [$F(3, 285) = 3.62$, $p < 0.05$], while the *Group* and *Operation Type* factors were not significant. In fact, the means of the groups and types of operation do not show important variations, while the verbal problems of change proved easier than those of comparison and equalization.

The second evaluation was carried out all along February with the aim of verifying only the experimental groups' progress in mathematical learning. The results also showed significant differences in the *Task* factor, with significant differences between the following problems: change and equalization, compare and equalization, and equalization and numerical expressions problems. The *Group* factor is not statistically significant, although the mean of group III is usually higher than that of the other groups.

At the end of de course, we carried out the third evaluation to all participants, both experimental and control groups. The results show significant effects on the factors *Group* [$F(4, 94) = 9.42$, $p < 0.01$], and *Task* [$F(3, 282) = 9.48$, $p < 0.01$]. In fact, in this evaluation the means of the three experimental groups exceeded significantly the means obtained from the control groups (Gex I = 1.18; Gex II = 0.92; Gex III = 1.41; Gc IV = 0.73; Gc V = 0.39), which allows us to affirm, at least provisionally, that the application of the PEIM had a positive effect on the students of the experimental groups. On the other hand, although there are no significant differences between the scores obtained by the three experimental groups, it is clear that group III obtained the best results, followed by group I and then group II (see **Table 1**).

As far as the teachers' educational profile is concerned, questionnaire I showed that they had generally little knowledge of addition and subtraction verbal problems, a fact that limited themselves mainly to the change type of problems. This limited information was also shown when they were asked to judge the degree of difficulty of the different verbal problems, as well as the strategies used by children and their errors in each type of verbal problem, confirming the thesis that teachers used to evaluate their students focusing on the results rather than the processes used.

TABLE 1 | Global means of all groups in three evaluations.

Evaluations	G.I	G.II	G.III	G.IV	G.V
1	0.55	O.47	0.67	0.56	0.42
2	0.96	0.73	0.99	–	–
3	1.28	0.97	1.51	0.85	0.52

Questionnaire II focused on the teacher's views and beliefs on the teaching-learning mathematics, specifically, what they know of constructivist principles, their application in the classroom and how evaluation is carried out. Among other results, we found that teacher 3 (Gex III) showed more systematic agreement on the constructivist perspective compared to other teachers, who were in greater disagreement when coming to the application of constructivist ideas in the classroom. In a second evaluation using the same questionnaire, teacher 3 (Gex III) confirmed the results obtained in the first evaluation, whereas teacher 1 (Gex I) showed a clear approximation to the constructivist principles.

The information obtained in questionnaire III suggests that the PEIM had a positive impact, in general, on the three teachers' mathematics teaching to the experimental group. We can emphasize that teacher 1 found very importance the specific mathematical development of children and showed his interest in taking into account children's strategies and errors when assessing and evaluating. Teacher 2 underscores, among other things, the importance of knowing and applying the different verbal problems of adding and subtracting in the classroom. And, finally, teacher 3 informs, among other things, of incorporating the different verbal problems into his teaching, as well as introducing changes in how to evaluate, by helping the child to reflect on the "mistakes made." Summing up the results of questionnaire III, teacher 3 is the one who better knows and applies the constructivist approach in the classroom, followed by teacher 1 who shows special interest in the ideas of this approach and convinced of the instructional effectiveness it can provide.

The observation guide that we used to assess the constructivist dynamics in the classroom focused on four main areas: the teacher's interventions and students' initiative degree, the types of activities and the teaching resources and evaluation. With respect to the first area, teacher 3 allowed the student to discover the solution to the problem with some frequency, whereas the other two teachers preferred to explain themselves how to solve the problems. The three teachers marked the students' assignments individually, and teacher 3 frequently explained individually the mistakes to the students. In general, the students of the three teachers solved the tasks individually, although with some frequency all the students taught by teacher 3 participated in the solution of the task. Concerning the types of activity, the algorithm was used by teachers 1 and 2 to work in general with

addition and subtraction, although in most of the cases, they also proposed to work on change and combination problems. In contrast, teacher 3 used word problems to teach addition and subtraction, asking them to solve word problems, or formulate word problems extracted from some data. Regarding teaching resources to solve the problems (materials, drawings, etc.), teacher 3 was the only one to use some with his students. Finally, learning assessment was not carried out only from the students' results, but rather all teachers also chose to evaluate the processes quite frequently.

Experiment 2

The four groups were very similar in terms of intelligence and previous mathematical knowledge according to the BADyG E1 General Intelligence Test and TEDI-MATH tests. The differences between the control and experimental group regarding the difference in the scores obtained in the TEDI-MATH pretest and post-test applied to the students, were analyzed in an ANOVA 2 (groups: experimental, control) × 2 (time of measurement: pre-test, post-test), with a second intrasubject factor, since both groups had samples with a normalized distribution. The results showed a significance of the main effects, $F = 282.95$, $p < 0.0000$, and $F = 113.73$, $p < 0.0000$, for measurement time and group, respectively.

For the present work, we also found interesting the difference in scores obtained in the pre-test and post-test with respect to problem solving, which is also significant both in 1st and 2nd grade groups. As we did not obtained a normalized distribution in any of the courses with respect to the score difference variables, in 1st (K-Scontrol = 0.123; $p = 0.200$) and (K-Sexperimental = 0.215; $p = 0.007$) and in 2nd (K-Scontrol = 0.280; $p = 0.000$) and (K-Sexperimental = 131; $p = 0.200$), we needed to carry out a Mann-Whitney test on the difference in the correct score between the different moments, UMann Whitney = −5,226; $p = 0.000$ and UMann Whitney = −5.827; $p = 0.000$, respectively.

To carry out the differential study regarding the evolution of the learning process after the educational intervention, the analysis is performed with the sample that belongs to the experimental group, since we are interested in knowing if there is any correlation between the methodology used, the mathematical competence and the students' ability. The analysis was carried out differentiating the course the students belonged to. We built a categorization of the students in the experimental group with respect to the IQ obtained in the BADyG E1 test, and then we analyzed the difference in the score obtained in solving problems with respect to the pre-test and post-test.

In order to accomplish this, we established three categories according to the IQ of the students following the classification of the Wechsler scale, which has an average equal to 100 and a standard deviation equal to 15, implying that the values relate with the categories of most common diagnostic use corresponding to low ≤ 89, 90 ≤ medium ≤ 110, and high ≥ 110.

In 1st graders' sampling, the hypothesis of sample normality is accepted, so an ANOVA, $F = 2{,}324$ and $p < 0.124$, is carried out, which makes it acceptable that the evolution of learning is similar in all categories, what is graphically reflected in the box of boxes and mustaches (see **Figure 1**).

Likewise, in 2nd grade, the same categorization is established whereby Shapiro-Wilk allows accepting the normality of the samples in each category, applying the ANOVA analysis, $F = 0.632$, $p < 0.542$, that is, the results show a similar learning evolution in all three categories, which we can see graphically in **Figure 2**.

DISCUSSION

Teaching and instruction are two closely related concepts in educational practice. A modification in teaching by implementing a more constructivist instruction, which starts in knowing the student's specific mathematical development,

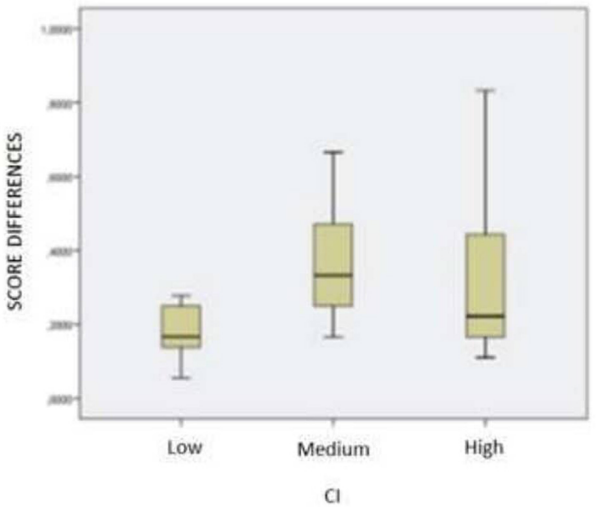

FIGURE 1 | 1st grade group, evolution of learning with respect to IQ.

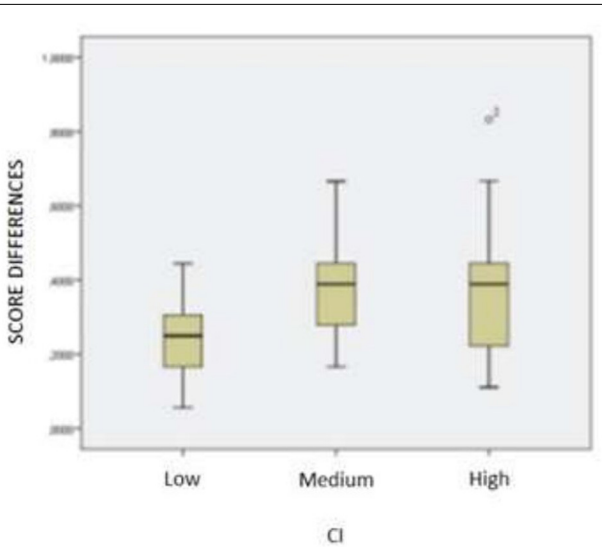

FIGURE 2 | 2nd grade group, evolution of learning with respect to IQ.

seems to have positive effects on the development of the mathematical competence. It has been shown that individuals who have received knowledge passively tend to continue using mathematics in this way both in their jobs and in their daily life (Boaler and Selling, 2017). In experiment I it can be stated that there exists a relationship between the level of application of constructivism in the classroom and the mathematical performance of children, as can be seen in **Figure 3**. This is the case of teacher 3, who knows and applies constructivist principles better in the classroom, and whose students achieve higher scores in mathematics. Likewise, we find clear differences concerning evaluation, in the sense that even if, before starting the implementation of the PEIM the teachers focused their evaluation on the results obtained, they eventually analyzed and evaluated the processes as well.

The results of the second experiment are highly consistent with what can be found in the first experiment. The differences between the experimental groups, in which a constructivist methodology was developed, and the control group are significant both in their mathematical competence and in solving problems. Furthermore, the strategies used in the experimental group bring about developmental differences compared to the control group.

If we look at the students' learning evolution in terms of their capability, the data obtained shows that their performance may be slightly higher in students with more abilities; however, it is not the case of their learning evolution. This is especially important since the students who show more difficulties in the area of mathematics, have a similar evolution to the rest of the students. We think that, for those students, the program could be an effective alternative. At a qualitative level, it was possible to observe that in the experimental group, the students who did not have strategies to approach problem solving, due to some initial blocked state, they started to be more self-confidence and achieved important results, because once they had addressed the problem and could not solve it, they tried to solve it in many other ways. If math classrooms do not actively engage students, by giving positive messages and opportunities to all students (Boaler and Sengupta-Irving, 2016; Boaler, 2015; Boaler and Selling, 2017), this may be due to some mismatching between the math learnt in school and the math they need for today's adaptative innovative and technological world.

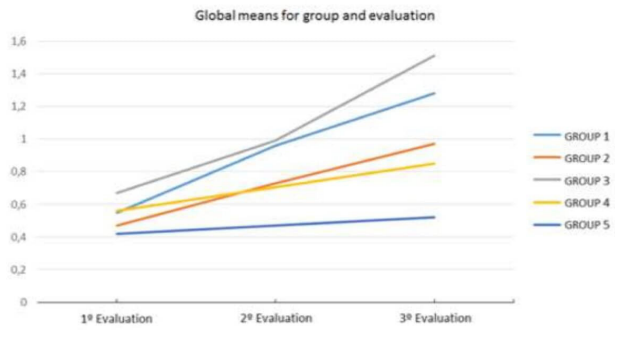

FIGURE 3 | Global means for group and evaluation.

One of the reasons of PEIM'S positive results is that it allows students in the experimental group to carry out intellectual work, since, through discovery, they were able to develop and reason methods to solve problems in the context of the real world and based on their prior knowledge. However, the control group was guided toward resolution procedures that they could understand and apply but did not actually internalize.

The constructivist methodology encourages students to confront and agree on ideas, besides allowing them to structure knowledge from their own cognitive processes, integrating their own ideas based on those learned with their classmates. The benefits of peer work have been demonstrated in meta-analysis studies in which they conclude that the benefits in elementary education outnumber those in secondary education (Alegre et al., 2019a; Anderson et al., 2005). In the experimental group, a certain critical attitude in problem solving was detected, leaving aside more procedural mechanisms that they had acquired in previous years. The approach was to understand the situation raised rather than choosing an algorithm that would allow them to resolve it.

Contextualizing the tasks and having been posed in different ways allowed students with more difficulties to have a starting point for solving them, that is, it allowed students to accommodate and assimilate those tasks with respect to experiential situations they had experienced before. This also allowed them to build resolution models and a generation of tasks in a more affordable way. This is the reason why their significantly improved performance contrasted with other groups.

Considering that the classroom climate of the experimental group brought to light working in a cooperative learning context, it is not surprising that its evolution was similar taking into consideration the clearly positive effects that these groups generally have on learning. There are relatively few environments in which students actively interact with mathematics and participate in a wide range of practices (Jacobs et al., 2006; Litke, 2015; Boaler and Selling, 2017).

GENERAL CONSIDERATIONS

The classes in which we worked through the PEIM allowed for a series of favorable conditions for the improvement of learning to occur, such as participation, dialogue, construction of knowledge, and the ability to reason and debate. In addition, the development of group work contributed to improve the efficiency and persistence in searching for solutions. The teacher will guide the student's knowledge construction process and will be the one who manages an adequate classroom dynamic.

The positive effects of the PEIM are evident, both in the changes that occurred in the improvement of the mathematical performance, contributing to the students' search for solutions and strategies as well as in the classroom dynamic. In the

most traditional teaching processes, the informal knowledge with which the student arrives in school is not taken into account, ranging from teaching arithmetic operations to verbal problems, which produces a kind of schizophrenia in children due to the lack of a continuum from the daily life mathematics to the school mathematics. Furthermore, the student learns arithmetic independently of verbal problems, a fact that leads the student to make a mechanical choice between two algorithms when finding a solution to verbal problems (Harris and Graham, 1994).

Many students do not address verbal problems by building a mental representation of the problem, from which to apply the relevant strategies to solve it. In contrast, what they usually do is to follow the procedure of finding key words in the verbal formulation that may give a false clue about the type of operation they should choose. For this reason, it is convenient for students to be accustomed to deal with verbal problems by first seeking the construction of its mental representation. By searching for keywords, it will not only condition their success at mandatory educational levels such as elementary education, but also all along their school years.

For this reason, it would be advisable for teachers to start working with students' prior knowledge, the same way as Luis Vives had kindly defended in the sixteenth century, and a century later, Jean Jacques Rousseau put forward in the prolog of his hallmark educational treaty, *Emilio*: "Start by studying to your students, because surely you don't know them." The effectiveness of these classical authors and their teaching is highly significant when present-day teachers know extensively about the specific development of each and every fundamental school mathematics content. Therefore, bearing in mind such influential views and knowledge, we can guide, collaborate and effectively help the child to walk along "step by step" into acquiring the specific mathematical content.

Children's manipulating materials constitutes an indispensable element to streamline their mathematical learning. In this respect, notorious neuroscience authors such as Dehaene (1997) and Butterworth (1999) confirm this fact when they advise instructing mathematics by intuitively reasoning and manipulating materials. Rivera-Rivera (2019) adds that "the manipulation of materials generates a brain activity that facilitates understanding. If what is being learned is understood and comprehended, various brain areas are activated, meanwhile if it is memorized without sense, neuronal activity is much poorer" (p. 166). Along these lines, Bermejo and Lago (1988) clarify and empirically show that the use of materials is very positive at the beginning of the mathematical content learning, although it can be an obstacle once this phase has been overcome. Likewise, some authors defend the importance of the use of fingers in mathematical development (Barrocas et al., 2020; Fischer et al., 2020). Therefore, it is convenient to "de-algorithmize" the mathematics classes since the algorithm is only an instrument for solving tasks, and not their ground foundation. In addition, we must insist on presenting the tasks considering their degree of difficulty, analyzing the semantic structure and the place of the unknown, which condition their difficulty. Non-routine problems are an opportunity that allows the child to find a solution in an alternative way, using his divergent thinking.

Moreover, although the PEIM has been applied in this work to 1st and 2nd grade elementary school students, we believe that the PEIM can also be applied to other educational levels. We should highlight that one of the limitations that we can find is to develop this program in very large groups since the PEIM advocates for the personalization of mathematics teaching, tailored to each student's mathematical profile. It would be a matter of choosing the appropriate mathematical content according to the developmental-mathematical level of the participants, and having teachers received the corresponding training. If the students' educational levels are higher, the use of materials in teaching could be less significant, or in any case, it would be necessary to choose the appropriate ones (Bermejo, 2014). Neither do we have data on students with learning difficulties. However, we think that the PEIM could be applied with positive results to these schoolers. It would consist, on one hand, in teachers selecting the appropriate mathematical contents according to the participants' mathematical knowledge; and on the other, in teachers receiving the appropriate training to teach these students the mathematical contents, considering also, their personal characteristics. In this case, it would be necessary to know the peculiarity of the students so that the classroom dynamic can based on constructivism.

CONCLUSION

To summarize, we would like to conclude by providing the basic ideas that make up a teacher's training program:

- The main constructivist foundations of the PEIM: (a) children will construct their own knowledge; (b) instruction guides and supports their knowledge construction; (c) instruction will focus on understanding and solving problems; and (d) specific mathematical development will form the foundation for sequencing instructional objectives.
- Profile of the constructivist student: (a) he constructs his own knowledge; (b) is mentally and manually active; (c) acquires significant knowledge; and (d) is autonomous and independent in constructing their knowledge.
- Profile of the constructivist teacher: (a) the child constructing his knowledge is the protagonist of the classroom; (b) learning mathematics involves understanding the procedures and solving problems; (c) schoolchildren come with previous knowledge before class instruction; (d) the teacher has an active attitude, by listening and asking his students, continuously evaluating all the processes and intervening whenever appropriate; and (e) personalized interaction with students.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

Ethical review and approval was not required for the study on human participants in accordance with the local legislation and institutional requirements. Written informed consent to participate in this study was provided by the participants' legal guardian/next of kin.

AUTHOR CONTRIBUTIONS

VB: team coordination, theoretical framework, data analysis experiment, and intervention program. PE: data analysis experiment, intervention program, results, and discussion. IM: editing coordination, revision, final proofreading, and discussion. All authors contributed to the article and approved the submitted version.

ACKNOWLEDGMENTS

We want to thank all participants for their disinterested collaboration, to teachers, tutors, and principals to permit collect data and evaluate participants, and specially to pupil participants for their work and effort, very valuable for data collection.

REFERENCES

Albarracín, L., Badillo, E., Giménez, J., Vanegas, Y., and Vilella, X. (2018). *Aprender a enseñar matemáticas en la educación primaria*. Madrid: Editorial Síntesis.

Alegre, F., Moliner, L., Maroto, A., and Lorenzo-Valentin, G. (2019b). Peer tutoring in algebra: a study in middle school. *J. Educ. Res.* 112, 693–699. doi: 10.1080/00220671.2019.1693947

Alegre, F., Moliner, L., Maroto, A., and Lorenzo-Valentin, G. (2019a). Peer tutoring and mathematics in secondary education: literature review, effect sizes, moderators, and implications for practice. *Heliyon* 5:e02491. doi: 10.1016/j.heliyon.2019.e02491

Anderson, J., White, P., and Sullivan, P. (2005). Using a schematic model to represent influences on, and relationships between, teachers' problem-solving beliefs and practices. *Math. Educ. Res. J.* 17, 9–38. doi: 10.1007/BF03217414

Bagassi, M., Salerni, N., Castoldi, V., Sala, V., Caravona, L., Poli, F., et al. (2020). Improving Children's Logical and Mathematical Performance via a Pragmatic Approach. *Front. Psychol.* 5:54. doi: 10.3389/feduc.2020.00054

Barrocas, R., Roesch, S., Gawrilow, C., and Moeller, K. (2020). Putting a finger on numerical development – Reviewing the contributions of kindergarten finger gnosis and fine motor skills to numerical abilities. *Front. Psychol.* 11:1012. doi: 10.3389/fpsyg.2020.01012

Bermejo, V. (2014). *Cómo enseñar matemáticas para aprender mejor*. Madrid: Editorial CCS.

Bermejo, V. (2018). *Cómo y cuándo el niño aprende las matemáticas*. San José: Construyendo puentes entre Universidad-Escuela.

Bermejo, V., and Lago, M. O. (1988). Representación y magnitud de los sumandos en la resolución de problemas aditivos. *Infancia y Aprendizaje* 44, 109–121. doi: 10.1080/02103702.1988.10822220

Bermejo, V., and Nieto, M. J. (2012). "Cibernética, constructivismo y construccionismo en Psicoterapia," in *Manual de Terapia Familiar y de Pareja*, eds V. Bermejo, A. García-Moltó, and T. Herranz (Madrid: Editorial Complutense), 70–92.

Bermejo, V., Lago, M. O., and Rodríguez, P. (1998). Aprendizaje de la adición y substracción. Secuenciación de los problemas verbales según su dificultad. *Revista de Psicología General y Aplicada* 51, 533–552.

Bermejo, V., Lago, M. O., and Rodríguez, P. (2000a). "La perspectiva constructivista en la enseñanza de las matemáticas," in *De la Psicología de la Instrucción a las necesidades curriculares*, ed. J. N. García-Sánchez (Barcelona: Oikos-tau), 83–92.

Bermejo, V., Lago, M. O., and Rodríguez, P. (2000b). "Las creencias de alumnos y profesores sobre las matemáticas," in *Intervención psicopedagógica y currículum escolar*, eds J. A. Beltrán, V. Bermejo, L. Pérez, M. D. Prieto, D. Sánchez, and Y. R. González (Navarrete: Ed. Pirámide), 129–151.

Bermejo, V., Lago, M. O., Rodríguez, P., Dopico, C., and Lozano, J. M. (2002). *PEI Un programa de intervención para la mejora del rendimiento matemático*. Madrid: Editorial Complutense.

Boaler, J. (2002a). *Experiencing school mathematics: Traditional and reform approaches to teaching and their impact on student learning*. New Jersey,NJ: Erlbaum.

Boaler, J. (2002b). Learning from teaching: Exploring the relationship between reform curriculum and equity. *J. Res. Math. Educ.* 33, 239–258. doi: 10.2307/749740

Boaler, J. (2015). *What's math got to do with it? How teachers and parents can transform mathematics learning and inspire success*. New York: Penguin.

Boaler, J., and Selling, S. K. (2017). Psychological Imprisonment or Intellectual Freedom? A Longitudinal Study of Contrasting School Mathematics Approaches and Their Impact on Adults' Lives. *J. Res. Math. Educ.* 48, 78–105. doi: 10.5951/jresematheduc.48.1.0078

Boaler, J., and Sengupta-Irving, T. (2016). The many colors of algebra: The impact of equity focusedteaching upon student learning and engagement. *J. Math. Behav.* 41, 179–190. doi: 10.1016/j.jmathb.2015.10.007

Butterworth, B. (1999). *The mathematical Brain*. New York: McMillan.

Carpenter, T. P., Fennema, E., and Franke, M. L. (1996). Cognitively guided instruction: A knowledge base for reform in primary mathematics instruction. *Elementary School J.* 97, 3–20. doi: 10.1086/461846

Carpenter, T. P., Fennema, E., Franke, M. L., Levi, L., and Empson, S. B. (2014). *Children's mathematics: Cognitively Guided Instruction*, 2nd Edn. New Hampshire: Heinemann.

Carpenter, T. P., Franke, M. L., Jacobs, V. R., Fennema, E., and Empson, S. B. (1998). A longitudinal study of invention and understanding in children's multidigit addition and subtraction. *J. Res. Math. Educ.* 29, 3–20.

Cobb, P.(1988). The tension between theories of learning and instruction in mathematics education. *Educ. Psychologist* 23, 87–103. doi: 10.1207/s15326985ep2302_2

Cobb, P. (1996). "Where is the mind? A coordination of sociocultural and cognitive constructivist perspectives," in *Constructivism: Theory, perspectives, and practice*, ed. C. Fosnot (New York, NY: Teachers College Press), 33–52.

Cobb, P. (1998). Learning from distributed theories of intelligence. *Mind Culture Activity* 5, 187–204. doi: 10.1207/s15327884mca0503_4

Cobb, P. (ed.) (1995). *The emergence of mathematical meaning: Interaction in classroom cultures*. New Jersey: Erlbaum.

Cross Francis, D. I. (2015). Dispelling the notion of inconsistencies in teachers' mathematics beliefs and practices: A 3-year case study. *J. Math. Teacher Educ.* 18, 173–201. doi: 10.1007/s10857-014-9276-5

Dehaene, S. (1997). *The number sense: How the mind creates mathematics*. Oxford: Oxford University Press.

Fischer, U., Suggate, S. P., and Stoeger, H. (2020). The implicit contribution of fine motor skills to mathematical insight in early childhood. *Front. Psychol.* 11:1143. doi: 10.3389/fpsyg.2020.01143

Fosnot, C. (ed.) (1996b). *Constructivism: Theory, perspectives and practice*. New York, NY: Teachers College Press.

Fosnot, C. T. (1996a). "Constructivism: A psychological theory of learning," in *Constructivism: Theory, perspectives, and practice*, ed. C. T. Fosnot (New York, NY: Teachers College Press), 8–33. doi: 10.4324/9780203461921_chapter_2

Ginsburg, H. P., and Seo, K. H. (1999). Mathematics in children's thinking. *Math. Thinking Learning* 1, 113–129.

Groen, G. J., and Resnick, L. B. (1977). Can preschool children invent addition algorithms? *J. Educ. Psychol.* 69, 645–652. doi: 10.1037/0022-0663.69.6.645

Harris, K. R., and Graham, S. (1994). Spelling-combining will with skill. *Teaching* 8, 16.

Hatano, G., and Inagaki, K. (1991). "Sharing cognition through collective comprehension activity," in *Perspectives on socially shared cognition*, eds L. B. Resnick, J. M. Levine, and S. D. Teasley (Washington, D.C: APA), 331–348. doi: 10.1037/10096-014

Huber, H. B., and Carter, E. W. (2019). "Fostering peer relationships and shared learning for students with autism spectrum disorders," in *The SAGE Handbook of Autism and Education*, eds R. Jordan, J. M. Roberts, and K. Hume (Newbury Park, CA: Sage), 265–275. doi: 10.4135/9781526470409.n21

Jacobs, J. K., Hiebert, J., Givvin, K. B., Hollingsworth, H., Garnier, H., and Wearne, D. (2006). Does eighth-grade mathematics teaching in the United States align with the NCTM Standards? Results from the TIMSS 1995 and 1999 video studies. *J. Res. Math. Educ.* 37, 5–32. doi: 10.2307/30035050

Jacobson, E. (2017). Field Experience and Prospective Teachers' Mathematical Knowledge and Beliefs. *J. Res. Math. Educ.* 48, 148–190. doi: 10.5951/jresematheduc.48.2.0148

Johnson, D. W., and Johnson, R. T. (1989). *Cooperation and Competition: Theory and Research*. Edina: Interaction Book Company.

Johnson, D. W., Johnson, R. T., and Maruyama, G. (1983). Interdependence and Interpersonal Attraction among Heterogeneous and Homogeneous Individuals: A Theoretical Formulation and a Meta-analysis of the Research. *Rev. Educ. Res.* 53, 5–54. doi: 10.3102/00346543053001005

Kagan, D. (1988). Teaching as clinical problem solving: A critical exam initiation of the analogy and its implications. *Rev. Educ. Res.* 58, 482–505. doi: 10.3102/00346543058004482

Koponen, M., Asikainen, M. A., Viholainen, A., and Hirvonen, P. E. (2016). Teachers and their Educators - Views on Contents and their Development Needs in Mathematics Teacher Education. *Math. Enthusiast* 13, 149–170.

Lampert, M. (1989). "Choosing and using mathematical tools in classroom discourse," in *Advances in research on teaching*, ed. J. Brophy (Greenvich: JAI Press), 223–264.

Litke, E. G. (2015). *The state of the gate: A description of instructional practice in algebra in five urban districts*. Doctoral dissertation, University of Delaware, Delaware.

Moliner, L., and Alegre, F. (2020). Peer Tutoring Effects on Students' Mathematics Anxiety: A Middle School Experience. *Front. Psychol.* 11:1610. doi: 10.3389/fpsyg.2020.01610

National Council of Teachers of Mathematics (2000). *Principles and standards for school mathematics*. Reston, VA: NCTM.

Nelson-Le Gall, S. (1995). "Children's Instrumental Help-Seeking: Its Role in the Social Acquisition and Construction of Knowledge," in *Interaction in Cooperative Groups. The Theoretical Anatomy of Group Learning*, eds R. Hertz-Lazarowitz and N. Miller (Cambridge: Cambridge University Press), 49–68.

Palincsar, A. S., and Brown, A. L. (1998). Social constructivist perspectives on teaching and learning. *Annu. Rev. Psychol.* 49, 345–375. doi: 10.1146/annurev.psych.49.1.345

Philipp, R. A. (2007). "Mathematics teachers' beliefs and affect," in *Second handbook of research on mathematics teaching and learning*, ed. F. K. Lester Jr. (Charlotte: Information Age), 257–315.

Piaget, J. (1937/1967). *La construction du réel chez l'enfant*, 5th Edn. France: Delachaux et Niestlé Ed.

Presseisen, B. (1992). "A Perspective on the Evolution of Cooperation Thinking," in *Enhancing Thinking through Cooperative Learning*, eds N. Davidson and T. Worsham (New York, NY: Teachers College Press).

Primi, C., Donati, M. A., Izzo, V., Guardabassi, V., O'Connor, P., Tomasetto, C., et al. (2020). The Early Elementary School Abbreviated Math Anxiety Scale (the EES-AMAS): A New Adapted Version of the AMAS to Measure Math Anxiety in Young Children. *Front. Psychol.* 11:1014. doi: 10.3389/fpsyg.2020.01014

Resnick, L. (1992). "From protoquantities to operators: Building mathematical competence on a foundation of everyday knowledge," in *Analysis of arithmetic for mathematics teaching*, eds G. Leinhardt, R. Putnam, and R. A. Hattrup (Hillsdale: Hillsdale Educational Publishers), 275–323.

Rivera-Rivera, E. (2019). NeuroLearning in teaching mathematics: A new educational proposal. *Revista Entorno* 67, 157–168.

Russell, R. L., and Ginsburg, H. P. (1984). Cognitive analysis of children's mathematical difficulties. *Cognit. Instruct.* 1, 217–244.

Sarid, M., Meltzer, Y., and Raveh, M. (2020). Academic achievements of college graduates with learning disabilities vis-a-vis admission criteria and academic support. *J. Learn. Disabil.* 53, 60–74. doi: 10.1177/0022219419884064

Saxe, G. B. (1991). *Culture and cognitive development: Studies in mathematical understanding*. New Jersey: Erlbaum.

Saxe, G. B., and Guberman, S. R. (1998). Studying mathematics learning in collective activity. *Learning Instruct.* 8, 489–501. doi: 10.1016/s0959-4752(98)00037-1

Sharan, S. (1990). *Cooperative Learning. Theory and Research*. Connecticut: Praeger Publishers.

Simplicio, H., Gasteiger, H., Dorneles, B. V., Grimes, K. R., Haase, V. G., Ruiz, C., et al. (2020). Cognitive Research and Mathematics Education—How Can Basic Research Reach the Classroom? *Front. Psychol.* 11:773. doi: 10.3389/fpsyg.2020.00773

Slavin, R. E. (1983a). *Cooperative Learning*. London: Longman.

Slavin, R. E. (1983b). When Does Cooperative Learning Increase Students Achievement? *Psychol. Bull.* 49, 429–455. doi: 10.1037/0033-2909.94.3.429

Valentine, K. D., and Bolyard, J. (2019). Lived Moments of Shift in Prospective Elementary Teachers' Mathematical Learning. *J. Res. Math. Educ.* 4, 436–463. doi: 10.5951/jresematheduc.50.4.0436

Weeb, N., and Farivar, S. (1994). Promoting helping behavior in cooperative small groups in middle school mathematics. *Am. Educ. Res. J.* 31, 369–395. doi: 10.3102/00028312031002369

Youde, A. (2020). I don't need peer support: effective tutoring in blended learning environments for part-time, adult learners. *High. Educ. Res. Dev.* 39, 1040–1054. doi: 10.1080/07294360.2019.1704692

Yurekli, B., Kay Stein, M., and Correnti, R. (2020). Teaching Mathematics for Conceptual Understanding: Teachers' Beliefs and Practices and the Role of Constraints. *J. Res. Math. Educ.* 51, 234–247. doi: 10.5951/jresematheduc-2020-0021

Conflict of Interest: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

frontiers in Psychology

ORIGINAL RESEARCH
published: 26 January 2021
doi: 10.3389/fpsyg.2020.525034

The Implications of Filial Piety in Study Engagement and Study Satisfaction: A Polish-Vietnamese Comparison

Joanna Różycka-Tran[1], Paweł Jurek[1], Thi Khanh Ha Truong[2] and Michał Olech[1,3]*

[1] Institute of Psychology, University of Gdańsk, Gdańsk, Poland, [2] VNU University of Social Sciences and Humanities, Vietnam National University, Hanoi, Vietnam, [3] Department of Psychology, Medical University of Gdańsk, Gdańsk, Poland

Even in psychological literature, which describes many determining variables related to the school domain, few studies have investigated the universal (i.e., etic) mechanism underlying parent–child relations, which is a prototype matrix for future student–teacher relations. The role of the imprinted schema of children's obligations toward parents seems to be crucial for school functioning in classroom society. The Dual Filial Piety Model (DFPM; Yeh, 2003) is comprised of two higher-order factors that correspond to the two focal filial piety attributes: reciprocal (need of interpersonal relatedness) and authoritarian (need of social belonging and national identity), which have been shown to have distinct implications on social adaptation and individuals' psychological functioning. In this study, we investigate the relationship between *filial piety* and student attitudes (study engagement and satisfaction) in a more individualistic and egalitarian culture (Poland, $N = 310$) and in a more collectivistic and hierarchical society (Vietnam, $N = 297$). The measurement invariances of three scales, i.e., the Vietnamese adaptation of DFP Scale, the Utrecht Work Engagement Scale (UWES–S9), and the Study Satisfaction Scale, were improved in the MLM analyses. Our results show that in more individualistic cultures, the RFP (reciprocal mode) is a stronger predictor of study engagement and study satisfaction; however, the AFP (authoritarian mode) is a better factor to predict study engagement in more collectivistic cultures. What is more, only RFP positively correlates with study satisfaction in individualistic culture. Our findings revealed that in different cultures, different aspects of filial piety should be emphasized by parents in the context of the future academic achievements of their children. The conclusion is that the prevention and intervention strategies or techniques intended for children with school problems should be culturally appropriate and addressed to the parents of kindergarten and later to very early-stage education teachers. The results of studies based on the DFPM may stimulate practical applications and policy development within the domain of success and failure in the academic environment.

Keywords: filial piety, DFPS, study engagement, study satisfaction, cross-culture psychology

OPEN ACCESS

Edited by:
Jesus de la Fuente, University of Navarra, Spain

Reviewed by:
Nikolaos Pellas, University of Western Macedonia, Greece
Olga Arias, Universidad de León, Spain

****Correspondence:***
Joanna Różycka-Tran
joanna.tran@ug.edu.pl

Specialty section:
This article was submitted to Educational Psychology, a section of the journal Frontiers in Psychology

Received: *07 January 2020*
Accepted: *22 December 2020*
Published: *26 January 2021*

Citation:
Różycka-Tran J, Jurek P, Truong TKH and Olech M (2021) The Implications of Filial Piety in Study Engagement and Study Satisfaction: A Polish-Vietnamese Comparison. Front. Psychol. 11:525034. doi: 10.3389/fpsyg.2020.525034

INTRODUCTION

Nowadays, we can observe an increased interest in the topic of school achievement, as school failure seems to have become an important issue in the present world (Galindo et al., 2018). With respect to the development of prevention and intervention strategies and techniques, the factors that underline school problems and the variables responsible for academic achievement and failure, should be first investigated and diagnosed, especially in the cross-cultural context of multiculturalism and the internationalization of education.

In psychological literature describes many determining variables related with school failure and academic achievement or satisfaction, e.g.,: the influence of self-control and grit on academic self-efficacy and satisfaction with school (Oriol et al., 2017); the links between career preparedness and academic development (Oliveira et al., 2017); the relationship between emotion understanding and school achievement (Franco et al., 2017); the association between variables of individual and school-related well-being and those of school achievement and performance (López et al., 2017); and the influence of family socio-economic status and parental support on success at school (Pires et al., 2017). Although many relationships between different variables and school problems have already been established, few studies have investigated the universal (i.e., etic) psychological mechanism underlying parent–child relations, which could be applicable in any culture. The imprinted schema of a child's obligations toward their parents seems to be a prototype for the student–teacher relationship in school society.

In this study, we investigate the relationship between *filial piety* and student attitudes (study engagement and satisfaction) in a more individualistic and egalitarian culture (Poland) and in a more collectivistic and hierarchical society (Vietnam), [see Hofstede et al. (2010) and Różycka-Tran et al. (2017)].

Filial piety is a quite modern psychological variable with origins in Asian (mainly Chinese) indigenous psychology. Filial piety was viewed as a culture-specific concept, denoting the idea of family interdependence and the close connection between children and their parents (Ho, 1994; Yeh and Bedford, 2003). Several filial piety duties have been described in the traditional culture of China, including the care and respect for and attendance upon the needs of one's parents and the provision of physical and financial care for one's parents (Yeh, 2003). In the classic definition, filial piety was viewed as a strong belief based on love and respect and amorally justified behavior referring to children's attitudes about how they should treat their parents; it has thus been conceptualized in Chinese research as an indicator of parent–child interaction quality (Yeh, 2003, 2006; Wong et al., 2010; Chen and Ho, 2012).

Although the expression of affection may differ by culture, the affection-based interaction and relations between children and parents are present in all cultures. Some studies in filial attitudes and behaviors have been conducted also in non-Chinese cultures, such as those of Korea, Japan, Thailand, and United States (Sung, 1995; Harris et al., 1998; Sharps et al., 1998). The given results suggest that this emic (i.e., culture-specific) Confucian virtue should be viewed as an etic (i.e., universal) construct. The consideration of filial piety as one of the 40 items in the book of The Chinese Culture Connection (1987) and as one of the 57 items in the Schwartz Value Survey (Schwartz, 1992) has, in previous studies, confirmed the universality of this culturally derived specific concept. Although filial practice may be different in many cultures, a universal (etic) nature of this variable has already been established, and this has provided an empirical base for studying it beyond Confucian cultures.

Nowadays, filial piety is one of the most basic universal virtues found in different cultures; it not only determines norms and beliefs within the family, but it also shapes the social and ethical directions for maintaining a stable society (Low and Ang, 2012). In modern psychological studies, filial piety is defined as a cognitive script for social exchanges in intimate relationships which shape individuals' attitudes. However, the existing research has produced conflicting findings over whether filial piety is beneficial or harmful to individual development (e.g., inhibiting the individual's independence, suppressing creativity, eliminating personal desires, and interests).

The Dual Filial Piety Model (DFPM; Yeh, 2003) integrates these conflicting findings and is comprised of two higher-order factors that correspond to the two focal filial piety attributes—reciprocal (need of interpersonal relatedness) and authoritarian (need of social belonging and collective identity)—which have been shown to have distinct implications on social adaptation and individuals' psychological functioning (Yeh and Bedford, 2004; Yeh et al., 2013; Chen, 2014; Chen et al., 2015). The DFPM proposes to try to transform filial piety from its Chinese culture-specific norms to a *contextualized personality* construct that is represented by culturally-sensitive psychological schemas of parent–child interaction.

Such matrix of social relations could be an object for investigation in any culture. Contextualized personality refers to stable patterns of thoughts, feelings, and behaviors that occur within a given context (Bedford and Yeh, 2019). Its authors claim that DFPM represents four possible modes of parent–child interactions: *balanced mode, reciprocal mode, authoritarian mode*, and *non-filial mode*. Interestingly, researchers have considered comparing filial piety and attachment style: *secure attachment style* corresponds to the balanced mode (high RFP and high AFP), the *avoidant attachment style* represents the non-filial mode (low RFP and low AFP), and the *ambivalent attachment style* refers to both reciprocal (high RFP and low AFP) and authoritarian (high AFP and low RFP) modes (see: Bedford and Yeh, 2019).

Two facets of DFPM could be measured by the Dual Filial Piety Scale (DFPS) consisting of 16 items (Yeh and Bedford, 2003). It must be noted that reciprocal and authoritarian factors are not in opposition but coexist in the mind of the person and may cause the same effect (Bedford and Yeh, 2019). The results show that both factors could be analyzed on different levels: as individual motives (reciprocal vs. authoritarian) in the context of parent–child relations, the horizontal vs. vertical structural properties of the parent–child interactions, and the core vs. the changing aspect of social changes in filial norms and differences across societies in the expression of filial piety (Tsao and Yeh, 2019). At the cross-cultural level, RFP

(representing psychological prototype) and AFP (representing cultural prototype) describe two fundamental psychological schemas that can be identified as universal etic construct (Yeh et al., 2009).

Reciprocal filial piety (RFP) meets the psychological need for emotional connectedness in social relations and is created by long-term positive interaction with parents in everyday life. The practices of RFP, i.e., respecting, caring for, and attending to one's parents, fulfill the internal desire for relatedness between two individuals with a horizontal (equal) relationship. The concept of RFP is convergent with the Western ideas of equality and democracy (Yeh et al., 2013). Because RFP is motivated by gratitude and a desire to repay one's parents for their efforts in the child-raising process (Yeh et al., 2013), its effects are generally positive, producing better interpersonal relationships with parents (Yeh and Bedford, 2004) and higher life satisfaction (Chen, 2014).

The second factor, authoritarian filial piety (AFP), is based on role obligations, compliance with and subordination to parental authority, and is driven by the need for collective identification in vertical (hierarchical) relationships. Individuals with AFP are accustomed to following the rigid social definition of being a son or a daughter consistent with parental demands and expectations (Yeh et al., 2013). Some authors claim that the effects of AFP are generally more negative because they are related to increased levels of depression, anxiety, and aggression (Yeh, 2006). Although the expectation of conformity to parental wishes and the restrictions associated with AFP may block individual autonomy, the willingness to sacrifice for the family may help to maintain harmony within the family and thus benefit the family as a whole system (Yeh and Bedford, 2004; Yeh, 2006).

Filial piety is aimed at deploying notions of social responsibility to create peace and harmony in society, as it underscores the importance of social relationships, solidarity, justice, and sincerity. This applies also to business transactions because a good leader has an obligation to cultivate and improve loyalty and morality. In this case, Yang (1996) views filial piety as a social orientation through which reciprocity functions as a *self-reinforcing power*. Bedford and Yeh (2019) see filial piety as a contextualized personality construct connecting individual-level motivations or goals to their social context.

Thus, family obligation has also been found to correlate with greater academic achievement (Fuligni and Zhang, 2004). A recent study in Hong Kong found that RFP and AFP represent two different motivational beliefs, each with its own influence on academic success (Chen and Wong, 2014). However, results of other different studies are confusing: RFP tends to be positively associated with a higher level of education and positively correlates with life satisfaction (Wong et al., 2010), but AFP seems to be positively associated with less education and lower life satisfaction because of self-suppression (Yeh, 2006). Also, other results showed that RFP was positively associated with academic achievement *via* the satisfaction of the need for autonomy, while the AFP was negatively associated with academic achievement (Zhou et al., 2020). Furthermore, the authors suggest that while filial piety is embedded in Eastern settings, it can be applied to a global context, where RFP in society, but not AFP, is related to student academic achievement (*via* autonomy).

However, there is no study investigating the influence of RFP and AFP on school attitude and functioning in a different cultural context.

HYPOTHESES

In our study, we decide to investigate the influence of filial piety (RFP and AFP) as an independent variable on study engagement and study satisfaction (dependent variables) in the more individualistic and egalitarian Polish culture versus the more collectivistic and hierarchical Vietnamese society (culture as moderator).

The aim of the study was to describe the moderating effect of culture on the relationship between filial piety and attitudes toward study. In other words, the main purpose was to investigate the cultural similarities and differences in the psychological functions of RFP and AFP as predictors of study engagement and study satisfaction. The theoretical model tested in the given research is showed in **Figure 1**.

Regarding the theoretical background and our model, which we tested in the study, we stated four hypotheses in which we looked for the moderating effect of culture (Polish vs. Vietnamese).

H1: The country in which one lives affects the relationship between RFP and study engagement; reciprocal filial piety correlates more strongly with studies engagement in the case of Polish students than it does among Vietnamese students.

H2: The country in which one lives affects the relationship between AFP and study engagement; authoritarian filial piety correlates more strongly with study engagement among Vietnamese students than it does among Polish students.

H3: The country living which one lives affects the relationship between RFP and study satisfaction; reciprocal filial piety correlates more strongly with study satisfaction among Polish students than it does among Vietnamese students.

H4: The country in which one lives affects the relationship between AFP and study satisfaction; authoritarian filial piety correlates more strongly with study satisfaction among Vietnamese students than it does among Polish students.

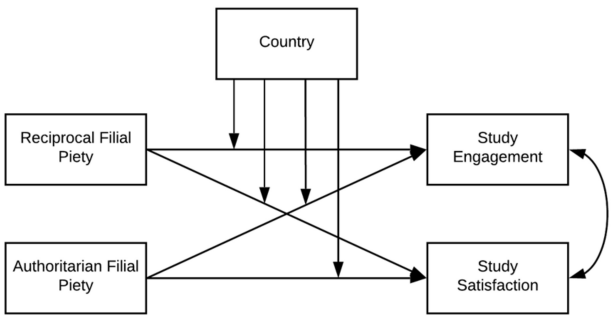

FIGURE 1 | Theoretical model tested in the study.

MATERIALS AND METHODS

Participants and Procedure

The survey was conducted among college students, some of whom received extra course credit points. Participation in the study was voluntary and anonymous. We followed APA standards and the Declaration of Helsinki during the preparation and conduction of the study. The study protocol was approved by the Ethics Board for Research Projects at the Institute of Psychology, University of Gdańsk.

The Polish sample comprised N = 310 students of social sciences (75% female, M_{age} = 20.69, SD = 3.10) from the University of Gdańsk (UG). The Vietnamese sample comprised N = 297 students (77% female, M_{age} = 19.23, SD = 1.02) from the University of Social Sciences and Humanities (USSH) in Hanoi.

Bilingual psychologists with scientific experience created country-level versions of the scales using the back-translation procedure. The English versions of the scales were used as the basis for all translations. Participants completed a paper and pencil version of the questionnaires (Polish or Vietnamese version, respectively) and answered demographic questions.

Measures

Participants were asked to complete the Dual Filial Piety Scale (DFPS) developed by Yeh and Bedford (2003). We used the Polish adaptation by Różycka-Tran et al., unpublished and the Vietnamese adaptation by Truong et al. (2020). Both adaptations were authorized by the authors of the original version of the tool. In the study, we also used the Utrecht Work Engagement Scale for Students (UWES–S9) developed by Schaufeli et al., 2002; see

TABLE 1 | CFA fit statistics for the structural models of the three scales used in the study.

Country	Measure	χ^2	*df*	CFI	RMSEA	SRMR
Poland	Dual filial piety scale (two-factor model)	249.94	102	0.90	0.068	0.072
	UWES-S9 (one-factor model)	112.79	25	0.93	0.106	0.071
	Study satisfaction scale (one-factor model)	25.61	4	0.97	0.132	0.039
Vietnam	Dual filial piety scale (two-factor model)	203.21	102	0.91	0.060	0.073
	UWES-S9 (one-factor model)	83.99	25	0.93	0.089	0.051
	Study satisfaction scale (one-factor model)	33.92	4	0.96	0.159	0.047

χ^2, chi square; df, degrees of freedom; CFI, comparative fit index; RMSEA, root mean square error of approximation; SRMR, standardized root mean square residual.

TABLE 2 | Global fit measures in measurement invariance tests for the three scales used in the study.

Measure	Level of invariance	χ^2	*df*	CFI	Δ CFI
Dual filial piety scale	Configural (equal form)	451.07	204	0.91	–
	Metric (equal factor loadings)	480.27	218	0.90	0.01
	Partial scalar (equal intercepts but not all) [a]	495.88	224	0.89	0.01
	Scalar (equal intercepts)	1228.27	232	0.65	0.25
UWES-S9	Configural (equal form)	195.82	50	0.93	–
	Metric (equal factor loadings)	210.05	58	0.93	0.00
	Partial scalar (equal intercepts but not all) [b]	215.11	60	0.92	0.01
	Scalar (equal intercepts)	618.93	66	0.78	0.15
Study satisfaction scale	Configural (equal form)	61.56	8	0.96	–
	Metric (equal factor loadings)	83.55	12	0.95	0.01
	Partial scalar (equal intercepts but not all) [c]	95.50	13	0.94	0.01
	Scalar (equal intercepts)	167.41	16	0.90	0.05

χ^2, chi square; df, degrees of freedom; CFI, comparative fit index; [a]Intercepts for item 1, 2, 3, 5, 7, 9, 10, and 16 were released; [b]Intercepts for item 1, 2, 6, 7, 8, and 9 were released; [c]Intercepts for item 1, 2, and 4 were released.

TABLE 3 | Differences between the average results of the studied variables between Polish and Vietnamese students.

Variable	Poland		Vietnam		*t*(*df*)	*P*	*Cohen's d*
	M	*SD*	*M*	*SD*			
Reciprocal filial piety	5.76	0.87	6.14	0.71	−5.80 (605)	<0.001	0.49
Authoritarian filial piety	2.81	0.91	3.95	1.03	−14.43 (605)	<0.001	1.17
Study engagement	3.17	1.11	3.16	0.99	0.11 (605)	=0.916	0.01
Study satisfaction	4.45	1.26	3.90	1.27	5.37 (605)	<0.001	0.43

N_{Poland} = 310, $N_{Vietnam}$ = 297.

also Carmona-Halty et al., 2019) and the Study Satisfaction Scale—a modified version of the Career Satisfaction Scale developed by Greenhaus et al. (1990).

The Dual Filial Piety Scale (DFPS) consists of 16 items. Eight items measure reciprocal (RFP), and eight items measure authoritarian (AFP) filial piety. Respondents were asked to indicate on a scale from 1 to 7 the importance of each statement. Examples of items measuring RFP include the following statement: "Be grateful to parents for raising you"; and AFP includes the following item: "Live with parents even after marriage." In the current study internal consistency coefficients (Cronbach's alphas) were strong for both scores in both national samples: 0.87 and 0.85 for RFP subscale in the Polish and Vietnamese samples, respectively; 0.77 and 0.84 for AFP subscale in the Polish and Vietnamese samples, respectively.

The Utrecht Work Engagement Scale for Students (UWES–S9; Schaufeli et al., 2002; Carmona-Halty et al., 2019) is a widely used tool to assess study engagement. The scale consists of nine items grouped into three dimensions with three items each: vigor (e.g., "When I'm doing my work as a student, I feel bursting with energy"), dedication (e.g., "I am proud of my studies"), and absorption (e.g., "I feel happy when I am studying intensely"). All items are scored on a frequency rating scale ranging from 0 (*never*) to 6 (*always*). In the current study, we used only the general score of the scale to indicate overall study engagement. Internal consistency coefficients (Cronbach's alphas) were strong in both samples: 0.90 and 0.89 in the Polish and Vietnamese samples, respectively.

The Study Satisfaction Scale is the student version of the widely accepted measure of career satisfaction developed by Greenhaus et al., 1990; see also Spurk et al., 2011). It is a five-item self-report scale measuring subjective feelings of study-related success (e.g., "I am satisfied with the progress I have made toward meeting my overall study goals"). All items are scored on a 7–point Likert scale ranging from 1 (*strongly disagree*) to 7 (*strongly agree*). In the current study internal consistency coefficients (Cronbach's alphas) were strong in both samples: 0.86 and 0.88 in the Polish and Vietnamese samples, respectively.

Statistical Analysis

First, we needed to determine whether the three scales we used in the study measured the same constructs in both countries, i.e., that they demonstrated measurement invariance across the Polish and Vietnamese samples. Thus, we assessed the three scales' cross-country equivalence through multigroup confirmatory factor analysis (MGCFA). In the beginning, the factorial structure of each scale was assessed separately for Polish and Vietnamese samples using CFA. To assess the fit of the models, we followed Brown (2015), using the following criteria: CFI > 0.90 and RMSEA < 0.08 (e.g., Brown, 2015).

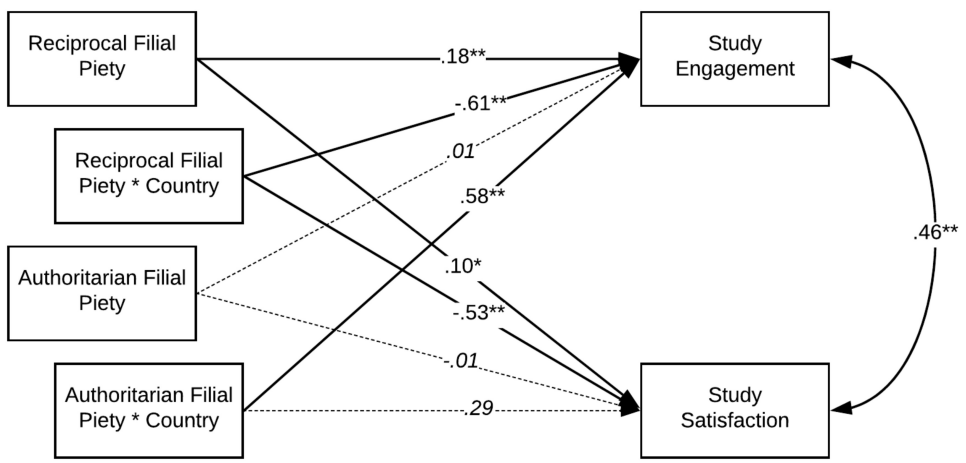

FIGURE 2 | Results of the regression analysis – standardized coefficients.

TABLE 4 | Results of the regression analysis separately for the Polish and Vietnamese samples.

Dependent variable	Country	Predictors	B	SE	Beta	Model summary
Study engagement	Poland	Reciprocal filial piety	0,25	0,08	**0,20****	$F(2, 309) = 5.33$, $p < 0.01$, $R^2 = 0.03$
		Authoritarian filial piety	−0,07	0,08	−0,06	
	Vietnam	Reciprocal filial piety	0,15	0,08	0,11	$F(2, 296) = 6.42$, $p = 0.75$, $R^2 = 0.04$
		Authoritarian filial piety	0,13	0,06	**0,14***	
Study satisfaction	Poland	Reciprocal filial piety	0,28	0,09	**0,20****	$F(2, 309) = 5.80$, $p < 0.01$, $R^2 = 0.03$
		Authoritarian filial piety	−0,02	0,09	−0,01	
	Vietnam	Reciprocal filial piety	−0,07	0,11	−0,04	$F(2, 296) = 0.29$, $p = 0.75$, $R^2 = 0.00$
		Authoritarian filial piety	0,05	0,08	0,04	

However, Kenny et al. (2015) showed that RMSEA often underestimates fit when the degree of freedom is small, so we used an SRMR criterion <0.08 for the UWES-9S and the Study Satisfaction Scale.

In the steps following, we tested the measurement invariance of the three scales we used in the study in Poland and Vietnam. In cross-country research, we usually estimate three levels of invariance: configural, metric, and scalar. Each of them is defined by the parameters that are constrained to be equal across samples (Milfont and Fisher, 2010; Beaujean, 2014). Configural invariance is present if in all groups the measurement model is built of the same number of factors that consist of the same indicators; metric invariance is determined when factor loadings are equal across the groups; and scalar invariance requires that factor loadings and all intercepts are equal across the groups. It is also possible to determine partial invariance, which is considered to be sufficient for cross-group comparisons (Byrne et al., 1989). Partial invariance requires that the parameters of at least two indicators per construct are equal across the groups.

We started the measurement invariance investigation by testing for configural invariance across the Polish and Vietnamese samples. To identify subsequent levels of measurement invariance (metric and scalar), we used the following cut-off criteria: $\Delta CFI \leq 0.01$ (see Chen, 2007). The R environment (R Core Team, 2018) supported by the lavaan package (Rosseel, 2012) was used to conduct measurement invariance analysis using maximum likelihood with robust standard errors estimation (MLM).

We next compared the significance of differences between the average results of the studied variables between Polish and Vietnamese students. For this purpose, we used the *t* test for independence samples. We also conducted a linear regression analysis to test the hypothesis about the moderation role of a country in the relationships between filial piety and study attitudes (engagement and satisfaction). Our model included two independent variables (RFP and AFP): one moderator (country) and two dependent variables (study engagement and study satisfaction) (see **Figure 1**). Finally, to illustrate the moderation effect, we conducted a linear regression analysis separately on the Polish and Vietnamese samples.

RESULTS

Measurement Invariance of the Scales Used in the Study

First, we conducted a series of CFAs (separate for each country) testing a two-factor model of the DFPS, a one-factor model of the UWES-9S, and a one-factor model of the Study Satisfaction Scale. As can be seen in **Table 1**, the CFI as well as RMSEA and SRMR (for models with a small degree of freedom) values suggested a good fit in both countries.

Next, we conducted a three-level measurement invariance test for each scale. **Table 2** presents the global fit coefficients for configural, metric, scalar, and partial scalar equivalent. These results allow us to conclude that all three of the measures we used in the study reached partial scalar invariance across samples, which allows us to make cross-country comparisons.

Polish-Vietnamese Differences in the Examined Variables

As can be seen in **Table 3**, Vietnamese students scored higher on both reciprocal and authoritarian filial piety subscales compared to Polish students. At the same time, Polish students reported higher study satisfaction compared to their peers in Vietnam. However, there were no significant differences in study engagement between students from both countries.

Moderating Effect of Country on the Relationship Between Filial Piety and Study Attitudes

As can be seen in **Figure 2**, according to H1 and H2, the country of living has a significant moderating effect on the relationship between reciprocal filial piety and study engagement ($\beta = -0.61$, $p < 0.01$) as well as on the relationship between authoritarian filial piety and study engagement ($\beta = 0.58$, $p < 0.01$). After adding interaction components to the model, the adjusted R^2 value increased significantly from 0.02 to 0.05 (F Change = 8.12, $p < 0.01$). As expected, RFP has a significant positive relationship with study engagement, but only in the group of Polish students. The opposite result was found for AFP, which is related to study engagement, but only in the group of Vietnamese students (see **Table 4**).

According to H3, the country of living has a significant moderating effect on the relationship between RFP and study satisfaction ($\beta = -0.53$, $p < 0.01$). After adding interaction components to the model, the adjusted R^2 value increased significantly from 0.01 to 0.06 (F Change = 17.49, $p < 0.01$). As expected, RFP has a significant positive relationship with study satisfaction but only in the group of Polish students. However, the results do not support hypothesis H4. In both countries, there is no significant relationship between AFP and study satisfaction (see **Table 4**).

It is worth noting that study engagement correlates more positively with study satisfaction in the group of Polish students ($r = 0.56$) than among their Vietnamese peers ($r = 0.38$). In addition, it should be noted that Vietnamese students in the current study declared significantly lower satisfaction with academic achievements than did the Polish students. These two results can help find an explanation for the lack of relationship between filial piety and study satisfaction in the group of Vietnamese students.

DISCUSSION

From the perspective of DFPM, the major developmental task of children, instead of just the personal autonomy whose inculcation is prioritized especially in western cultures, is to form self-volition by integrating numerous social roles as in eastern cultures. Shaping the social matrix is very important because the parent–child relationship becomes the foundation

for future social relations with others and helps enrich a more complex identity composed of different social roles (Bedford and Yeh, 2019). It means that filial piety mode established in early childhood influences future relations in school between children and teachers, being an important predictor of academic achievement and study satisfaction.

Our study contributed new results to the theory about the cross-cultural context of teacher–student relations. The cross-cultural comparison studies should not focus on the level of filial piety in every society but should identify cultural similarities and differences in the psychological functions of RFP and AFP (Tsao and Yeh, 2019). Our results show that in more individualistic cultures, the RFP (reciprocal mode) is a stronger predictor of study engagement and study satisfaction; however, the AFP (authoritarian mode) is a better factor to predict study engagement in more collectivistic cultures. So, the implications for practice could concern reciprocity enhanced during the raising of children in a more individualistic culture; however, the authoritarian mode should be enhanced in a more collectivistic society. What is more, only RFP is positively correlated with study satisfaction in an individualistic culture; different predictors of study satisfaction should thus be investigated in more collectivistic cultures in future studies. Our findings revealed that in different cultures, different aspects of filial piety should be underlined by parents in the context of future academic achievements of their children.

The correlation between AFP and study satisfaction in both cultures could result from the definition of AFP: filling social roles and fulfilling social obligations requires self-suppression, where satisfaction is not so important a motivator. In Vietnam, hewing to filial piety norms has nothing in common with personal satisfaction—these are two different motives of psychological functioning and behavior in a collectivistic culture. However, our results show that in an individualistic and egalitarian culture, RFP influences both study engagement and study satisfaction, and it is therefore important to enhance reciprocity in raising individualistic children.

Our findings are consistent with a cross-cultural study by Li et al. (2010) who analyzed Chinese and European American young adults with respect to how they perceive maternal socialization goals (self-development, filial piety, and collectivism), parenting styles (authoritative, authoritarian, and training), and the social-emotional adjustment (self-esteem, academic self-efficacy, and depression). They found cross-cultural similarities between perceived maternal authoritative parenting and socioemotional adjustment (e.g., higher self-esteem and higher academic self-efficacy). However, only Chinese participants declared perceived maternal authoritarian parenting styles as related to socioemotional adjustment (e.g., higher academic self-efficacy). It means that a parenting style shaped by socialization goals is crucial for socio-emotional adjustment (i.e., academic achievement and satisfaction), although it is moderated by culture.

The final conclusion is that the prevention and intervention strategies or techniques intended for children with school problems should be appropriate to the culture and addressed to the parents of children in kindergarten and later to very early-stage education teachers. The intervention should be through a combination of both in-school and external factors. Teachers should promote high expectations and strong teacher–student relationships in a collectivistic society because high expectations increase students' sense of self-efficacy and motivation, which improves achievement and aspirations. In more individualistic cultures, achievements could be improved by quality teacher–student relationships based on support and the emotional sensitivity of the teacher. The results of studies based on the DFPM may stimulate practical applications and policy development in the domain of success and failure in the academic environment.

LIMITATIONS AND FUTURE STUDIES

The main limitation of the study is student samples that are not representative of the whole of the respective countries. Further studies should use a sample with a broader range of ages and occupations; for example, employees in different organizations. Currently, there is a growing interest in human capital analytics, which consists of explaining and predicting the efficiency of the organization by means of employee data. One of the important sources of information on the functioning of the organization and people employed in it are employee opinion surveys. It would be interesting to investigate the role of filial piety in perceived working conditions and work engagement through employees' attitudes toward the organization.

In future studies, the construct validity of the DFPS-V should be tested by examining the relationship of filial piety with other validated measurements using other assessment methods such as children's ratings of their parents and as ratings done by parents.

Future studies examining filial piety ratings by both parents and children would be a significant contribution to the knowledge about this important social and psychological concept on both the individual and cultural level.

DATA AVAILABILITY STATEMENT

The datasets generated for this study are available on request to the corresponding author.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Ethics Board for Research Projects at the Institute of Psychology, University of Gdańsk. Written informed consent for participation was not required for this study in accordance with the national legislation and the institutional requirements. Written informed consent was obtained from the individual(s) for the publication of any potentially identifiable images or data included in this article.

AUTHOR CONTRIBUTIONS

JR-T and PJ designed the study, gathered data, wrote the manuscript, searched references, and organized fundings for the manuscript. PJ and MO analyzed and interpret the data. TKHT gathered data and gave comments. All authors contributed to the article and approved the submitted version.

REFERENCES

Beaujean, A. A. (2014). *Latent Variable Modeling Using R. a Step-by-Step Guide*. New York, NY: Routledge Taylor & Francis Group.

Bedford, O., and Yeh, K.-H. (2019). The history and the future of the psychology of filial piety: chinese norms to contextualized personality construct. *Front. Psychol.* 10:100.

Brown, T. A. (2015). *Confirmatory Factor Analysis for Applied Research*, 2nd Edn. New York, NY: The Guilford Press.

Byrne, B. M., Shavelson, R. J., and Muthеìn, B. O. (1989). Testing for equivalence of factor covariance and mean structures: the issue of partial MI. *Psychol. Bull.* 105, 456–466. doi: 10.1037/0033-2909.105.3.456

Carmona-Halty, M. A., Schaufeli, W. B., and Salanova, M. (2019). The utrecht work engagement scale for students (UWES–9S): factorial validity, reliability, and measurement invariance in a chilean sample of undergraduate university students. *Front. Psychol.* 10:1017.

Chen, F. F. (2007). Sensitivity of goodness of fit indexes to lack of measurement invariance, structural equation modeling. *Multidisciplinary J.* 14, 464–504. doi: 10.1080/10705510701301834

Chen, W. W. (2014). The relationship between parenting style, filial piety, and life satisfaction in Hong Kong. *J. Fam. Psychol.* 28, 309–314.

Chen, W. W., Wu, C. W., and Yeh, K. H. (2015). How parenting and filial piety influence happiness, parent–child relationships and quality of family life in Taiwanese adult children. *J. Fam. Stud.* 22, 80–96. doi: 10.1080/13229400.2015.1027154

Chen, W.-W., and Ho, H.-Z. (2012). The relation between perceived parental involvement and academic achievement: the roles of Taiwanese students' academic beliefs and filial piety. *Int. J. Psychol.* 47, 315–324. doi: 10.1080/00207594.2011.630004

Chen, W.-W., and Wong, Y.-L. (2014). What my parents make me believe in learning: the role of filial piety in Hong Kong students' motivation and academic achievement. *Int. J. Psychol.* 49, 249–256.doi: 10.1002/ijop.12014

Franco, V., Melo, M., Santos, G., Apolónio, A., and Amaral, L. (2017). A national early intervention system as a strategy to promote inclusion and academic achievement in Portugal. *Front. Psychol.* 8:1137. doi: 10.3389/fpsyg.2017.01137

Fuligni, A. J., and Zhang, W. (2004). Attitudes toward family obligation among adolescents in contemporary urban and rural China. *Child Dev.* 75, 180–192. doi: 10.1111/j.1467-8624.2004.00662.x

Galindo, E., Candeias, A. A., Pires, H. S., and Carbonero, M. Á (2018). Editorial: school achievement and failure in Portuguese and Spanish speaking countries. *Front. Psychol.* 9:1074. doi: 10.3389/fpsyg.2018.01074

Greenhaus, J. H., Parasuraman, S., and Wormley, W. M. (1990). Effects of race on organizational experiences, job performance evaluations, and career outcomes. *Acad. Manag. J.* 33, 64–86.doi: 10.2307/256352

Harris, P. B., Long, S. O., and Fujii, M. (1998). Men and elder care in Japan: a ripple of change. *J. Cross Cult. Gerontol.* 13, 177–198.

Ho, D. Y. F. (1994). Filial piety, authoritarian moralism, and cognitive conservatism in Chinese societies. *Genet. Soc. Gen. Psychol. Monogr.* 120, 349–365.

Hofstede, G., Hofstede, G. J., and Minkov, M. (2010). *Cultures and Organizations: Software of the Mind. Revised and Expanded*, 3rd Edn. New York: McGraw-Hill.

Kenny, D. A., Kaniskan, B., and McCoach, D. B. (2015). The performance of RMSEA in models with small degrees of freedom. *Sociol. Methods Res.* 44, 486–507. doi: 10.1177/0049124114543236

Li, Y., Costanzo, P. R., and Putallaz, M. (2010). Maternal socialization goals, parenting styles, and social-emotional adjustment among Chinese and European American young adults: testing a mediation model. *J. Genet. Psychol.* 171, 330–362. doi: 10.1080/00221325.2010.505969

López, V., Oyanedel, J. C., Bilbao, M., Torres, J., Oyarzún, D., Morales, M., et al. (2017). School achievement and performance in Chilean high schools: the mediating role of subjective wellbeing in school-related evaluations. *Front. Psychol.* 8:1189. doi: 10.3389/fpsyg.2017.01189

Low, K. C. P., and Ang, S. L. (2012). Confucian leadership and corporate social responsibility, the way forward. *J. Bus. Res.* 2, 85–108.

Milfont, T. L., and Fisher, R. (2010). Testing measurement invariance across groups: applications in cross-cultural research. *Int. J. Psychol. Res.* 3, 111–121.doi: 10.21500/20112084.85

Oliveira, ÍM., Taveira, M. C., and Porfeli, E. J. (2017). Career preparedness and school achievement of Portuguese children: longitudinal trend articulations. *Front. Psychol.* 8:618. doi: 10.3389/fpsyg.2017.00618

Oriol, X., Miranda, R., Oyanedel, J. C., and Torres, J. (2017). The role of self-control and grit in domains of school success in students of primary and secondary school. *Front. Psychol.* 8:1716. doi: 10.3389/fpsyg.2017.01716

Pires, H. S., Candeias, A. A., Grácio, L., Galindo, E., and Melo, M. (2017). The influence of family support according to gender in the Portuguese language course achievement. *Front. Psychol.* 8:1610. doi: 10.3389/fpsyg.2017.01610

R Core Team (2018). *R: a Language and Environment for Statistical Computing*. Vienna: R Foundation for Statistical Computing.

Rosseel, Y. (2012). lavaan: an R package for structural equation modeling. *J. Stat. Softw.* 48, 1–36. doi: 10.1002/9781119579038.ch1

Różycka-Tran, J., Truong, T. K. H., Cieciuch, J., and Schwartz, S. H. (2017). Universals and specifics of the structure and hierarchy of basic human values in Vietnam. *Health Psychol. Rep.* 5, 193–204.doi: 10.5114/hpr.2017.65857

Schaufeli, W. B., Martinez, I. M., Marques–Pinto, A., Salanova, M., and Bakker, A. (2002). Burn out and engagement in university students: a cross–national study. *J. Cross Cult. Psychol.* 33, 464–481. doi: 10.1177/0022022102033005003

Schwartz, S. H. (1992). "Universals in the content and structure of values: theoretical advances and empirical tests in 20 countries," in *Advances in Experimental Social Psychology, 25*, ed. M. P. Zanna (Cambridge, MA: Academic Press), 1–65. doi: 10.1016/s0065-2601(08)60281-6

Sharps, M. J., Price-Sharps, J. L., and Hanson, J. (1998). Attitudes of young adults toward older adults: evidence from the United States and Thailand. *Educ. Gerontol.* 24, 655–660. doi: 10.1080/0360127980240703

Spurk, D., Abele, A. E., and Volmer, J. (2011). The career satisfaction scale: longitudinal measurement invariance and latent growth analysis. *J. Occup. Organ. Psychol.* 84, 315–326. doi: 10.1111/j.2044-8325.2011.02028.x

Sung, K.-T. (1995). Measures and dimensions of filial piety in Korea. *Gerontologist* 35, 240–247. doi: 10.1093/geront/35.2.240

The Chinese Culture Connection (1987). Chinese values, and the search for culture-free dimensions of culture. *J. Cross Cult. Psychol.* 18, 143–164. doi: 10.1177/0022002187018002002

Truong, T. K. H., Jurek, P., Różycka-Tran, J., Tran, H. T., and Le, V. H. (2020). Vietnamese version of the dual filial piety scale: preliminary validation in a student sample. *Health Psychol. Rep.* 8, 263–272. doi: 10.5114/hpr.2020.95409

Tsao, W.-C., and Yeh, K.-H. (2019). "Indigenous implications and global applications of the dual filial piety model: a psychological re-conceptualization of 'xiao,'" in *Asian Indigenous Psychologies in the Global Context, Palgrave Studies in Indigenous Psychology*, ed. K.-H. Yeh (Berlin: Springer).

Wong, S. M., Leung, A. N. M., and McBride-Chang, C. (2010). Adolescent filial piety as a moderator between perceived maternal control and mother adolescent relationship quality in Hong Kong. *Soc. Dev.* 19, 187–201. doi: 10.1111/j.1467-9507.2008.00523.x

Yang, K. S. (1996). "The psychology transformation of the Chinese people as a result of societal modernization," in *The Handbook of Chinese Psychology*, ed. M. H. Bond (Hong Kong: Oxford University Press), 479–498.

Yeh, K. H., and Bedford, O. (2003). Filial piety: a test of the dual filial piety model. *Asian J. Soc. Psychol.* 6, 215–228. doi: 10.1046/j.1467-839x.2003.00122.x

Yeh, K. H., and Bedford, O. (2004). Filial belief and parent-child conflict. *Int. J. Psychol.* 39, 132–144. doi: 10.1080/00207590344000312

Yeh, K. H., Yi, C. C., Tsao, W. C., and Wan, P. S. (2013). Filial piety in contemporary Chinese societies: a comparative study of Taiwan, Hong Kong, and China. *Int. Sociol.* 28, 277–296. doi: 10.1177/0268580913484345

Yeh, K.-H. (2003). "The beneficial and harmful effects of filial piety: an integrative analysis," in *Contributions in Psychology, no. 42. Progress in Asian Social Psychology: Conceptual and Empirical Contributions*, eds K.-S. Yang, K.-K. Hwang, P. B. Pedersen, and I. Daibo (Westport, CT: Greenwood Publishing Group).

Yeh, K.-H. (2006). The impact of filial piety on the problem behaviours of culturally Chinese adolescents. *J. Psychol. Chinese Societies* 7, 237–257.

Yeh, K.-H., Bedford, O., and Yang, Y.-J. (2009). A cross-cultural comparison of coexistence and domain superiority of individuating and relating autonomy. *Int. J. Psychol.* 44, 213–221. doi: 10.1080/00207590701749146

Zhou, J., Guo, Q., and Xu, R. (2020). Reciprocal filial piety facilitates academic success via autonomy: generalizing findings in chinese society to a global context. *Front. Psychol.* 11:69. doi: 10.3389/fpsyg.2020.00069

Conflict of Interest: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

frontiers in Psychology

ORIGINAL RESEARCH
published: 23 February 2021
doi: 10.3389/fpsyg.2021.639089

The Effect of School Psychologists and Social Workers on School Achievement and Failure: A National Multilevel Study in Chile

Verónica López[1,2]*, *Karen Cárdenas*[1,2] *and Luis González*[2]

[1] School of Psychology, Pontificia Universidad Católica de Valparaíso, Valparaíso, Chile, [2] Center for Research in Inclusive Education, Viña del Mar, Chile

School achievement and failure have become growing political and social concerns due to the negative consequences of school failure for individuals and society. The inclusive educational movement, which calls for equal access, permanence, participation, and promotion of all students worldwide, poses many challenges for schools and school systems. As a public policy strategy, some countries have provided additional funds for incorporating non-teaching professionals such as school psychologists and social workers in regular K-12 schools. However, there is lack of research on the effects of these psychosocial professionals on student outcomes. This national multilevel study explored the effect of psychologists (n = 8,469) and social workers (n = 3,524) on indicators of eighth-grade (n = 147,531) and 10th-grade (n = 106,347) students' academic achievement and dropout in Chile. A multilevel secondary analysis was performed using national records of non-teaching professionals working as school staff members, achievement scores on the national SIMCE test, and dropout rates based on official records. Results showed that after controlling for individual and school variables known to affect achievement and dropout, schools with psychologists and social workers working as staff members had lower short- and long-term dropout rates. The presence and higher number of school psychologists per school was positively associated with higher math achievement, with a reduced effect in low-SES schools. Lower-SES schools with more social workers had higher math scores. These results support policies that increase funding for school psychologists and social workers, since their incorporation partly explains better school achievement and less school failure when controlling for individual and school characteristics, but emphasize the need to further explore the mechanisms through which school achievement and failure are developed with the support of psychologists and social workers in schools. We discuss the need to regulate the type of prevention and intervention strategies from a whole-school, evidence-based approach, as well as to incorporate psychosocial training modules and comprehensive guidelines as part of professional training programs and as certified requisites for working in schools.

Keywords: school psychologists, social workers, school achievement, school failure, multilevel, Chile

OPEN ACCESS

Edited by:
Edgar Galindo,
University of Evora, Portugal

Reviewed by:
Adelinda Araujo Candeias,
University of Evora, Portugal
Markus Gebhardt,
University of Regensburg, Germany

***Correspondence:**
Verónica López
veronica.lopez@pucv.cl

Specialty section:
This article was submitted to Educational Psychology, a section of the journal Frontiers in Psychology

Received: *08 December 2020*
Accepted: *26 January 2021*
Published: *23 February 2021*

Citation:
López V, Cárdenas K and González L (2021) The Effect of School Psychologists and Social Workers on School Achievement and Failure: A National Multilevel Study in Chile. Front. Psychol. 12:639089. doi: 10.3389/fpsyg.2021.639089

INTRODUCTION

Access to education, permanence, participation, promotion, and graduation are fundamental pillars for the achievement of an inclusive education (Ascorra and López, 2019). According to UNESCO UNICEF (2007), every girl or boy has the right to go to school, access relevant learning, and be treated with dignity under conditions of equality. School systems around the world must guarantee that their students remain in the school system and provide engaging learning opportunities for all students (Ainscow, 2019).

During the 1990s, concern about integrating quality measurements in education began to rise internationally, based on the need to provide quality learning experiences for all students to reduce inequities (Liu et al., 2019). These discussions were strongly reinforced by international organizations, which urged their member countries to develop mechanisms for the evaluation, monitoring, and improvement of education from an economic perspective and rationality, wherein the main objective was to reduce poverty (Anaya, 2019; Prieto, 2019). Initially, this conception of quality considered only academic performance, but it later began to incorporate other dimensions of learning from a more holistic perspective (Cohen and Espelage, 2020).

Historically, academic performance or achievement has been considered one of the most important indicators in terms of quality and equity in education, because it has been shown to be a predictor of the quality of life of students (Organisation for Economic Cooperation Development., 2016; Liu et al., 2019). Traditionally, the international literature understood academic achievement as learning outcomes measured through a standardized assessment. These assessments can be at the school level, considering national or district assessments, or at the student level, considering their individual performance (Ruiz et al., 2018; Granvik et al., 2020). Although initially academic performance or achievement was considered the sole indicator that could verify the achievement of learning, Coleman et al. (1966) report, which verified the relevance of the socioeconomic status (SES) of families to student performance, paved the path for including other relevant factors inside and outside the school.

During the past 30 years, numerous studies have been carried out regarding the factors that affect academic performance or achievement. These studies have made it possible to elucidate factors internal to the school that can influence this phenomenon, even acting as moderators of SES (Liu et al., 2018, 2019; Granvik et al., 2020). Some factors shown to have an effect on intraschool performance or achievement are school leadership, high teacher expectations, teacher–student support (Thapa et al., 2013; Granvik et al., 2020), student and parent participation (Boonk et al., 2018; Lei et al., 2018), school climate (Astor et al., 2009; Thapa et al., 2013; Ruiz et al., 2018), and specialized programs or interventions (O'Connor, 2018; Arslan and Coşkun, 2020; Mulhern, 2020).

With time and the persistent and progressive movement toward inclusion and equity in education, the evaluation of educational quality outcomes began considering school failure and factors that act as barriers for students' promotion and permanence in the regular school system (Ainscow, 2019). School dropout is considered the utmost indicator of school failure, but it is understood as a culminating milestone of a progressive process of distancing from the school (Ministerio de Educación, 2020a). External and internal aspects of the school intervene in this process, which constitute mechanisms of exclusion (Román, 2013; Robison et al., 2017; Gubbels et al., 2019), in the sense that the students don't drop out, but instead are pushed out due to internal school factors or pulled out due to external community and social factors (Doll et al., 2013). The intraschool variables are factors such as school belonging, social and pedagogical support from teachers, and availability of institutional support, among others. On the other hand, among extraschool variables are the socioeconomic level of the families of origin, parents' educational level, and place of residence, among other aspects (Román, 2013; Pate et al., 2016; Robison et al., 2017). This is how school dropout is constituted as a complex and multicausal phenomenon (Román, 2013; Archambault et al., 2017; Hernández and Diaz, 2017; Gubbels et al., 2019). Research on school dropout has shown risk factors that can propitiate its outcome (Gubbels et al., 2019). In this regard, factors external to school, such as family problems, the need to work, living in vulnerable neighborhoods, physical or mental health problems, or criminal problems, are some factors that affect dropout (Iachini et al., 2016; Gubbels et al., 2019; Parviainen et al., 2020). Likewise, factors internal to the school such as absenteeism, repetition, low academic performance, expulsion or suspension policies, negative school climate or little socioemotional support are some incident factors (Pate et al., 2016; Tello and Lonn, 2017; Filippello et al., 2019; Gubbels et al., 2019).

However, the phenomenon of school dropout does not occur in the same way in all groups of students. Research has shown that the groups with the highest risk of dropping out are those with low socioeconomic SES, ethnic groups, and immigrants (Duncan and Murnane, 2011; Román, 2013; Archambault et al., 2017; Hernández and Diaz, 2017; Robison et al., 2017; Tello and Lonn, 2017; Ministerio de Educación, 2020a). This poses challenges for schools and public policy makers, who might have difficulty incorporating these both pedagogically and socioculturally (Archambault et al., 2017; Robison et al., 2017).

In this regard, schools are challenged to meet the demands of the inclusive educational movement, which calls for equal access, permanence, participation, and promotion of all students worldwide, poses many challenges for schools and school systems. One of these challenges is how to identify and attend to the psychosocial needs of possible risk groups according to their internal and external characteristics (Pate et al., 2016; Archambault et al., 2017; Tello and Lonn, 2017), and how to best serve them through adequate prevention and intervention strategies. As a public policy strategy, some countries have provided additional funds for incorporating non-teaching professionals such as school psychologists and social workers in regular K-12 schools. The rationale is that incorporating these support professionals in regular school systems can help identify and intervene in these phenomena, and through this, influence quality indicators of school achievement and school failure, such as academic performance and school

dropout (Hernández and Diaz, 2017; Tello and Lonn, 2017; Kuperminc et al., 2019).

Organisation for Economic Cooperation Development. (2019), the average school enrollment rate of its member countries in the population between 15 and 18 years old is 84.5%. Specifically, in Chile, this figure corresponds to 80.9%, which is below the OECD average but higher than the reality of other Latin American countries such as Mexico or Brazil. On the other hand, the dropout figures in Chile for 2010 reached < 1%, being one of the lowest figures in Latin America (UNESCO., 2013). However, the country is recognized for having one of the most segregated education systems in the world (Organisation for Economic Cooperation Development., 2016). This is how, according to a report prepared by the Study Center of the Ministry of Education, it is observed that the highest rate of school dropout occurs mainly in quintiles I and II; that is, the lowest-income quintiles in the country (Ministerio de Educación, 2020a).

This scenario of deep segmentation has emphasized the need to develop compensatory policies that from a focused perspective seek to cushion the learning gaps generated by the system (Almonacid, 2000; Bellei, 2007; García-Huidobro, 2007; Jorrat and Rojas, 2016). In this context, since the beginning of this century, policies such as the preferential school voucher law (known as SEP, an acronym for Ley de Subvención Escolar Preferencial, Law Nr. 20.248., 2008) or the pro-retention law (Law Nr. 19.873., 2003) were created. These policies assume that low-SES students (identified in the Chilean policies as "vulnerable students") are more expensive to educate, and therefore, schools with more low-SES students need a bigger budget. In Chile, this additional funding, given the market-based voucher financing of the school system (not per school but per student enrolled and attending schools), is delivered via a double or triple voucher per student identified as socioeconomically vulnerable. These funds, provided mainly from the SEP law, have allowed schools to acquire educational materials and hire new professional support, which historically were not in the school system.

Prior to this period, some public initiatives in education, such as the Schools and High Schools for All program, gradually made it possible to incorporate psychologists and social workers into education. Timidly, other similar programs counted on their presence in a counseling mode, such as the Liceos Prioritarios program. Since the end of the 90s with differential groups, and later with the School Integration Programs (PIE) aimed at students with disabilities, psychologists have been approaching the school space in their professional practice. However, it was not until the SEP law that the schools, along with the hiring of teaching staff for pedagogical support, could independently hire psychosocial support professionals. Many schools jointly hired psychologists and social workers to train what came to be called "psychosocial pairs" (López and Carrasco, 2018).

Since 2010, when the SEP law began implementation, psychosocial pairs have grown exponentially in publicly funded schools (Raczynski et al., 2013; López et al., 2020). Between 2010 and 2018, there was an increase of more than 800% in psychosocial professionals hired in schools. According to official records, the 1,704 professionals hired in 2010 grew to more than 14,000 professionals by 2018 (López et al., 2020).

Although the working conditions of these professionals have improved, many of them have 10-month contracts (March to December, summer holidays not included) that are renewed annually, which generates job instability that discourages the permanence of these professionals (López and Carrasco, 2018). López et al. (2020), when carrying out an analysis regarding the socio-labor characteristics of these professionals, found that in 2018, around 45% of psychologists and social workers had a professional practice experience of 0 and 4 years, probably due to working conditions. This means that today, although there are psychosocial professionals in 60% of the schools that receive funding from the state (public and subsidized private), these tend to be recently graduated young professionals whose first work exercise is to work in schools, which was evidenced by López et al. (2020), who found professionals who had stayed < 2 years in the same establishment grew from 0% in 2015 to 49% in 2018.

Moreover, the progressive incorporation of psychosocial professionals in Chilean schools occurred without an explicit intervention model, but under the assumption of support directed at individual students. On the one hand, the SEP law, by focusing on the provision of additional resources to schools, did not and still does not incorporate a psychosocial intervention model (Law Nr. 20.248., 2008), although it does emphasize the need for "psychosocial supports" but with undefined intervention models and plans. Rather, this Law provides a model of school management in four areas –one of them is school climate- but, following a decentralized logic of education, does not mandate nor suggest any given program or intervention model. It was not until 2017 that the Ministry of Education provided guidelines for the formation of school climate teams (Ministerio de Educación, 2017). In this document, some of the actions to be carried out by the psychosocial pairs were made explicit by way of suggestions and orientations, but maintained a logic of individual diagnosis and intervention. On the other hand, the professionals hired by PIE funds present a similar situation. The regulations for PIE are very clear as to which disability diagnoses (special educational needs or SEN) are eligible for funding, and who and how must perform the diagnoses (Decree No. 170, 2010). However, it was not until 2015 that guidelines were established regarding support plans for these students, which emphasized the formation of "classroom teams" with co-teaching tasks (Decree No. 83, 2015). Despite this, the student support functions of the school psychologists hired under PIE funding are still not delimited. Guidelines elaborated in 2016 were still not clear as to what a support plan for PIE psychologists should look like, but only mentioned collaborative actions with classroom teachers (Ministerio de Educación, 2016).

In this context, the national policy, instead of proposing an intervention model with an evidence-based comprehensive school approach (Dimmit and Robillard, 2014), assumes that psychologists and social workers should work individually with students with the greatest needs. In most schools, the school administrators and school principals in practice define the type of work, roles, and functions of these professionals, and these definitions are frequently based on deficit theories and individual

approaches to intervention (López and Carrasco, 2018). Thus, the predominant intervention logic has been intervention in the "case" identified or reported by the school and generally, without the characteristic of a "pair" or "team," but rather through specific professional interventions of each professional directly with specific students, who are treated as and even called "cases" (López and Carrasco, 2018). In this way, a pathologizing approach has been instituted, wherein students who do not respond adequately to the official curriculum are diagnosed, intervened with, or referred (Sandoval and Lamas, 2017; Cárcamo-Vásquez et al., 2020), just as if they were in a medical system.

Indeed, a national study by Center for Research in Inclusive Education (Ascorra et al., 2019) recently showed that most schools, regardless of their dependence, predominantly carry out actions of "putting out fires" or paying individual attention to students, to the detriment of group intervention actions, coordination with other professionals, or networking. These types of intervention focused on individual interventions correspond to level 3 of tiered whole-school approaches (Dimmit and Robillard, 2014), which are recommended only for 5–10% of a school's student population. Prior to these actions, tiered whole-school approaches recommend tier 1 actions, which are primary prevention actions aimed at all students and the school community that promote the well-being of students and the school, both curricularly and psychosocially, articulating both dimensions systematically. In the case of students who for various reasons do not respond well to level 1 actions, it is recommended to move to level 2 actions, or secondary prevention, which generally correspond to group intervention actions on groups of students identified as at risk or with greater socioemotional needs (Dimmit and Robillard, 2014). In the case of Chile, the evidence shows that the pyramid in whole-school approach models is inverted, because Chilean psychosocial professionals most frequently implement tier 3 interventions.

However, the entry of these professionals is an opportunity for schools to attend to the various problems and needs of students and incorporate contextual variables into the school (Gatica, 2016). Research has shown that psychosocial pairs have been able to address different issues associated with vulnerability, enabling access to state benefits, access to health networks, attention to psychosocial needs, and protection of the rights of girls, boys, and young people, among other aspects (López et al., 2011a,b; Cádiz and Manríquez, 2015; Gatica, 2016; Jorrat and Rojas, 2016; López and Carrasco, 2018; Cárcamo-Vásquez et al., 2020).

However, in the context of a mode of intervention that focuses on tier 3 interventions and is not based on evidence-based approaches, it is necessary to understand the consequences or effects of progressive incorporation of psychosocial professionals on schools in terms of improvement in some key dimensions of educational quality such as permanence and school achievement.

The international literature shows few studies that evaluate or expose the effects of the incorporation of other support professionals in schools such as psychologists, social workers, or school counselors on school achievement and failure (Mulhern, 2020). Studies related to this issue have instead focused on verifying the impact of specific programs in some schools or districts. These programs have generally been developed from a counseling model, with the participation of school counselors and teachers, and with a lower percentage of psychologists and social workers (O'Connor, 2018; Healy et al., 2020).

The implementation of intervention or counseling programs has been shown to have similar characteristics. Most of these programs have focused on the development of skills or socioemotional competencies, and there are also—to a lesser extent—others that aimed to improve academic indicators or other aspects (Ballard et al., 2014; Franklin et al., 2017; Healy et al., 2020). Although these programs were implemented from a promotional approach, they might also include large- or small-group tier 2 interventions. Programs that have been developed exclusively from an individual approach have been shown to have less impact on students (Franklin et al., 2017; Healy et al., 2020). Likewise, these programs, despite having effects on different groups of students, have been shown to have a higher effect on higher-risk students, who generally present a gap in achievement indicators compared to their peers (Hoagwood et al., 2007; Franklin et al., 2017; Mason and Dye, 2017; O'Connor, 2018; Healy et al., 2020).

The effects of programs linked to psychosocial supports have been varied. Some studies have shown a decrease in behaviors of physical and sexual violence at school (Kernsmith and Hernandez-Jozefowicz, 2011; Healy et al., 2020), discrimination against minorities (Cohen et al., 2006; Tello and Lonn, 2017; Mulhern, 2020), and risk behaviors or mental health problems (Baskin et al., 2010; Ballard et al., 2014; Franklin et al., 2017; O'Connor, 2018), alongside an increase in prosocial behaviors (Kuperminc et al., 2019). Along the same lines, some studies have shown an increase in school engagement and a positive assessment of relationships at school (Kuperminc et al., 2019; Healy et al., 2020; Mulhern, 2020). Other studies found improvements in the subjective well-being of school members, which has improved students' academic performance (López et al., 2017; Arslan and Coşkun, 2020).

Regarding the effect of non-teaching personnel on indicators of school achievement and school failure, Mulhern (2020) found that the presence of school counselors had a negative effect on school suspensions, reducing the probability that students who participated in counseling would be suspended. Likewise, a positive effect on the probability of accessing, remaining in, and graduating from university education was evidenced. This has been supported in previous studies (Poynton and Lapan, 2017). The effects were shown to be greater in students with lower SES or school performance. Other programs have shown a reduction in the likelihood of school dropout (Harris and Franklin, 2003) and number of school suspensions (Ballard et al., 2014).

On the other hand, specialized programs in student groups have been shown to have an impact on academic performance. These programs have shown that adaptation to the local context of the school and positive appreciation of the program by students are essential for their success (Baskin et al., 2010; Yeager and Walton, 2011; Henry et al., 2017; Mason and Dye, 2017). In this way, the literature shows that it is important for schools to have defined intervention models and programs to improve school experience and performance.

In this context, the purpose of this study was to analyze the effect of the presence of school psychosocial professionals on indicators of school achievement and school failure, beyond students' individual and school characteristics known to affect achievement and dropout.

MATERIALS AND METHODS

Participants

The dataset of the Chilean national assessment system (Sistema de Medición de la Calidad de Educación, known as SIMCE) in its 2017 version was used. SIMCE is a standardized testing system that provides nationwide information about students and schools that participate in the regular educational system. In this study, participants were eighth- and 10th-grade students and their parents. For this study, the students' tests scores and questionnaire were used; the latter provided self-report information related to their school experiences. Additionally, the parents' questionnaire provided information that allowed a sociodemographic characterization of the students and their families. Of the initial student sample, 81% had matched information with the parents' questionnaire. Additionally, the 2017 National Record of Educational Assistants was used. This data allowed identification of the psychosocial professionals hired by all Chilean schools, by type of professional, type of funding (SEP or PIE), and number of professionals per school. The process of merging both datasets produced a loss of 3% of the matched sample. Finally, the 2018 and 2019 General Information System of Students database was used. This dataset provided information about students' likelihood of dropping out during the next 2 years of schooling, by providing information regarding if a student was studying in the school system in the following 2 years.

Finally, we restricted our study to students who had no missing values in the study variables. The final sample consisted of 147,531 eighth-grade students and 106,347 10th-grade students from public, subsidized private, and private schools in Chile, representing 70% of the initial sample, along with 8,469 psychologists and 3,524 social workers working in 2017 as non-teaching school staff members in 5,091 of the 6,358 public, subsidized, and private schools in the total sample. To characterize the sample, descriptive statistics are reported for students and psychosocial professionals in **Tables 1**, **2**, respectively.

Measures

Dependent Variables

Math and Language SIMCE Test Scores

Scores of the standardized 2017 SIMCE test of mathematics and language for eighth- and 10th-grade students. Since 1999, the SIMCE scores are scaled based on Item Response Theory, with a national standardized mean of 250 points and a standard deviation of 50, using 1999 as the baseline year.

Dropout Status

Two indexes were created for students' dropout status. First, ***short-term dropout*** was computed as a dichotomous variable took the value of 1 if a student who was enrolled in a school in 2017 left school before finalizing the school year and took the value of 0 if the student finished the school year. Second, a ***long-term dropout*** was computed as a dichotomous variable that took the value of 1 if a student who was enrolled in a school in 2017 was not enrolled in any school in 2018 and 2019, and took the value of 0 if the student was enrolled in any school in Chile in 2018 or 2019.

Independent Variables: Individual Characteristics

Gender and Age

The students' gender and age were obtained from the official records of schools.

Socioeconomic Status

SES was obtained through the parents' questionnaires of the 2017 SIMCE test, wherein parents responded about their family income and the education level of the student's father and mother. A standardized index was computed.

Indigenous Ascendance

Each student's mother responded if she identified with any of the ethnic minorities recognized by law in Chile. This variable was codified as a dichotomous index: 1 indicates the student's mother belongs to any ethnic minority, and 0 indicates otherwise.

Attendance

Students' school attendance was obtained from the official school records.

School Motivation

An index of school motivation was constructed using seven items from the students' questionnaires with a 4-point Likert scale regarding their agreement from 1 (*strongly disagree*) to 4 (*strongly agree*) of the 2017 SIMCE database. The items were "I make an effort to do well in all subjects"; "I have fun learning new things in class"; "I make an effort to understand what is taught in class"; "I make an effort to have good grades"; "I like to study"; "I always do my homework"; and "Learning what is taught in class is very important for me." The confirmatory factor analysis showed a good fit of the model: $\chi^2(12) = 13{,}740.75$, $p < 0.001$, RMSEA $= 0.068$, CFI $= 0.975$, TLI $= 0.956$.

Independent Variables: School Characteristics

Percentage of Female Students

The proportion of female students was computed for each school.

School Socioeconomic Status

The school SES was obtained from the 2017 SIMCE database, which classifies each school according to a school vulnerability index and the family income and schooling years of the enrolled students' parents. The school SES index has five categories (1 = *low SES*, 2 = *mid-low SES*, 3 = *mid SES*, 4 = *mid-high SES*, 5 = *high SES*).

TABLE 1 | Means and standard deviation of individual-level study variables by full sample and grade.

Variable	Total sample		8th grade		10th grade		Differences (8th−10th)
	Mean (or %)	SD	Mean (or %)	SD	Mean (or %)	SD	
Math SIMCE score	268.72	55.52	262.11	48.72	277.91	62.65	−15.80***
Language SIMCE score	252.16	50.45	246.69	49.30	259.78	51.04	−13.10***
Short–term dropout	0.02	0.14	0.01	0.11	0.03	0.16	−0.01***
Long–term dropout	0.02	0.13	0.01	0.11	0.03	0.16	−0.01***
Female	0.52	0.50	0.50	0.50	0.53	0.50	−0.03***
Age	14.16	1.17	13.32	0.62	15.33	0.61	−2.01***
Individual SES	0.06	0.87	0.02	0.86	0.12	0.88	−0.10***
Indigenous ascendance	0.13	0.34	0.14	0.35	0.12	0.33	0.02***
Attendance	93.59	5.26	93.84	5.14	93.24	5.39	0.60***
School Motivation	0.03	0.67	0.03	0.66	0.03	0.68	−0.00

Standard errors in parentheses. T–tests performed for the estimation of differences by grade.
****p < 0.001.*

TABLE 2 | Means and standard deviation of descriptive variables of psychologists ($N = 8,469$) and social workers ($N = 3,524$).

	Psychologists		Social workers		Total	
Variable	Mean (or %)	SD	Mean (or %)	SD	Mean (or %)	SD
Female	75.66	–	86.27	–	78.72	–
Age	34.29	7.29	34.82	7.86	34.97	7.46
Years of experience	3.92	4.59	3.59	4.28	3.83	4.51
Type of contract						
Indefinite contract	35.57	–	34.41	–	35.23	–
Fixed term	62.65	–	63.24	–	62.82	–
Fee contract	1.78	–	2.35	–	1.94	–
Working hours per week	30.63	13.45	30.73	14.03	30.66	13.62

Percentage of Vulnerable Students

This index was computed as the proportion of a school's enrolled students in 2017 who had an individual SES index that was one standard deviation below the school's mean.

Attendance (School Average)

The school rate of attendance was obtained by calculating the average of the enrolled students' attendance.

School Funding

The schools were classified according to their funding. This index has three categories (1 = *public*, 2 = *subsidized private*, 3 = *private*).

Rural School

A dichotomous index was codified to classify the schools. This variable takes the value of 1 if the school was in a rural zone and 0 if it was in an urban zone.

Type of School According to Hiring Policy

The schools were classified in four categories according to their policy of hiring psychosocial professionals. The first category was "no psychosocial professionals" if the school did not have any psychologist or social worker hired in 2017. The second category was "psychologist only" if the school hired at least one psychologist but had no social workers hired in 2017. The third category was "social worker only" if the school hired at least one social worker but had no psychologist hired in 2017. The fourth category was "psychosocial pairs" if the school hired at least one psychologist and one social worker in 2017.

Number of Psychosocial Professionals Hired

The total number of psychologists and social workers hired in each school was obtained from the 2017 National Record of Education Assistants.

Percentage of Psychosocial Professionals Hired With Indefinite Contract

The percentage of psychosocial professional hired with indefinite contracts was obtained from the 2017 National Record of Education Assistants.

Percentage of Psychosocial Professionals Hired With Fixed-Term Contract

The percentage of psychosocial professional hired with fixed-term contracts was obtained from the 2017 National Record of Education Assistants.

Percentage of Psychosocial Professionals Hired With SEP Funds

The percentage of psychosocial professional hired with SEP funds was obtained from the 2017 National Record of Education Assistants.

Percentage of Psychosocial Professionals Hired With PIE Funds

The percentage of psychosocial professional hired with PIE funds was obtained from the 2017 National Record of Education Assistants.

Analytic Plan

Statistical analyses were carried out using Stata 13. The syntax and statistical processing can be found at https://mfr.osf.io/render?url=https%3A%2F%2Fosf.io%2Fnwp5r%2Fdownload.

First, we viewed the descriptive data on each variable. Later, we performed a two-level linear multilevel analysis using math and language scores as dependent variables. The predictor variables took into consideration individual factors (level 1) and school factors (level 2). At the student level, we included the sociodemographic characteristics. At the school level, the variables were obtained by averaging the reported individual-level variables and included the schools' urbanicity and type of funding, as well as the key variables of the study related to the psychosocial professionals. Additionally, we performed a quantile regression analysis on the 25th, 50th, 75th, and 90th quantile of test achievement, to test if there were differentiated effects of the presence of psychosocial professionals on the mentioned performance groups. Finally, we performed a two-level logistic multilevel analysis using the dropout index as the dependent variable. To test the contribution of psychosocial professionals to academic performance and dropout, we estimated four models, considering their presence (Model 1), the number of school psychologists and social workers in schools (Model 2), their type of contract (Model 3), and their source of funding (Model 4).

Ethical Considerations

This study was approved by the institutional review board of the first author's institution. Deidentified information from all datasets preserved the confidentiality of the students. We used an obfuscated identifier to merge the databases.

RESULTS

Descriptive Statistics of Study Variables

Table 1 shows the means and standard deviations of individual-level variables for the total sample and by grade level. The mean tests scores of the eighth and tenth grade sample were about 10 to 20 points above the national mean of 250, except for the language tests of eighth grade students, which were almost 4 points below. The sample of 10th-grade students had higher short- and long-term dropout rates, a higher proportion of female students, higher SES, a lower proportion of students with Indigenous backgrounds, and a lower attendance rate. There were no statistically significant differences between grades in the school motivation index.

Descriptive statistics related to the relevant school-level study variables are reported in **Table 3**, in which we estimated the differences among schools by their school SES. With respect to the type of schools according to their hiring policy, schools with high and mid-high SES were more likely to have no psychosocial professionals hired or only psychologists. On the other hand, low and mid-low SES schools had a greater proportion of psychosocial pairs hired. There were no differences in the proportion of schools with only social workers. When considering the mean number of psychologists hired by school SES, mid-low SES schools had the highest mean and mid-high SES schools had the lowest mean, with no significant differences among the other categories. High SES schools had the highest mean proportion of professionals with indefinite contracts, and low and mid-low SES schools had the highest mean proportion with fixed-term contracts. Mid-low and mid-SES schools had the highest mean proportion of psychosocial professionals hired with SEP funds. Finally, there was a lower proportion of professionals hired with PIE funds in schools with higher SES.

Linear Multilevel Regressions and Quantile Regressions Analyses Predicting Math and Language 2017 SIMCE Test Scores

Table 4 shows the results of the multilevel estimation predicting math and language achievement score of eighth- and 10th-grade students in Model 1. With respect to the individual-level variables, findings showed that being a female student predicted lower scores in math in eighth ($b = -6.71$, $p < 0.001$) and 10th ($b = -8.11$, $p < 0.001$) grades and higher scores in language ($b = 9.11$ in eighth grade and $b = 12.99$ in 10th grade, $p < 0.001$). This is consistent with previous findings among Chilean students (Organisation for Economic Cooperation Development., 2012; Raczynski et al., 2013). Older students were associated with lower scores in both tests and grades ($b = -13.48$ to -8.64). On the other hand, a higher student SES predicted higher scores in math and language ($b = 5.48$ to 7.69). Ethnic origin only had a significant contribution to language scores in eighth grade ($b = 0.93$, $p < 0.01$) and to math scores in 10th grade ($b = 0.93$, $p < 0.05$). A higher student attendance rate ($b = 0.18$ to 1.07) and higher school motivation ($b = 5.80$ to 10.89) predicted higher scores in both language and math.

When considering the school-level variables, the proportion of female students was related to higher scores in both math and language ($b = 0.11$ to 0.19). Higher school-level SES predicted better language and math achievement scores, with higher effects found in high-SES schools ($b = 23.80$ to 68.34). A higher average school attendance rate was associated with higher math and language scores ($b = 1.13$ to 1.82). With respect to school funding, there were only consistent contributions in the eighth-grade sample, wherein subsidized private schools ($b = 4.71$, $p < 0.001$) and private schools ($b = 17.61$, $p < 0.001$) had higher scores in the math SIMCE test; a similar effect was found for eighth-grade students from private schools ($b = 6.47$, $p < 0.01$) in language. Urbanicity had diverse effects on test scores, with a

TABLE 3 | Percentages, means (and standard deviations) of school–level study variables for the whole sample and by school–SES.

Variables	Whole sample	School SES					*Post–hoc*
		Low (1) (*N* = 1,545)	Mid–low (2) (*N* = 2,078)	Mid (3) (*N* = 1,430)	Mid–high (4) (*N* = 645)	High (5) (*N* = 265)	
Type of schools							
No psychosocial professionals hired (%)	19.1	16.1	11.9	21.8	33.3	44.5	5>4>3>1>2
Only psychologists (%)	36.6	30.3	30.8	41.6	52.7	52.5	5, 4>3>2, 1
Only social workers (%)	1.9	2.0	2.2	2.0	1.4	0.8	1=2=3=4=5
Psychosocial pairs (%)	42.4	51.7	55.2	34.7	12.6	2.3	1, 2>3>4>5
Number of psychologists hired	1.4 (1.1)	1.2 (0.9)	1.5 (1.2)	1.4 (1.2)	1.1 (1.1)	1.2 (1.7)	2>1, 3, 5>4
Number of social workers hired	0.6 (0.7)	0.7 (0.7)	0.7 (0.8)	0.4 (0.7)	0.2 (0.4)	0.0 (0.2)	1, 2>3>4, 5
Percentage of psychosocial professionals with indefinite contract	28.6 (37.5)	23.7 (34.7)	29.0 (35.9)	30.7 (35.4)	30.7 (41.8)	38.5 (45.4)	5>2, 3, 4>1
Percentage of psychosocial professionals with fixed–term contract	51.7 (43.0)	59.1 (42.3)	58.5 (40.5)	47.5 (42.8)	35.8 (43.8)	16.1 (32.4)	1, 2>3>4>5
Percentage of psychosocial professionals hired with SEP funds	22.3 (32.7)	18.6 (29.8)	25.7 (32.4)	28.5 (37.4)	9.9 (26.7)	0.0 (0.0)	2, 3>1>4>5
Percentage of psychosocial professionals hired with PIE funds	25.6 (35.1)	34.2 (39.1)	28.1 (34.4)	19.6 (31.3)	13.0 (29.0)	2.5 (15.3)	1>2>3>4>5

One–way ANOVA tests were performed. The numbers in parentheses in column heads refer to the numbers used for illustrating significant differences in the post-hoc column.

rural setting making a small but positive contribution to math scores in the 10th-grade sample ($b = 1.51$, $p < 0.05$) and a negative effect on language scores for eighth-grade ($b = -8.74$, $p < 0.01$) and 10th-grade ($b = -4.37$, $p < 0.05$) students.

With respect to the variables related to psychosocial professionals in Model 1, findings showed that schools that only hired psychologists predicted better math scores in eighth grade ($b = 1.92$, $p < 0.05$) and 10th grade ($b = 5.20$, $p < 0.001$) compared to schools without psychosocial professionals. Schools that only hired social workers did not have statistically significant contributions to test scores. Schools with psychosocial pairs did not show consistent effects, predicting lower language scores in eighth grade ($b = -1.93$, $p < 0.05$) and higher math scores in 10th grade ($b = 5.00$, $p < 0.01$).

Quantile regressions on the 25th, 50th, 75th, and 90th quantiles of performance were performed based on Model 1. **Table 5** shows the results on math and language achievement of eighth grade students. In math, the presence of psychologist ($b = 1.67$, $p < 0.01$) and psychosocial pairs ($b = 1.15$, $p < 0.05$) predicted higher math scores for the 25th quantile group. On the contrary, the presence of social workers ($b = -5.86$, $p < 0.05$) and psychosocial pairs ($b = -1.43$, $p < 0.001$) predicted lower scores in the 90th quantile group. In language, the presence of psychologists predicted lower scores in all quantiles but the 90th ($b = -1.07$ to -1.47, $p < 0.01$). The presence of social workers predicted lower scores in the 50th ($b = -2.80$, $p < 0.05$) and 75th ($b = -3.05$, $p < 0.05$) quantiles. Finally, the presence of psychosocial pairs predicted lower scores in all quantiles ($b = -1.30$ to -3.21, $p < 0.001$ and $p < 0.01$).

Table 6 presents the results of the quantile regressions on math and language in tenth grade students Similar to eight graders, schools that only hired psychologists predicted higher scores in math tests in all quantiles but the 50th quantile ($b = 1.12$ to 1.85, $p < 0.001$ and $p < 0.05$), but did not had statistically significant effects on language scores. Schools with only social workers predicted lower scores in math ($b = -3.14$ to -4.19, $p < 0.05$) and language ($b = -2.94$ to -6.74, $p < 0.001$) in all quantiles but the 90th. Finally, schools that hired psychosocial pairs did not have statistically significant effects on math scores but predicted lower language scores on the 75th and 90th quantiles ($b = -1.53$ to -1.13, $p < 0.05$ and $p < 0.001$). Wald tests were performed after estimation to test whether the magnitude of the coefficients was different between quantiles, but the equality hypothesis was not rejected at the 5% level.

The results of the estimation of Model 2 are reported in **Table 7**. In Model 2, the variable related to the type of school according to its hiring policy was replaced by variables reporting the number of psychologists and social workers hired by a school. To provide a better understanding of the relationship of these variables with school SES, we introduced a different index that reflects the proportion of vulnerable students and the moderation effect with the number of psychosocial professionals hired. Findings showed that the proportion of vulnerable students predicted lower scores in math and language ($b = -0.25$ to -1.39) and number of psychologists hired in the schools had a positive effect in the scores of math tests in eighth grade ($b = 1.84$, $p < 0.001$) and 10th grade ($b = 1.55$, $p < 0.001$), with no significant effects on language scores. The interaction effects showed that the positive direct effect found for the number of psychologists hired was moderated by the proportion of vulnerable students for the eighth-grade sample ($b = -0.08$ to -0.05), reducing their effectiveness in schools with more vulnerable students. In contrast, the number of social workers was related to negative effects on language and math scores ($b = -2.64$ to -8.06). However, the moderation effect between the number of social workers and the proportion of vulnerable students predicted a positive effect in all tests but language for the 10th-grade sample ($b = 0.07$ to 0.36), meaning that a higher number of social workers had a positive effect on school achievement in schools with a greater proportion of low-SES students.

Additional estimations that took the form of robustness checks were conducted using different measures of the presence of psychosocial professionals in schools described as Models 3

TABLE 4 | Multilevel linear model predicting math and language score for 8th grade and 10th grade testing the contribution of the type of school according to hiring policy with individual and school–level predictors.

	8th grade		10th grade	
Variables	**Math score b (SE)**	**Language Score b (SE)**	**Math score b (SE)**	**Language score b (SE)**
Individual level				
Female (Yes = 1)	−6.71***	9.95***	−8.11***	12.99***
	(0.21)	(0.24)	(0.30)	(0.28)
Age	−9.38***	−8.64***	−13.48***	−10.26***
	(0.17)	(0.19)	(0.24)	(0.23)
Socioeconomic status	7.42***	7.26***	7.69***	5.48***
	(0.17)	(0.19)	(0.23)	(0.21)
Indigenous ancestry	0.27	0.93**	0.93*	0.42
	(0.31)	(0.35)	(0.46)	(0.43)
Attendance	0.65***	0.18***	1.07***	0.40***
	(0.02)	(0.02)	(0.03)	(0.03)
School motivation	5.80***	6.89***	10.89***	8.31***
	(0.16)	(0.18)	(0.21)	(0.20)
School level				
Percentage of female students	0.15***	0.11***	0.19***	0.15***
	(0.02)	(0.02)	(0.03)	(0.02)
School SES (reference category: Low–SES school)				
Mid–low	7.23***	4.61***	14.59***	7.01***
	(0.79)	(0.72)	(1.65)	(1.22)
Mid	18.77***	12.52***	36.21***	16.95***
	(0.92)	(0.83)	(1.82)	(1.36)
Mid–high	32.17***	19.96***	52.98***	23.61***
	(1.14)	(1.03)	(2.13)	(1.59)
High	44.14***	23.80***	68.34***	31.94***
	(2.67)	(2.34)	(4.56)	(3.40)
Attendance (school average)	1.13***	1.30***	1.82***	1.54***
	(0.07)	(0.07)	(0.12)	(0.09)
School funding (reference category: public)				
Subsidized private	4.71***	0.05	1.67	−2.75*
	(0.70)	(0.62)	(1.51)	(1.11)
Private	17.61***	6.47**	4.97	−4.54
	(2.76)	(2.40)	(4.55)	(3.38)
Rural school (Yes = 1)	0.05	1.51*	−8.74**	−4.37*
	(0.84)	(0.76)	(2.71)	(2.05)
Type of school (reference category: No psychosocial professionals hired)				
Psychologists only	1.92*	−0.42	5.20***	1.48
	(0.76)	(0.68)	(1.35)	(1.00)
Social workers only	2.51	0.60	1.09	−1.13
	(2.11)	(1.86)	(3.37)	(2.48)
Psychosocial pairs	1.61	−1.93*	5.00**	0.52
	(0.85)	(0.75)	(1.61)	(1.19)
Constant	192.49***	202.76***	174.00***	211.47***
	(7.26)	(6.90)	(11.54)	(9.05)
Number of students	147,531	147,531	106,347	106,347
Number of schools	5,608	5,608	2,382	2,382
Log–likelihood	−749,854.2	−768,088.4	−558,834.0	−551,571.6

*Unstandardized coefficients reported. Standard errors in parentheses. *p < 0.05, **p < 0.01, ***p < 0.001.*

TABLE 5 | Quantile regression predicting math and language score for 8th grade testing the contribution of the type of school according to hiring policy with individual and school–level predictors.

	Math Test				Language Test			
Variables	**b (SE)**	**b (SE)**	**b (SE)**	**b (SE)**	**b (SE)**	**b (SE)**	**b (SE)**	**b (SE)**
Individual level								
Female (Yes = 1)	−6.67***	−7.27***	−7.39***	−7.25***	10.97***	10.02***	9.03***	7.87***
	(0.36)	(0.26)	(0.38)	(0.26)	(0.50)	(0.26)	(0.39)	(0.30)
Age	−10.19***	−10.54***	−10.56***	−10.35***	−9.15***	−9.50***	−9.87***	−9.08***
	(0.25)	(0.32)	(0.25)	(0.24)	(0.22)	(0.13)	(0.18)	(0.22)
Socioeconomic status	9.45***	10.02***	9.90***	9.55***	7.68***	9.07***	9.19***	8.58***
	(0.32)	(0.17)	(0.26)	(0.28)	(0.33)	(0.26)	(0.30)	(0.38)
Indigenous ancestry	−0.71	−0.35	−0.32	−0.37	1.85***	1.70***	1.03	0.69
	(0.50)	(0.25)	(0.50)	(0.26)	(0.43)	(0.46)	(0.71)	(0.86)
Attendance	0.47***	0.55***	0.71***	0.81***	0.17***	0.19***	0.14**	0.14**
	(0.03)	(0.03)	(0.03)	(0.04)	(0.03)	(0.03)	(0.04)	(0.05)
School motivation	5.08***	6.49***	7.62***	8,68***	7.87***	7.94***	7.65***	6.34***
	(0.33)	(0.17)	(0.29)	(0.28)	(0.21)	(0.23)	(0.26)	(0.18)
School level								
Percentage of female students	0.12***	0.12***	0.12***	0.09***	0.09***	0.11***	0.09***	0.07***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
School SES (reference category: Low–SES school)								
Mid–low	6.99***	7.62***	8.33***	9.02***	3.20***	5.01***	6.73***	7.79***
	(0.16)	(0.15)	(0.66)	(0.54)	(0.49)	(0.47)	(0.60)	(0.88)
Mid	18.21***	20.47***	21.20***	21.58***	12.04***	14.95***	17.15***	17.58***
	(0.38)	(0.44)	(1.01)	(0.91)	(0.48)	(0.65)	(0.78)	(0.71)
Mid–high	32.66***	33.62***	33.81***	34.18***	21.32***	24.12***	25.41***	24.42***
	(0.37)	(0.62)	(0.90)	(1.13)	(0.17)	(0.57)	(0.59)	(0.66)
High	44.99***	43.57***	41.02***	40.71***	25.03***	27.50***	25.33***	24.96***
	(1.05)	(0.83)	(1.22)	(1.13)	(1.84)	(2.28)	(1.67)	(1.33)
Attendance (school average)	1.42***	1.57***	1.65***	1.67***	1.62***	1.76***	1.64***	1.44***
	(0.06)	(0.09)	(0.05)	(0.02)	(0.07)	(0.08)	(0.03)	(0.04)
School funding (reference category: public)								
Subsidized private	5.11***	3.63***	2.70***	1.46***	−1.51***	−2.33	−3.50***	−3.44***
	(0.30)	(0.35)	(0.51)	(0.36)	(0.41)	(0.38)	(0.25)	(0.37)
Private	15.12***	13.59***	13.80***	8.90***	4.40**	2.34	1.55***	−0.69
	(0.80)	(1.16)	(0.54)	(2.25)	(1.67)	(2.13)	(1.91)	(0.69)
Rural school (Yes = 1)	−2.16***	−1.38***	−1.78***	−2.37***	0.26	−0.25	−0.80*	−1.93**
	(0.71)	(0.35)	(0.52)	(0.70)	(0.71)	(0.42)	(0.37)	(0.74)
Type of school (reference category: No psychosocial professionals hired)								
Psychologists only	1.67**	0.90	0.55	−0.58	−1.47**	−1.07**	−1.35**	−0.60
	(0.50)	(0.46)	(0.36)	(0.30)	(0.54)	(0.32)	(0.50)	(0.48)
Social workers only	1.09	−0.40	−2.93	−5.86*	−1.26	−2.80*	−3.05*	−0.73
	(0.74)	(0.84)	(1.13)	(2.24)	(1.68)	(1.29)	(1.24)	(1.54)
Psychosocial pairs	1.15*	0.58	0.48	−1.43***	−3.21***	−2.93***	−2.64***	−1.30**
	(0.56)	(0.41)	(0.27)	(0.41)	(0.40)	(0.42)	(0.56)	(0.45)
Constant	169.90***	182.09***	189.55***	205.09***	154.54***	174.02***	226.35***	261.68***
	(4.63)	(9.17)	(4.89)	(4.41)	(7.01)	(6.43)	(5.27)	(7.07)
Number of students	147,880	147,880	147,880	147,880	147,880	147,880	147,880	147,880
Pseudo R2	0.1434	0.1538	0.1553	0.1529	0.0792	0.0907	0.0891	0.0789

*Unstandardized coefficients reported. Robust standard errors in parentheses. *p < 0.05, **p < 0.01, ***p < 0.001.*

TABLE 6 | Quantile regression predicting math and language score for 10th grade testing the contribution of the type of school according to hiring policy with individual and school–level predictors.

	Math Test				Language Test			
Variables	**b (SE)**	**b (SE)**	**b (SE)**	**b (SE)**	**b (SE)**	**b (SE)**	**b (SE)**	**b (SE)**
Individual level								
Female (Yes = 1)	−7.53***	−8.80***	−9.83***	−11.06***	16.82***	13.15***	8.95***	7.18***
	(0.41)	(0.47)	(0.49)	(0.47)	(0.46)	(0.15)	(0.29)	(0.42)
Age	−16.85***	−15.97***	−14.91***	−13.63***	−11.72***	−12.41***	−12.13***	−11.39***
	(0.44)	(0.24)	(0.14)	(0.28)	(0.36)	(0.29)	(0.33)	(0.41)
Socioeconomic status	10.81***	9.78***	8.73***	8.27***	5.79***	6.93***	7.16***	7.40***
	(0.29)	(0.28)	(0.15)	(0.37)	(0.26)	(0.32)	(0.32)	(0.06)
Indigenous ancestry	0.79	0.94	−0.05	−1.92***	1.15*	0.55	0.06	−0.45
	(0.52)	(0.63)	(0.84)	(0.48)	(0.58)	(0.37)	(0.45)	(1.04)
Attendance	0.95***	0.99***	1.07***	1.11***	0.35***	0.38***	0.36***	0.34***
	(0.03)	(0.03)	(0.02)	(0.05)	(0.03)	(0.02)	(0.02)	(0.02)
School motivation	11.83***	12.01***	12.39***	12.06***	10.23***	9.63***	9.11***	8.10***
	(0.27)	(0.20)	(0.16)	(0.27)	(0.38)	(0.28)	(0.30)	(0.33)
School level								
Percentage of female students	0.17***	0.12***	0.08***	0.06***	0.14***	0.10***	0.09***	0.06***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
School SES (reference category: Low–SES school)								
Mid–low	13.43***	17.43***	20.08***	21.22***	6.16***	8.83***	11.37***	12.90***
	(0.73)	(0.75)	(1.08)	(0.65)	(0.60)	(0.82)	(0.78)	(0.92)
Mid	37.49***	41.93***	40.14***	37.36***	17.86***	20.58***	23.59***	23.92***
	(1.18)	(0.55)	(0.92)	(1.09)	(0.84)	(0.84)	(0.95)	(0.95)
Mid–high	58.71***	57.21***	52.24***	47.45***	25.38***	27.20***	29.80***	29.17***
	(1.23)	(0.69)	(1.20)	(1.33)	(0.53)	(0.63)	(0.98)	(0.97)
High	70.42***	66.70***	59.34***	56.57***	27.64***	32.96***	32.63***	34.06***
	(1.41)	(1.34)	(2.41)	(4.26)	(1.00)	(1.44)	(1.16)	(3.18)
Attendance (school average)	2.25***	2.31***	2.30***	2.28***	1.92***	1.94***	1.80***	1.64***
	(0.07)	(0.05)	(0.02)	(0.06)	(0.03)	(0.03)	(0.03)	(0.08)
School funding (reference category: public)								
Subsidized private	−1.23	−3.84***	−5.48	−6.06***	−4.92***	−6.63***	−8.26***	−9.41***
	(0.77)	(0.60)	(0.37)	(0.67)	(0.52)	(0.35)	(0.41)	(0.45)
Private	4.35*	−0.00	−0.55	−2.81	−1.54	−5.71***	−4.37***	−9.15**
	(2.04)	(1.97)	(1.60)	(3.64)	(1.06)	(0.37)	(0.27)	(3.14)
Rural school (Yes = 1)	−8.02***	−9.45***	−8.53***	−10.10***	−2.98**	−2.20	−2.04*	−2.42
	(1.97)	(1.42)	(1.25)	(2.13)	(1.02)	(1.71)	(1.00)	(2.26)
Type of school (reference category: No psychosocial professionals hired)								
Psychologists only	1.30*	1.13	1.12***	1.85***	0.28	0.19	−0.53	−0.36
	(0.66)	(0.65)	(0.29)	(0.31)	(0.56)	(0.56)	(0.36)	(0.74)
Social workers only	−4.19*	−4.00*	−3.14*	−1.17	−6.74***	−5.41***	−2.94***	−2.38
	(1.81)	(1.56)	(1.54)	(1.90)	(0.50)	(0.77)	(0.66)	(1.24)
Psychosocial pairs	2.13	1.30	0.59	0.74	−1.44	−0.98	−1.13*	−1.53***
	(1.44)	(0.79)	(0.57)	(0.96)	(0.91)	(1.02)	(0.44)	(0.35)
Constant	173.69***	189.84***	204.43***	213.61	175.51***	215.97***	258.47***	293.12***
	(13.03)	(5.78)	(3.74)	(5.78)	(10.81)	(5.82)	(7.42)	(10.56)
Number of students	106,347	106,347	106,347	106,347	106,347	106,347	106,347	106,347
Pseudo R2	0.2076	0.2208	0.1991	0.1771	0.1197	0.1246	0.1213	0.1087

*Unstandardized coefficients reported. Robust standard errors in parentheses. *p < 0.05, **p < 0.01, ***p < 0.001.*

TABLE 7 | Multilevel linear model predicting math and language score for 8th grade and 10th grade testing the contribution of the number of psychosocial professionals hired with individual and school–level predictors.

	8th grade		10th grade	
	Math score	**Language Score**	**Math score**	**Language score**
Variables	**b (SE)**	**b (SE)**	**b (SE)**	**b (SE)**
Individual level				
Female (Yes = 1)	−6.68***	9.99***	−8.09***	13.01***
	(0.21)	(0.24)	(0.30)	(0.28)
Age	−9.44***	−8.71***	−13.51***	−10.30***
	(0.17)	(0.19)	(0.24)	(0.23)
Socioeconomic status	7.90***	7.82***	8.06***	5.81***
	(0.17)	(0.19)	(0.23)	(0.21)
Indigenous ancestry	0.33	0.89*	0.96*	0.40
	(0.31)	(0.35)	(0.46)	(0.43)
Attendance	0.64***	0.17***	1.07***	0.39***
	(0.02)	(0.02)	(0.03)	(0.03)
School motivation	5.76***	6.83***	10.87***	8.29***
	(0.16)	(0.18)	(0.21)	(0.20)
School level				
Percentage of female students	0.19***	0.13***	0.20***	0.16***
	(0.02)	(0.02)	(0.04)	(0.03)
Attendance (school average)	1.40***	1.46***	2.53***	1.90***
	(0.08)	(0.07)	(0.13)	(0.09)
School funding (reference category: public)				
Subsidized private	8.19***	2.57***	1.51	−2.82*
	(0.70)	(0.61)	(1.65)	(1.17)
Private	39.74***	17.19***	30.09***	8.02***
	(1.51)	(1.31)	(2.57)	(1.84)
Rural school (Yes = 1)	0.89	1.13	−6.63*	−4.47*
	(0.91)	(0.82)	(2.94)	(2.14)
Number of psychologists hired	1.84***	0.22	1.55**	0.20
	(0.33)	(0.28)	(0.56)	(0.39)
Number of social workers hired	−4.76***	−2.64***	−8.06***	−3.06***
	(0.64)	(0.55)	(1.26)	(0.89)
Percentage of vulnerable students	−0.48***	−0.25***	−1.39***	−0.52***
	(0.03)	(0.03)	(0.10)	(0.07)
Moderation effects				
Number of psychologists x % Vulnerable students	−0.08***	−0.05*	−0.05	−0.02
	(0.02)	(0.02)	(0.06)	(0.04)
Number of social workers x % Vulnerable students	0.20***	0.07**	0.36***	0.05
	(0.03)	(0.03)	(0.08)	(0.06)
Constant	186.48***	200.33***	150.78***	197.94***
	(7.47)	(7.02)	(12.12)	(9.20)
Number of students	147,531	147,531	106,347	106,347
Number of schools	5,608	5,608	2,382	2,382
Log–likelihoodd	−751,860.8	−770,046.3	−559,016.2	−551,652

*Unstandardized coefficients reported. Standard errors in parentheses. *p < 0.05, **p < 0.01, ***p < 0.001.*

and 4 (see **Supplementary Tables 1, 2**). Results of these models predicted that the type of contract of professionals hired did not had significant effects on achievement, and that a higher proportion of psychosocial professionals hired with SEP funds was associated with better math scores among eighth-grade students; and a higher proportion of psychosocial professionals hired with PIE funds was associated with lower scores in math and language.

Logistic Multilevel Models Predicting Short- and Long-Term School Dropout

Table 8 presents the logistic multilevel model predicting students' dropout for the sample of eighth-grade students. Columns A and B of each model show the effects of independent variables on short- and long-term dropout, respectively. The predictors in the estimations of the probability of dropping out were the same used in the estimation of math and language test scores. The odds ratios (ORs) were calculated by exponentiating the coefficients obtained from the estimations. ORs compare the relative odds of occurrence of dropout given the exposure to a predictor. If an OR is > 1, the exposure to a predictor is associated with higher odds of dropping out; if it is lower than 1, it is associated with lower odds.

Regarding individual-level variables, students' gender and SES were not statistically significant in this sample. Being an older student was associated with higher odds of dropping out ($OR =$ 3.97 to 4.21, $p < 0.001$). Students with an Indigenous background had OR below 1 in all models, predicting that these students were less likely to drop out ($OR = 0.77$ to 0.79, $p < 0.001$). A higher attendance predicted lower odds of dropout in the short and long term ($OR = 0.94$ to 0.95, $p < 0.001$). School motivation did not show a statistically significant effect in any model using the short-term dropout variable, but it had a counterintuitive effect in all models of long-term dropout, wherein higher motivation predicted higher odds of dropping out ($OR = 1.18$, $p < 0.001$).

Regarding school-level variables, the proportion of female students in schools predicted a lower likelihood of students dropping out. Higher attendance predicted lower odds of dropout in the short and long term ($OR = 0.98$ to 0.99, $p < 0.001$). School SES was linked with statistically significant differences between medium-high SES schools and low-SES schools, with the former predicting lower odds of dropout ($OR = 0.64$ to 0.69, $p < 0.001$). Rural schools did not make a significant contribution in any estimated models. With respect to type of school, private subsidized schools predicted a lower probability of having students that dropped out compared to public schools ($OR = 3.98$ to 4.21, $p < 0.001$).

Considering the relevant study variables at the school level, schools with only psychologists reduced the odds of short-term ($OR = 0.76$, $p < 0.05$) and long-term ($OR = 0.76$, $p < 0.01$) dropout compared to schools with no psychosocial professionals hired. Schools with only social workers also predicted lower odds of short-term ($OR = 0.49$, $p < 0.05$) and long-term ($OR = 0.50$, $p < 0.05$) dropout, and schools with psychosocial pairs hired predicted a lower likelihood of students dropping out in the same year ($OR = 0.66$, $p < 0.001$) and in the following 2 years ($OR =$ 0.66, $p < 0.001$). A higher number of psychologists hired reduced the odds of dropping out (short term: $OR = 0.94$, $p < 0.05$; long term: $OR = 0.94$, $p < 0.05$). Similar results were found for the number of social workers hired, wherein a higher number reduced the probability of students dropping out in the short term ($OR = 0.88$, $p < 0.010$) and long term ($OR = 0.89$, $p <$ 0.01). The contributions of the proportion of professionals hired based on the type of contract and funds used were not statistically significant in the sample of eighth-grade students.

Table 9 reports the results of the logistic multilevel estimations for the sample of 10th-grade students. Regarding individual-level variables, being a female student predicted lower odds of dropout in all models ($OR = 0.65$ to 0.68, $p < 0.001$). Age had similar effects in the eighth-grade sample, wherein older students were associated with a higher probability of dropping out of school in the short and long term ($OR = 4.42$ to 4.65, $p < 0.001$). Attendance predicted a lower likelihood of dropping out in the short and long term ($OR = 0.91$ to 0.92, $p < 0.001$). In contrast to findings for eighth-grade students, school motivation in this sample was statistically significant in all models, wherein higher motivation was related with a lower likelihood of dropout ($OR =$ 0.70 to 0.72, $p < 0.001$). Indigenous background and individual SES were not statistically significant for this sample.

At the school level, the percentage of female students in school was not statistically significant in any model. Medium-high SES schools showed lower odds of dropout in all models ($OR =$ 0.49 to 0.55, $p < 0.001$), compared to low-SES schools. Private schools predicted a lower likelihood of dropout compared to public schools in all models with this variable ($OR = 0.38$ to 0.43, $p < 0.05$ and $p < 0.01$).

Schools with only psychologists had lower odds of dropout in the short term ($OR = 0.85$, $p < 0.05$) and long term ($OR =$ 0.84, $p < 0.05$). Schools with psychosocial pairs also had a lower likelihood of students dropping out in the short term ($OR = 0.84$, $p < 0.050$) and long term ($OR = 0.81$, $p < 0.05$) compared to schools with no psychosocial professionals hired. The number of psychologists hired predicted a lower probability of short-term ($OR = 0.95$, $p < 0.05$) and long-term ($OR = 0.95$, $p < 0.05$) dropout. The effects related to the number of social workers in the eighth-grade sample were not replicated in the sample of 10th-grade students. Similarly, the proportion of professionals hired with different contracts and funds did not have statistically significant effects on dropout.

DISCUSSION

Academic achievement and school dropout are considered indicators of school achievement and school failure, respectively. Both have been pinpointed as relevant indicators of educational quality worldwide (Organisation for Economic Cooperation Development., 2019). However, attaining the goal of quality education for all students (Ainscow, 2019) in an inclusive educational context has not been an easy task, and most countries are struggling with unequal distribution of gains and failures among students due to socioeconomic differences and related factors. In particular, school failure is overrepresented among

TABLE 8 | Multilevel logistic model predicting the probability of students' short and long–term dropout for 8th grade with individual and school–level predictors.

	Model 1 (A)	Model 1 (B)	Model 2 (A)	Model 2 (B)	Model 3 (A)	Model 3 (B)	Model 4 (A)	Model 4 (B)
Variables	**OR (SE)**	**OR (SE)**	**OR (SE)**	**OR (SE)**	**OR (SE)**	**OR (SE)**	**OR (SE)**	**OR (SE)**
Individual level								
Female (Yes = 1)	0.97	0.97	0.98	0.97	0.98	0.97	0.98	0.96
	(0.05)	(0.06)	(0.05)	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)
Age	3.97***	4.21***	3.97***	4.21***	3.98***	4.19***	4.01***	4.21***
	(0.10)	(0.11)	(0.10)	(0.11)	(0.11)	(0.12)	(0.11)	(0.12)
Socioeconomic status	1.12	1.13	1.12	1.13	1.13	1.15	1.13	1.15
	(0.11)	(0.11)	(0.11)	(0.11)	(0.11)	(0.11)	(0.11)	(0.11)
Indigenous ancestry	0.77**	0.78**	0.77**	0.78**	0.79**	0.77**	0.79**	0.77**
	(0.06)	(0.06)	(0.06)	(0.06)	(0.07)	(0.07)	(0.07)	(0.07)
Attendance	0.95***	0.95***	0.95***	0.95***	0.94***	0.95***	0.95***	0.95***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
School motivation	1.13	1.18***	1.13	1.18***	1.14	1.18***	1.13	1.18***
	(0.10)	(0.05)	(0.10)	(0.05)	(0.10)	(0.05)	(0.10)	(0.05)
School level								
Percentage of female students	0.99**	0.99*	0.99**	0.99*	0.99*	1.00*	0.99*	0.99*
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
School SES (reference category: Low–SES school)								
Mid–low	0.90	0.91	0.91	0.92	0.93	0.93	0.93	0.94
	(0.09)	(0.09)	(0.09)	(0.09)	(0.09)	(0.09)	(0.09)	(0.10)
Mid	0.87	0.90	0.88	0.92	0.98	1.02	0.98	1.02
	(0.10)	(0.10)	(0.10)	(0.10)	(0.11)	(0.12)	(0.11)	(0.12)
Mid–high	0.61**	0.55***	0.63**	0.56***	0.67*	0.61**	0.65*	0.60**
	(0.09)	(0.09)	(0.09)	(0.09)	(0.11)	(0.11)	(0.11)	(0.11)
High	0.48	0.31*	0.49	0.32*	0.36	0.17*	0.22	0.00
	(0.20)	(0.15)	(0.20)	(0.15)	(0.22)	(0.13)	(0.17)	(0.00)
Attendance (school average)	0.94***	0.94***	0.94***	0.94***	0.94***	0.94***	0.95***	0.94***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
School funding (reference category: public)								
Subsidized private	0.70***	0.69***	0.70***	0.70***	0.68***	0.66***	0.67***	0.65***
	(0.06)	(0.06)	(0.06)	(0.06)	(0.05)	(0.05)	(0.05)	(0.05)
Private	0.99	1.32	1.05	1.42	1.52	2.53		
	(0.40)	(0.61)	(0.42)	(0.65)	(0.93)	(1.94)		
Rural school (Yes = 1)	0.85	0.85	0.83	0.83	0.84	0.86	0.83	0.85
	(0.10)	(0.10)	(0.10)	(0.10)	(0.10)	(0.11)	(0.10)	(0.11)
Type of school (reference category: No psychosocial professionals hired)								
Psychologists only	0.76**	0.76**						
	(0.07)	(0.08)						
Social workers only	0.49*	0.50*						
	(0.14)	(0.15)						
Psychosocial pairs	0.66***	0.66***						
	(0.07)	(0.07)						
Number of psychologists hired			0.94*	0.94*				
			(0.03)	(0.03)				
Number of social workers hired			0.88*	0.89*				
			(0.04)	(0.05)				
Percentage of psychosocial professionals with indefinite contract					1.00	1.00		
					(0.00)	(0.00)		
Percentage of psychosocial professionals with fixed–term contract					1.00	1.00		
					(0.00)	(0.00)		
Percentage of psychosocial professionals hired with SEP funds							1.00	1.00

(Continued)

TABLE 8 | Continued

	Model 1 (A)	Model 1 (B)	Model 2 (A)	Model 2 (B)	Model 3 (A)	Model 3 (B)	Model 4 (A)	Model 4 (B)
Variables	**OR (SE)**	**OR (SE)**	**OR (SE)**	**OR (SE)**	**OR (SE)**	**OR (SE)**	**OR (SE)**	**OR (SE)**
							(0.00)	(0.00)
Percentage of psychosocial professionals hired with PIE funds							1.00	1.00
							(0.00)	(0.00)
Constant	0.00***	0.00***	0.00***	0.00***	0.00***	0.00***	0.00***	0.00***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Number of students	147,531	147,531	147,531	147,531	123,574	123,574	118,239	118,239
Number of schools	5,608	5,608	5,608	5,608	4,536	4,536	4,410	4,410
Log–likeli~d	−7,810.49	−7010.19	−7811.10	−7011.40	−6569.71	−5935.74	−6360.62	−5774.97

Standard errors in parentheses. Columns A used the short–term dropout as dependent variable. Columns B used the long–term dropout as dependent variable.
$^{*}p < 0.05$; $^{**}p < 0.01$; $^{***}p < 0.001$.

poorer students and students with learning and behavioral difficulties at school. It has become a political and social problem, with well-known negative consequences for individuals and society such as the achievement gap and the school-to-prison pipeline (Ruiz et al., 2018; Granvik et al., 2020).

In this context, the presence of non-teaching professionals in the school may provide important support for students, especially for those who—due to factors related to the school and outside of the school—find it difficult to engage in the learning process. However, there is scarce scientific knowledge accumulated concerning the effect of school counselors, psychologists, social workers, and other professionals on issues such as retention and academic performance (López et al., 2017; Kuperminc et al., 2019; Arslan and Coşkun, 2020). Within this context, this study aimed to analyze the effects of school psychologist and social workers, when working together as "psychosocial pairs" or not, on relevant indicators of school achievement and failure.

Several conclusions can be drawn from the findings of this national study. First, schools seem to have a differentiated scheme for incorporating psychologists or social workers, based on certain characteristics of their students. Schools with a higher proportion of students from low- and mid-low SES tend to hire more social workers, and schools with a higher proportion of students from mid-low and mid-SES tend to hire more psychologists. Although high-SES schools tend to hire only psychologists who also have more indefinite contracts, low-SES schools tend to hire more psychosocial pairs with SEP and PIE funds, which are state funds for low-SES students and students with disabilities, respectively. These findings suggest that not only does the nature of the interventions that school psychologists implement differ disciplinarily, but also that these professionals are targeted by contract to different school populations. These findings require further exploration. On the other hand, these results can be linked to the intervention models attributed to each professional type. According to previous studies in Chile, social workers are associated with a network-and-benefits management model, in charge of providing support at the health and welfare level (Concha, 2012; Cádiz and Manriquez., 2015). School psychologists are associated with individual treatment of problems at an academic, emotional, and social level (Erausquin and Bur, 2013; López and Carrasco, 2018; Cárcamo-Vásquez et al., 2020). In this way, a higher proportion of social workers in more vulnerable schools may be due to the need for timely access to benefits and support for families that allow students to stay in school.

Secondly, findings regarding the contribution of school psychologists and social workers on students' performance in math and language tests are inconclusive. On the one hand, this study showed a positive association between the presence and number of psychologists and math achievement. In eighth grade, school psychologists (and psychosocial pairs) have a significant effect on math gains, particularly for lower-performing student. In tenth grade, the positive associations between psychologists and math scores are significant in all but one quantile. These results could be explained by the content of the interventions developed by school psychologists, which are generally associated with the development of social-emotional skills such as problem solving, emotional regulation, and social skills (Cárcamo-Vásquez et al., 2020). These interventions are developed as tier 2 or tier 3 interventions, that is, in groups of students or individually. Several studies have shown positive association between the development of social-emotional skills and mathematical achievement (Matthews et al., 2009; Prafitriyani et al., 2019; Slot et al., 2020). For example, Masitoh and Fitriyani (2018) have shown that problem-solving ability has positive effects on the perception of self-efficacy in mathematics. In this aspect, the abilities to solve problems of daily life and their reinforcement through school psychologists could have a direct incidence in a better predisposition to learn this subject. On the other hand, a positive relationship has been observed between the perception of self-efficacy and achievement in mathematics (Bandura, 1982; Poynton and Lapan, 2017; Rahmi et al., 2017). Similarly, Matthews et al. (2009) found a positive relationship between self-regulation and math achievement, visualizing that support in this area can also contribute in a substantive way. These results are encouraging regarding the impact that these interventions could have at level 1 and 2. However, future research needs to continue to build

TABLE 9 | Multilevel logistic model predicting the probability of students' short and long–term dropout for 10th grade with individual and school–level predictors.

	Model 1 (A)	Model 1 (B)	Model 2 (A)	Model 2 (B)	Model 3 (A)	Model 3 (B)	Model 4 (A)	Model 4 (B)
Variables	**OR (SE)**	**OR (SE)**	**OR (SE)**	**OR (SE)**	**OR (SE)**	**OR (SE)**	**OR (SE)**	**OR (SE)**
Individual level								
Female (Yes = 1)	0.68***	0.66***	0.68***	0.66***	0.67***	0.65***	0.66***	0.65***
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
Age	4.51***	4.65***	4.51***	4.65***	4.42***	4.58***	4.44***	4.59***
	(0.11)	(0.12)	(0.11)	(0.12)	(0.12)	(0.13)	(0.12)	(0.13)
Socioeconomic status	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.02
	(0.03)	(0.03)	(0.03)	(0.03)	(0.04)	(0.04)	(0.04)	(0.04)
Indigenous ancestry	0.92	0.92	0.92	0.92	0.91	0.91	0.91	0.91
	(0.06)	(0.06)	(0.06)	(0.06)	(0.07)	(0.07)	(0.07)	(0.07)
Attendance	0.91***	0.92***	0.91***	0.92***	0.92***	0.92***	0.92***	0.92***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
School motivation	0.72***	0.72***	0.72***	0.72***	0.71***	0.70***	0.70***	0.70***
	(0.02)	(0.02)	(0.02)	(0.02)	(0.03)	(0.03)	(0.03)	(0.03)
School level								
Percentage of female students	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
School SES (reference category: Low–SES school)								
Mid–low	1.06	1.08	1.07	1.08	1.07	1.08	1.07	1.07
	(0.09)	(0.09)	(0.09)	(0.09)	(0.09)	(0.09)	(0.09)	(0.09)
Mid	0.83	0.83	0.84	0.83	0.82	0.81	0.82	0.81
	(0.08)	(0.08)	(0.08)	(0.08)	(0.09)	(0.09)	(0.09)	(0.09)
Mid–high	0.50***	0.48***	0.49***	0.48***	0.47***	0.44***	0.48***	0.45***
	(0.07)	(0.06)	(0.06)	(0.06)	(0.07)	(0.07)	(0.07)	(0.07)
High	1.04	0.84	1.02	0.82	0.87	0.80	0.85	0.79
	(0.32)	(0.28)	(0.32)	(0.27)	(0.34)	(0.32)	(0.34)	(0.33)
Attendance (school average)	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
School funding (reference category: public)								
Subsidized private	1.10	1.08	1.10	1.09	1.13	1.12	1.14	1.13
	(0.08)	(0.08)	(0.08)	(0.08)	(0.09)	(0.09)	(0.09)	(0.09)
Private	0.38**	0.39**	0.40**	0.41*	0.43*	0.38*		
	(0.12)	(0.14)	(0.13)	(0.14)	(0.18)	(0.17)		
Rural school (Yes = 1)	0.93	0.93	0.93	0.92	0.95	0.96	0.97	0.98
	(0.16)	(0.16)	(0.16)	(0.16)	(0.17)	(0.17)	(0.17)	(0.17)
Type of school (reference category: No psychosocial professionals hired)								
Psychologists only	0.85*	0.84*						
	(0.07)	(0.07)						
Social workers only	0.92	0.90						
	(0.16)	(0.16)						
Psychosocial pairs	0.82*	0.79*						
	(0.07)	(0.07)						
Number of psychologists hired			0.95*	0.95*				
			(0.02)	(0.02)				
Number of social workers hired			0.97	0.97				
			(0.04)	(0.05)				
Percentage of psychosocial professionals with indefinite contract					1.00	1.00		
					(0.00)	(0.00)		
Percentage of psychosocial professionals with fixed–term contract					1.00	1.00		
					(0.00)	(0.00)		
Percentage of psychosocial professionals hired with SEP funds							1.00	1.00

(Continued)

TABLE 9 | Continued

	Model 1 (A)	Model 1 (B)	Model 2 (A)	Model 2 (B)	Model 3 (A)	Model 3 (B)	Model 4 (A)	Model 4 (B)
Variables	**OR (SE)**	**OR (SE)**	**OR (SE)**	**OR (SE)**	**OR (SE)**	**OR (SE)**	**OR (SE)**	**OR (SE)**
							(0.00)	(0.00)
Percentage of psychosocial professionals hired with PIE funds							1.00	1.00
							(0.00)	(0.00)
Constant	0.00***	0.00***	0.00***	0.00***	0.00***	0.00***	0.00***	0.00***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Number of students	106,347	106,347	106,347	106,347	85,636	85,636	80,773	80,773
Number of schools	2,382	2,382	2,382	2,382	1,824	1,824	1,702	1,702
Log–likelihood	−9,312.88	−9,039.37	−9,312.46	−9,039.57	−7,624.23	−7,391.42	−7,426.67	−7,230.20

Standard errors in parentheses. Columns A used the short-term dropout as dependent variable. Columns B used the long-term dropout as dependent variable.
*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$.*

on these findings. However, there was also evidence, at least in eighth grade, of a negative association between the presence of psychologists and achievement in language. In this grade level, the presence of psychologists was associated with lower scores for all students except for very high achieving students. This negative association between the presence of psychologists and language achievement was not found in tenth grade. These findings also require further research.

On the other hand, findings regarding the associations between social workers and school achievement are complex in a different way, given the characteristics of the schools in which most social workers work. As noted, schools with low- and mid-low SES tend to hire more social workers, suggesting that schools require and ask them to work with students from lower-SES backgrounds. In some manner, this is a tiered support system in which the tier is not based on promotion or prevention strategies, but on students' SES and associated difficulties that, based on deficit theories, are assumed to require individual attention. These individual interventions are usually welfare-based strategies such as home visits (López and Carrasco, 2018). Findings from this study show that although the number of social workers in the total sample was related to negative effects on language and math scores, this was true only for schools with only social workers (which as we have shown is more frequent in lower-SES schools) and only for higher-achieving students in eighth grade, but for all but higher-achieving students in tenth grade. The associations were also moderated by school SES, wherein having more social workers positively affected school achievement in schools with a greater proportion of low-SES students. This moderation effect is highly important to consider. The negative effects on school achievement in the total sample might be due to the overrepresentation of social workers in low-SES schools. But even so, more social workers in low-SES schools might allow these social workers to not only work with more students but perhaps use more promotion and prevention (tier 1 and tier 2) strategies, which could explain why their greater presence positively affected student achievement in low-SES schools. However, it does not explain why the presence and number of social workers negatively affects higher-achieving student's performance. It might be due to an indirect effect on lower academic expectations on behalf of classroom teachers as an effect of a more network and welfare-based than academically-oriented school climate and support systems; however, this hypothesis requires further exploration.

Third, findings suggest that supporting students academically is naturally dependent on the type of work that psychosocial professionals are hired to do and with which students they are asked to work. In Chilean schools, these professionals are mainly hired through SEP or PIE funds. Whereas, the former provides more voucher support per student to schools that cater to lower-SES students identified as "socioeconomically vulnerable," the latter offers more voucher funding per student officially diagnosed with a disability. Although both allow hiring of psychologists and social workers from the school, SEP's policy does not delimit an exclusive work with students belonging to SEP. On the contrary, PIE policy requires schools to attend to the needs of students with special educational needs previously diagnosed with a specific permanent or transitory disability. In practice, this means that the professionals financed by SEP have more freedom to diagnose, design and implement interventions than the professionals financed by PIE, who are required to develop a specialized diagnosis and develop a more individualized line of intervention. The fact that a higher proportion of psychosocial professionals hired with PIE funds are associated with lower math and language scores may therefore be due to the fact that these professionals are required to provide support exclusively to students with disabilities. In this regard, we suggest that futures studies analyze the impact of PIE-funded psychologists and social workers on students with and without diagnosed disabilities.

Fourth, findings regarding dropout as an indicator of school failure are promising. Schools that hired only psychologists, only social workers, or both (psychosocial pairs) had a reduced probability of students dropping out in the short

and long term compared to schools that had no psychosocial professionals hired. In Chile, eighth grade is the last grade of primary school, and higher rates of school dropout occur between eighth and ninth grades, especially in schools that only provide primary schooling and oblige students to change schools. Similarly, hiring more psychologists and social workers was associated with a reduced likelihood of short- and long-term dropout for eighth-grade students. These are highly important findings that provide scientific evidence supporting public policies aimed at incorporating psychosocial professionals in the regular school system. However, these findings should be taken cautiously, considering evidence that these professionals are mainly performing tier 3 individual interventions with specific students and not implementing multi-tiered whole-school support systems (López et al., 2020).

Given the fact that in developing countries such as Chile, school psychologists and social workers are not required to hold graduate degrees to work in schools, not even professional diplomas related to school interventions, our findings suggest that with proper training on whole-school approaches and evidence-based intervention strategies to adequately meet the demands of the current inclusive educational context, these professionals could provide even more significant, relevant, and culturally sensitive supports for all students, with positive outcomes for students and school systems. Likewise, the lack of a clear intervention model and the emphasis on the development of individual intervention plans which are mandated by policies such as the PIE (Decree No. 170, 2010; Ministerio de Educación, 2016) and offered as suggestions by the SEP guidelines (Ministerio de Educación, 2017), makes it difficult to develop interventions that have an impact on the entire school community. In this aspect, we infer that the development of interventions at a level 1 and 2 can substantially contribute to the improvement of indicators such as performance and school dropout. During the COVID-19 pandemic, a promising venue has been the incorporation of a multi-tiered approach proposed by education researchers in april 2020 (Claro and Mizala, 2020) and later incorporated in the Chilean Ministry of Education's back to school guidelines (Ministerio de Educación, 2020b).

On the other hand, it is necessary to continue investigating the specific mechanisms through which school psychologists and social workers help to reduce dropout rates. Promotion and intervention strategies that support social and emotional learning, foster positive interpersonal relationships, develop a school mental health perspective, and improve school climate have been shown to increase students' sense of belonging to the school and academic and social success. These experiences have been shown to increase students' school commitment and attendance, factors that are critical to decreasing dropout rates (Hoagwood et al., 2007; Pate et al., 2016; Mason and Dye, 2017; Tello and Lonn, 2017; Filippello et al., 2019; Gubbels et al., 2019).

Overall, findings from this study support policies that increase funding for school psychologists and social workers, because their incorporation partly explains better school achievement and less school failure when controlling for individual and school characteristics. However, they highlight the need to further explore the mechanisms through which academic achievement and failure are developed with the support of psychologists and social workers in schools. These professionals, despite focusing most of their actions at level 3, have positive effects on students. This emphasizes the need to reformulate these actions from a whole-school perspective, opening the possibility of developing socioemotional skills in students via the curriculum and with greater participation of classroom teachers in tier 1 interventions (Hoagwood et al., 2007). As Mulhern (2020) and O'Connor (2018) pointed out, adults in the school are indispensable for the construction of a school climate that promotes a better school experience and achievement. However, they require time and space to develop these actions in schools.

In terms of policy and intervention, and to advance at a large scale a more evidence-based, tiered, whole-school approach, we suggest two strategies. First, the design and dissemination of training modules and comprehensive guidelines, particularly in the context of certified diplomas and master's-level training, could gradually be considered requisites for formal professional work in schools by non-teaching professional staff. Second, national or state-level policies should gradually require formal certification of training in school intervention approaches and the improvement of national and state-level datasets—in the case of Chile, the National Record of Educational Assistants—to allow registration of the multi-tiered type of interventions that school psychologists and social workers should be design and implement. This would improve opportunities for large-scale monitoring, follow up, and impact evaluations.

In this regard, a limitation of this study was the lack of a dataset from which to draw inferences regarding the tier or level of interventions developed by these professionals. Therefore, further studies should explore the effects of psychosocial professionals on student outcomes, considering the type of interventions deployed, and the proportion of professionals per school (O'Connor, 2018). Another limitation of the study was its cross-sectional design for the analyses on school achievement, which does not allow identifying causal relations between the study variables. A possible venue for future research is, therefore, to estimate such effects using longitudinal data, which might also allow explore the effects of non-teaching professionals in schools on future student educational outcomes such as entry, permanence, and graduation from higher education (Poynton and Lapan, 2017; O'Connor, 2018; Mulhern, 2020).

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Pontificia Universidad

Católica de Valparaíso. Written informed consent for participation was not required for this study in accordance with the national legislation and the institutional requirements.

AUTHOR CONTRIBUTIONS

All authors listed have made a substantial, direct and intellectual contribution to the work, and approved it for publication.

FUNDING

We declare that all sources of funding received for this research are being submitted. This research was funded by the PIA-ANID CIE160009 and FONDECYT Nr. 1191267 project.

SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpsyg.2021.639089/full#supplementary-material

REFERENCES

Ainscow, M. (2019). *The UNESCO Salamanca Statement 25 Years on Developing Inclusive and Equitable Education Systems. Discussion Paper*. UNESCO. Available online at: https://en.unesco.org/sites/default/files/2019-forum-inclusion-discussion-paper-en.pdf

Almonacid, C. (2000). "Educación y exclusión social: una mirada desde la experiencia educacional chilena [Education and social exclusion: a view from the Chilean educational experience]," in eds P. Gentili and G. Frigotto, *La Ciudadanía Negada. Políticas de Exclusión en la Educación y el Trabajo* [*Citizenship denied. Policies of exclusión in education and work*] (Buenos Aires: CLACSO), 159–165.

Anaya, E. (2019). Calidad educativa como precarización laboral: análisis de América Latina [Educational quality as labor precariousness: Analysis of Latin America]. *Rev. Latinoam. Estud. Educ.* 49, 9–34. doi: 10.48102/rlee.2019.49.2.15

Archambault, I., Janosz, M., Dupéré, V., Brault, M., and McAndrew, M. (2017). Individual, social, and family factors associated with high school dropout among low-SES youth: differential effects as a function of immigrant status. *Br. J. Educ. Psychol.* 87, 456–477. doi: 10.1111/bjep.12159

Arslan, G., and Coşkun, M. (2020). Student subjective wellbeing, school functioning, and psychological adjustment in high school adolescents: and latent variable analysis. *J. Posit. School Psychol.* 4, 153–164. doi: 10.47602/jpsp.v4i2.231

Ascorra, P., and López, V. (Eds.). (2019). *Una Década de Investigación en Convivencia Escolar [A Decade of Research on School Climate]*. Ediciones Universitarias. Available online at: http://www.euv.cl/archivos_pdf/UNADECADADEINVESTIGACION.pdf

Ascorra, P., López, V., Morales, M., Cuadros, O., Cárdenas, K., and Ortiz, S. (2019). *Caracterizar y Fortalecer la Gestión de la Convivencia Escolar en Chile*. Reporte Estudio con Profesionales de Apoyo a Nivel de la Escuela y del Sostenedor [Characterizing and strengthening the management of school climate in Chile. Report from the Study with Support Professionals at the School and Intermediate Level]. Centro de Investigación para la Educación Inclusiva.

Astor, R. A., Benbenishty, R., and Estrada, J. N. (2009). School violence and theoretically atypical schools: the principal's centrality in orchestrating safe schools. *Am. Educ. Res. J.* 46, 423–461. doi: 10.3102/0002831208329598

Ballard, K. L., Sander, M. A., and Klimes-Dougan, B. (2014). School-related and social–emotional outcomes of providing mental health services in schools. *Commun. Ment. Health J.* 50, 145–149. doi: 10.1007/s10597-013-9670-y

Bandura, A. (1982). Self-efficacy mechanism in human agency. *Am. Psychol.* 37, 122–147. doi: 10.1037/0003-066X.37.2.122

Baskin, T. W., Slaten, C. D., Sorenson, C., Glover-Russell, J., and Merson, D. N. (2010). Does youth psychotherapy improve academically related outcomes? a meta-analysis. *J. Counsel. Psychol.* 57, 290–296. doi: 10.1037/a0019652

Bellei, C. (2007). Expansión de la educación privada y mejoramiento de la educación en Chile: Evaluación a partir de la evidencia [Expansion of private schools and educational improvement in Chile: An evidence-based evaluation]. *Rev. Pens. Educ.* 40, 1–37. Available online at: http://pensamientoeducativo.uc.cl/index.php/pel/article/view/408

Boonk, L., Gijselaers, H. J., Ritzen, H., and Brand-Gruwel, S. (2018). A review of the relationship between parental involvement indicators and academic achievement. *Educ. Res. Rev.* 24, 10–30. doi: 10.1016/j.edurev.2018.02.001

Cádiz, J., and Manríquez, L. (2015). Configuración del trabajo interprofesional en psicólogos y trabajadores sociales en establecimientos municipales enmarcados en Ley SEP [Configuration of inter-professional work between school psychologists and social workers in municipal schools working with SEP Law] Undergraduate thesis, Pontificia Universidad Católica de Valparaíso]. *Catálogo Bibliográfico General PUCV*. Available online at: http://opac.pucv.cl/pucv_txt/txt-4000/UCD4083_01.pdf

Cárcamo-Vásquez, H., Jarpa-Arriagada, C., and Castañeda-Díaz, M. (2020). Demandas y desafíos desde la visión de los profesionales que intervienen en las escuelas de la Región de Ñuble [Demands and challenges from the perspective of the professionals involved in the schools of the Ñuble Region]. *Propós. Repres.* 8, 1–16. doi: 10.20511/pyr2020.v8n2.324

Claro, C., and Mizala, A. (2020). Propuestas Educación: Trabajo Interuniversitario Mesa Social COVID 19 [Proposals in Education-, Interuniversity Task Force COVID 19]. *Pontificia Universidad Católica de Chile and Universidad de Chile*. Available online at: https://www.uchile.cl/documentos/propuestas-sobre-educacion-mesa-social-covid-19_163074_0_4342.pdf

Cohen, G. L., Garcia, J., Apfel, N., and Master, A. (2006). Reducing the racial achievement gap: a social-psychological intervention. *Science* 313, 1307–1310. doi: 10.1126/science.1128317

Cohen, J., and Espelage, D. L. (2020). *Feeling Safe in School: Bullying and Violence Prevention around the World*. Cambridge: Harvard Education Press.

Coleman, J. S., Campbell, E. Q., Hobson, C. J., McPartland, F., Mood, A. M., Weinfeld, F. D., et al. (1966). *Equality of Educational Opportunity*. Washington, DC: U.S. Government Printing Office.

Concha, M. (2012). Rol, perfil y espacio profesional del Trabajo Social en el ámbito educativo [Role, profile and professional space of Social Work in the educational field]. *Rev. Cuad. Trab. Soc.* 5, 11–26. Available online at: https://dialnet.unirioja.es/servlet/articulo?codigo=7308381

Decree No. 170 (2010). Fija normas para determinar los alumnos con necesidades educativas especiales que serán beneficiarios de las subvenciones para educación especial [Sets standards for determining which students with special educational needs will be beneficiaries of special education voucher]. *Congreso de la República de Chile*. Available online at: http://bcn.cl/2hryq

Decree No. 83 (2015). Aprueba criterios y orientaciones de adecuación curricular para estudiantes con necesidades educativas especiales de educación parvularia y educación básica [Approves criterion and guidelines for curricular adaptation for students with special educational needs in kindergarten and elementary education]. *Congreso de la República de Chile*. Available online at: http://bcn.cl/2f7b6

Dimmit, C., and Robillard, L. (2014). *Evidence-Based Practices: Pro-Social Skill Development and Violence Prevention in K-8 Schools.* Amherst: Fredrickson Center for School Counseling Outcome Research and Evaluation.

Doll, J. J., Eslami, Z., and Walters, L. (2013). Understanding why students drop out of high school, according to their own reports: are they pushed or pulled, or do they fall out? a comparative analysis of seven nationally representative studies. *Sage Open.* 3:2158244013503834. doi: 10.1177/2158244013503834

Duncan, G. J., and Murnane, R. J. (2011). *Whither Opportunity?* Rising Inequality, Schools, *and Children's Life Chances*. New York, NY: Russell Sage Foundation.

Erausquin, C., and Bur, R. (2013). *Psicólogos en Contextos Educativos: Diez Años de Investigación [Psychologists in Educational* Contexts: *Ten Years of Research]*. Buenos Aires: Proyecto Editorial.

Filippello, P., Buzzai, C., Costa, S., and Sorrenti, L. (2019). School refusal and absenteeism: perception of teacher behaviors, psychological basic needs, and academic achievement. *Front. Psychol.* 10:1471. doi: 10.3389/fpsyg.2019.01471

Franklin, C., Kim, J. S., Beretvas, T. S, Zhang, A., Guz, S., Park, S., et al. (2017). The effectiveness of psychosocial interventions delivered by teachers in schools: a systematic review and meta-analysis. *Clin. Child Fam. Psychol. Rev.* 20, 333–350. doi: 10.1007/s10567-017-0235-4

García-Huidobro, J. (2007). Desigualdad educativa y segmentación del sistema escolar: consideraciones a partir del caso chileno [Educational inequality and school system segmentation: Reflections upon the Chilean case]. *Pens. Educ.* 40, 65–85. Available online at: http://pensamientoeducativo.uc.cl/index.php/pel/article/view/399/817

Gatica, F. (2016). Las intervenciones psicosociales en establecimientos educacionales municipales vulnerables bajo el marco de la Ley SEP [Psychosocial interventions in vulnerable municipal schools under the SEP Law]. *Rev. Estud. Polít. Públicas.* 3, 105–119. doi: 10.5354/0719-6296.2016.41830

Granvik, M., Plenty, S., and Modin, B. (2020). The role of academic achievement in the relationship between school ethos and adolescent distress and aggression: a study of ninth grade students in the segregated school landscape of Stockholm. *J. Youth Adolesc.* doi: 10.1007/s10964-020-01199-w. [Epub ahead of print].

Gubbels, J., Van der Put, C., and Assink, M. (2019). Risk factors for school absenteeism and dropout: a meta-analytic review. *J. Youth Adolesc.* 48, 1637–1667. doi: 10.1007/s10964-019-01072-5

Harris, M. B., and Franklin, C. G. (2003). Effects of a cognitive-behavioral, school-based, group intervention with Mexican American pregnant and parenting adolescents. *Soc. Work Res.* 27, 71–83. doi: 10.1093/swr/27.2.71

Healy, S. R., Valente, Y. J., Caetano, S. C., Martins, S. S., and Sanchez, Z. M. (2020). Worldwide school-based psychosocial interventions and their effect on aggression among elementary school children: a systematic review 2010-2019. *Aggress. Viol. Behav.* 55:101486. doi: 10.1016/j.avb.2020.101486

Henry, L. M., Bryan, J., and Zalaquett, C. P. (2017). The effects of a counselor-led, faith-based, school–family–community partnership on student achievement in a high-poverty urban elementary school. *J. Multicult. Couns. Dev.* 45, 162–182. doi: 10.1002/jmcd.12072

Hernández, R., and Diaz, W. (2017). Consideraciones teóricas y metodológicas para investigar sobre deserción escolar [Theoretical and methodological considerations for research on school dropout]. *Perspectivas* 2, 108–119. doi: 10.22463/25909215.1315

Hoagwood, K. E., Serene Olin, S., Kerker, B. D., Kratochwill, T. R., Crowe, M., and Saka, N. (2007). Empirically based school interventions targeted at academic and mental health functioning. *J. Emot. Behav. Disord.* 15, 66–92. doi: 10.1177/10634266070150020301

Iachini, A., Petiwala, A., and DeHart, D. (2016). Examining adverse childhood experiences among students repeating the ninth grade: implications for school dropout prevention. *Child. Schools* 38, 218–227. doi: 10.1093/cs/cdw029

Jorrat, P., and Rojas, C. (2016). *Interpretando Demandas Laborales Hechas a Psicólogos y Trabajadores en Liceos Adscritos a la Ley SEP [Interpreting labor demands made to psychologists and social workers hired under the SEP Law] (Undergraduate* thesis). Pontificia Universidad Católica de Valparaíso, Catálogo Bibliográfico General PUCV.

Kernsmith, P. D., and Hernandez-Jozefowicz, D. M. (2011). A gender-sensitive peer education program for sexual assault prevention in the schools. *Child. Schools* 33, 146–157. doi: 10.1093/cs/33.3.146

Kuperminc, G., Yi Chan, W., Hale, K., Joseph, H., and Delbasso, C. (2019). *The role of school-based group mentoring in promoting resilience among vulnerable high school students. Am. J. Community Psychol.* 65, 136–48. doi: 10.1002/ajcp.12347

Law Nr. 19.873. (2003). *Crea subvención educacional pro-retención [Creates pro-retention educational voucher]*. Congreso de la República de Chile. Available online at: http://bcn.cl/2l683

Law Nr. 20.248. (2008). *Establece Ley de Subvención Escolar Preferencial [Ley SEP; Establishes the Preferential School Voucher Law]*. Congreso de la República de Chile. Available online at: http://bcn.cl/2f6q4

Lei, H., Cui, Y., and Zhou, W. (2018). Relationships between student engagement and academic achievement: a meta-analysis. *Soc. Behav. Pers.* 46, 517–528. doi: 10.2224/sbp.7054

Liu, J., Peng, P., and Luo, L. (2019). The relation between family socioeconomic status and academic achievement in China: a meta-analysis. *Educ. Psychol. Rev.* 32, 49–76. doi: 10.1007/s10648-019-09494-0

Liu, R., Zhen, R, Ding, Y., Liu, Y., Wang, J., Jiang, R., and Xu, L. (2018). Teacher support and math engagement: roles of academic self-efficacy and positive emotions. *Educ. Psychol.* 38, 3–16. doi: 10.1080/01443410.2017.1359238

López, V., Cárdenas, K., Fernández-Vergara, A., González, L., Palacios, D., Ligueño, S., et al. (2020). *Apoyos psicosociales: Avances y Desafíos de las Duplas Psicosociales SEP [Psychosocial support: Advances and Challenges of the SEP Psychosocial Pairs]*. Manuscript under review. Centro de Investigación para la Educación Inclusiva, Pontificia Universidad Católica de Valparaíso.

López, V., and Carrasco, C. (2018) "El/la psicólogo/a en educación: un análisis desde "lo psicosocial" y la convivencia escolar [the psychologist in education: an analysis from "the psychosocial" and the school climate]," in *Temas en Psicología Educacional: contribuciones para la formación de especialidad [Topics in Educational Psychology: Contributions for specialized training]*, Vol. II, ed F. Leal (Buenos Aires: Noveduc), 113–144.

López, V., Carrasco, C., Morales, M., and Ayala, A. (2011a). El encapsulamiento de los psicólogos escolares y profesionales de apoyo psicosocial en la escuela [The encapsulation of school psychologists and school psychosocial support professionals]. *Rev. Int. Magist.* 53, 54–57. Available online at: http://www.mejoramientoescolar.cl/download.php?file=recursos/El_encapsulamiento_de_los_psicologos_escolares.pdf

López, V., Carrasco, C., Morales, M., Ayala, A., López, J., and Karmy, M. (2011b). Individualizando la violencia escolar: análisis de prácticas discursivas en una escuela municipal de la Región de Valparaíso [*Individualizing school violence: analysis of discursive practices in a municipal school in the Valparaiso Region*]. *Psykhe* 20, 75–91. doi: 10.4067/S0718-22282011000200002

López, V., Oyanedel, J.C., Bilbao, M., Torres, J., Oyarzún, D., Morales, M., et al. (2017). School achievement and performance in Chilean high schools: The mediating role of subjective wellbeing in school-related evaluations. *Front. Psychol.* 8:1189. doi: 10.3389/fpsyg.2017.01189

Masitoh, L. F., and Fitriyani, H. (2018). Improving students' mathematics self-efficacy through problem based learning. *Malikussaleh J. Math. Learn.* 1, 26–30. doi: 10.29103/mjml.v1i1.679

Mason, C. P., and Dye, L. (2017). Attending to basic needs: implementing reality therapy in school counseling programs to enhance academic achievement and career decision-making skills. *Int. J. Choice Theory Reality Ther.* 37, 46–55. Available online at: https://www.wglasserinternational.org/wp-content/uploads/bsk-pdf-manager/IJCTRT_Fall2017_223.pdf#page=46

Matthews, J. S., Ponitz, C. C., and Morrison, F. J. (2009). Early gender differences in self-regulation and academic achievement. *J. Educ. Psychol.* 101, 689–704. doi: 10.1037/a0014240

Ministerio de Educación (MINEDUC). (2016). *Manual de Apoyo a la Inclusión Escolar en el Marco de la Reforma Educacional [Support Manual for School Inclusion in the Framework of Educational Reform]*. División de Educación General MINEDUC. Availbel online at: https://especial.mineduc.cl/wp-content/uploads/sites/31/2016/09/Manual-PIE.leyOK_.web_-1.pdf

Ministerio de Educación (MINEDUC). (2017). *Orientaciones Para la Conformación y Funcionamiento de los Equipos de Convivencia Escolar en la Escuela/Liceo [Guidelines for the Formation and Operation of School Climate Teams in Primary and High Schools]*. División de Educación General MINEDUC. Availbel online at: https://www.mineduc.cl/wp-content/uploads/sites/19/2017/04/convivencia-escolar.pdf

Ministerio de Educación (MINEDUC). (2020a). *Medición de la Exclusión Escolar en Chile [Measuring School Exclusion in Chile]*. Centro de Estudios MINEDUC. Available online at: https://centroestudios.mineduc.cl/wp-content/uploads/sites/100/2020/04/DOCUMENTO-DE-TRABAJO-20_2020_f01.pdf

Ministerio de Educación (MINEDUC). (2020b). *Abrir las Escuelas Paso a Paso. Orientaciones Para Establecimientos Educacionales en Paso 3 y 4 [Re.Opening Schools Step by Step. Guidance for Educational Establishments in Steps 3 and 4]*. MINEDUC. Availbel online at: https://sigamosaprendiendo.mineduc.cl/wp-content/uploads/2020/09/Anexos-AbrirLasEscuelas-1.pdf

Mulhern, C. (2020). *Beyond* Teachers: *Estimating Individual Guidance Counselors' Effects on Educational Attainment*. Working paper.

O'Connor, P. (2018). How school counselors make a world of difference. *Phi Delta Kappan.* 99, 35–39. doi: 10.1177/0031721718767858

Organisation for Economic Cooperation and Development. (2012). *PISA 2012 Results: What Students Know and Can do: Student Performance in* Mathematics, *Reading and Science*. Paris: OECD Publishing.

Organisation for Economic Cooperation and Development. (2016). *Global Competency for an Inclusive World*. Paris: OECD Publishing.

Organisation for Economic Cooperation and Development. (2019). *Education at a Glance 2019: OECD Indicators.* Paris: OECD Publishing.

Parviainen, M., Aunola, K., Torppa, M., Poikkeus, A., and Vasalampi, K. (2020). Symptoms of psychological ill-being and school dropout intentions among upper secondary education students: a person-centered approach. *Learn. Ind. Diff.* 80, 1–11. doi: 10.1016/j.lindif.2020.101853

Pate, C., Maras, M., Whitney, S., and Bradshaw, C. (2016). Exploring psychosocial mechanisms and interactions: links between adolescent emotional distress, school connectedness, and educational achievement. *School Ment. Health.* 9, 28–43. doi: 10.1007/s12310-016-9202-3

Poynton, T. A., and Lapan, R. T. (2017). Aspirations, achievement, and school counselors' impact on the college transition. *J. Couns. Dev.* 95, 369–377. doi: 10.1002/jcad.12152

Prafitriyani, S., Magfirah, I., Amir, N.F., Irmawati, A., and Umanailo, M.C. (2019). Influence of emotional intelligence on mathematics learning outcomes of Class VII Middle School 9 Buru students. *Int. J. Sci. Technol. Res.* 8, 1490–1494. Available online at: http://www.ijstr.org/final-print/oct2019/Influence-Of-Emotional-Intelligence-On-Mathematics-Learning-Outcomes-Of-Class-Vii-Middle-School-9-Buru-Students.pdf

Prieto, M. (2019). Percepciones del profesorado sobre las políticas de aseguramiento de la calidad educativa en Chile [Teachers' perceptions of educational quality assurance policies in Chile]. *Educ. Soc. Camp.* 40, 1–20. doi: 10.1590/es0101-73302019189573

Raczynski, D., Muñoz, G., Weinstein, J., and Pascual, J. (2013). Subvención escolar preferencial (SEP) en Chile: Un intento por equilibrar la macro y micro política escolar [Preferential school subsidy (SEP) in Chile: An attempt to balance macro and micro school policy]. *Rev. Iberoam. Calidad Efic. Cambio Educ.* 11, 164–193. Available online at: http://www.rinace.net/reice/numeros/arts/vol11num2/art8.pdf

Rahmi, S., Nadia, R., Hasibah, B., and Hidayat, W. (2017). The relation between self-efficacy toward math with the math communication competence. *Infinity* 6, 177–182. doi: 10.22460/infinity.v6i2.p177-182

Robison, S., Jaggers, J., Rhodes, J., Blackmon, B., and Church, W. (2017). Correlates of educational success: predictors of school dropout and graduation for urban students in the Deep South. *Child. Youth Serv. Rev.* 73, 37–46. doi: 10.1016/j.childyouth.2016.11.031

Román, M. (2013). Factores asociados al abandono y la deserción escolar en América Latina: una mirada en conjunto [Factors associated with school dropout and dropout in Latin America: an overview]. *Rev. Iberoam. Calidad Efic. Cambio Educ.* 11, 33–59. Available online at: http://www.rinace.net/reice/numeros/arts/vol11num2/art2.pdf

Ruiz, L. D., McMahon, S. D., and Jason, L. A. (2018). The role of neighborhood context and school climate in school-level academic achievement. *Am. J. Community Psychol.* 61, 296–309. doi: 10.1002/ajcp.12234

Sandoval, E., and Lamas, M. (2017). Impacto de la Ley SEP en las escuelas: una mirada crítica y local en torno al rol de los psicólogos de la educación [The impact of the SEP Law in schools: a critical and local look regarding the role of educational psychologists]. *Paideia* 61, 57–81. Available online at: https://revistas.udec.cl/index.php/paideia/article/view/707

Slot, P., Bleses, D. and Jensen, P. (2020) Infants' and Toddlers' language, math and socio-emotional development: evidence for reciprocal relations and differential gender and age effects. *Front. Psychol.* 11:580297. doi: 10.3389/fpsyg.2020.580297

Tello, A., and Lonn, M. (2017). The role of high school and college counselors in supporting the psychosocial and emotional needs of Latinx first-generation college students. *Profess. Couns.* 7, 349–359. doi: 10.15241/amt.7.4.349

Thapa, A., Cohen, J., Guffey, S., and Higgins-D'Alessandro, A. (2013). A review of school climate research. *Rev. Educ. Res.* 83, 357–385. doi: 10.3102/0034654313483907

UNESCO and UNICEF (2007). *A Human Rights-Based Approach to Education for All*. New York, NY: UNESCO-UNICEF.

UNESCO. (2013). *Situación educativa de América Latina y el Caribe: hacia la educación de calidad para todos al 2015 [The State of Education in Latin America and the Caribbean: Towards Quality Education for All by 2015]*. Santiago de Chile: OREALC/UNESCO.

Yeager, D. S., and Walton, G. M. (2011). Social-psychological interventions in education: they're not magic. *Rev. Educ. Res.* 81, 267–301. doi: 10.3102/0034654311405999

Conflict of Interest: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

frontiers in Psychology

ORIGINAL RESEARCH
published: 29 March 2021
doi: 10.3389/fpsyg.2021.635171

The Relations Among Types of Parentification, School Achievement, and Quality of Life in Early Adolescence: An Exploratory Study

Judyta Borchet[1†], Aleksandra Lewandowska-Walter[1†], Piotr Połomski[1†], Aleksandra Peplińska[1†] and Lisa M. Hooper[2†]*

[1]Faculty of Social Sciences, Institute of Psychology, University of Gdańsk, Gdańsk, Poland, [2]Schindler Education Center, Center for Educational Transformation, University of Northern Iowa, Cedar Falls, IA, United States

OPEN ACCESS

Edited by:
Adelinda Araujo Candeias, University of Evora, Portugal

Reviewed by:
Lucyna Bakiera, Adam Mickiewicz University, Poland
Friederike Gerstenberg, Evangelische Hochschule Ludwigsburg, Germany
Raluca Buhas, University of Oradea, Romania

***Correspondence:**
Judyta Borchet
judyta.borchet@ug.edu.pl;
judyta.borchet@gmail.com

†ORCID:
Judyta Borchet
orcid.org/0000-0002-6212-9729
Aleksandra Lewandowska-Walter
orcid.org/0000-0001-9806-6339
Piotr Połomski
orcid.org/0000-0002-5930-0257
Aleksandra Peplińska
orcid.org/0000-0001-6632-038X
Lisa M. Hooper
orcid.org/0000-0002-5493-0110

Specialty section:
This article was submitted to Educational Psychology, a section of the journal Frontiers in Psychology

Received: 29 November 2020
Accepted: 14 January 2021
Published: 29 March 2021

Citation:
Borchet J, Lewandowska-Walter A, Połomski P, Peplińska A and Hooper LM (2021) The Relations Among Types of Parentification, School Achievement, and Quality of Life in Early Adolescence: An Exploratory Study. Front. Psychol. 12:635171. doi: 10.3389/fpsyg.2021.635171

Children who experience parentification may have trouble performing developmental tasks due to being overwhelmed by their family caregiving roles and responsibilities. Past studies have found that parentification is negatively associated with academic achievement. However, most of these studies are limited in that they are retrospective and examine the association but not the mechanisms shaping them. The aim of the study was to explore to what extent diverse types of parentification relate to academic achievement and to what extent these relations are mediated by self-reported quality of life among adolescents. The study sample was composed of Polish early adolescents (N = 191; age: M = 14.61; SD = 1.26). Types of parentification were measured with the Parentification Questionnaire for Youth, and quality of life was assessed with KidScreen27. School achievement was measured based on mean semester grade. We explored the associations among study variables and performed six mediation models in the planned analyses. Overall, bivariate relations were significant in a theoretically expected way, although the effect sizes for these associations were rather small. In the mediation analyses, the results showed that four of the six models were not significant. Different from previous studies, instrumental parentification was positively related to school achievement. Additionally, this positive association was mediated by adolescents' general quality of life. Taken together, the findings were similar and different from the empirical literature base on types of parentification and select outcomes.

Keywords: school achievement, school grades, instrumental parentification, current parentification, quality of life, adolescence

INTRODUCTION

The term parentification describes the family structure when a child is placed in a parental role toward the parent(s) (Boszormenyi-Nagy and Spark, 1973; Haxhe, 2016). Carrying out parental duties by children is often highly challenging in particular when the level of family stress is high. Children also may serve other adult-like roles such as raising siblings, caring for other family members, and performing roles and tasks at a level that often exceeds the child's age, abilities, and resources (Hooper et al., 2011a). The phenomenon of parentification is most

often considered in the context of family development and the consequences of burdening children with age-inappropriate tasks implicated in their current and later development (Jurkovic, 1997; Kerig, 2005). On the other hand, there is a body of research that suggests that when a child is parentified, the resulting caregiving responsibilities may lead to an increase in maturity and the positive competences (Hooper, 2007; Kuperminc et al., 2013; Chee et al., 2014). The competence at cost template suggests the complexity of the process of parentification and the related outcomes can have both a positive and a negative impact on children's development (Hetherington, 1999).

Thus, parentification in the family may be related to the neglect of the child's individual and relational and bonding needs with the parent (Wasilewska and Kuleta, 2014) and serve as a benefit to the child or adolescent in various areas of functioning, including school achievement (Chase et al., 1998). Several clinical and theoretical models describe these dichotomous outcomes (see Hooper, 2017). According to some clinical models, the burden on the child is that the parent ceases to act as a regulator of the family system and the child's instrumental and emotional life. Through the abdication of the parent role, children are forced to try to manage, regulate, and stabilize the family system, robbing the children of the ability to focus on and use their resources for their development.

Parentification has also been explained through the prism of resiliency (Hooper et al., 2008; Macfie et al., 2015). According to the theory of resilience, when some of the family caregiving duties carried out by children do not exceed their developmental capabilities, the process of role reversal may engender the child's growth and positive outcomes. Research and clinical models suggest that the condition for positive outcomes of parentification for many children will, however, be contingent upon the parent's recognition and appreciation for the family caregiving tasks performed (Jurkovic, 1997; Schier, 2014). Also, the positive consequences of parentification may be present in some areas of life and development while coexisting with negative ones (e.g., the adolescent may be mature, socially developed, but have problems managing her or his emotions).

The results of an increasing number of studies also indicate the benefits that can emerge when children engage in some caregiving responsibilities—even parental responsibilities—when these roles and responsibilities are acknowledged, appreciated, and valued by the adults in the family system. These benefits include an increase in relational competences when the child supports the parent emotionally and instrumentally, an increase in individuation and differentiation in immigrant families (Walsh et al., 2006), and psychosocial adaptation (McMahon and Luthar, 2007). These benefits are often differentiated by the type of parentification or caregiving responsibilities. The accumulated research has shown that instrumental parentification may promote a child's competence, self-efficacy, and skills. In one study role reversal, in which adolescents instrumentally supported their parent, it contributed to their growth and self-efficacy (Mayseless et al., 2004).

Parentification is a culture-immersed phenomenon, meaning some of its antecedents, outcomes, perception, and measurement may vary across cultures (e.g., East, 2010; Gilford and Reynolds, 2010; Kuperminc et al., 2013). Therefore, international studies on parentification are highly needed (Hooper, 2014). The current study focuses on young Polish adolescents and academic achievement. Specifically, we examine how types of parentification are related to academic achievement. In order to understand this relation in the broad context of the adolescent's situation, we examine the extent to which quality of life mediates the association.

Parentification often means that children are placed in the role of serving as a primary caregiver for the family system and its members. This can mean that the children and adolescents engage in various responsibilities and roles toward some (parents) or all of the family members. The tasks of parentified children and adolescents are developmentally inappropriate or excessive to the extent that enables them to perform their own developmental tasks (Hooper et al., 2011a).

Parentification is often differentiated by the type of caregiving activities (Jurkovic, 1997) and to whom the caregiving activities are directed (Hooper, 2009; Hooper et al., 2011b). This distinction helps to categorize the tasks that parentified children perform. Instrumental parentification consists of children performing parent-like household duties and helping care for—and in some cases raise—their siblings (Kościelska, 2007; Schier, 2014). Those may include, for example, managing family finances, earning money for the family, preparing meals, or cleaning. Instrumental parentification of adolescents may not be as easy to notice as it is in the case of younger children. The boundary between what is a fair duty that comes with age and expressive burden may not be that obvious. Therefore, it is important to remember that parentification is not only about the tasks themselves that the adolescents perform, but the fact that it is a stable pattern in their relationships with the parents and it is related to inverted family hierarchy and blurred boundaries between family members (Kerig, 2005). In this view, the housework related to parentification is not only a physical task and a duty, it is also a part of family loyalty (Byng-Hall, 2008; Haxhe, 2016).

Emotional parentification is primarily associated with the children fulfilling the emotional and social needs of their guardians (Byng-Hall, 2002, 2008; Peris et al., 2008; Schier, 2014). With this type of parentification, children can act as confidants, comforters or mediators. Both emotional and instrumental parentification are not exclusive and may coexist on various levels (Schier et al., 2015). Studies indicate that emotional parentification may be more deleterious and destructive than instrumental parentification (McMahon and Luthar, 2007; Tompkins, 2007; Byng-Hall, 2008). Ohntrup et al. (2011) contended emotional parentification is more severe because it is less explicit, overt, or possibly harder to detect than instrumental parentification. Additionally, the correlates and outcomes evidenced for these types of parentification may be different. The theoretical and empirical literature describes that instrumental parentification is not always a burden for the child, and later the adult, if the child's contribution to family life is revealed, temporary, named, and positively assessed by the environment (Jurkovic, 1997; McMahon and Luthar, 2007; Hooper et al., 2008).

Children who are placed at risk for experiencing parentification typically encounter similar family structures and have parents

and siblings diagnosed with physical and mental health disorders (Macfie and Swan, 2009). For example, family structures and parent hardships may include marital conflict (Peris et al., 2008), divorce (Wallerstein, 1985; Byng-Hall, 2008), substance abuse (Pasternak and Schier, 2014; Tedgård et al., 2019), economic hardship (Montalvo et al., 1967; Boszormenyi-Nagy and Spark, 1973), economic success (Winton, 2003), and immigrant status (Kuperminc et al., 2013; Toro et al., 2019).

Due to the complexity of the parentification process and the fact that it is embedded in culture, it is not surprising that studies present both a negative and a positive impact on children's development and well-being. Studies show that among the negative consequences of parentification are depression, increased levels of anxiety, propensity for risky behaviors associated with stimulants, as well as eating disorders and personality disorders of the borderline and dissociation type (Cicchetti, 2004; Hooper et al., 2011a; Jankowski et al., 2013; Obsuth et al., 2014). Although there is a lack of research indicating a direct association between current parentification and school achievement, it can be assumed on the basis of the literature that children who present with developmental challenges may have problems with learning. Additionally, it could be that these children may be living in a family context where parentification exists. On the other hand, constructive parentification may help adolescents learn efficient task management and thus facilitate school achievement or shape tendencies for compulsive overworking to fulfill tasks at home and school. Moreover, culture-specific factors may shape the relation between parentification and its bimodal outcomes (e.g., Gilford and Reynolds, 2010; Kuperminc et al., 2013; Burton et al., 2018).

While there are a lack of studies investigating the direct relationship between an adolescent's general quality of life and parentification, there are studies on parentification in association with constructs that are similar or related to the quality of life (e.g., well-being, life satisfaction, and positive and negative affect). Parenting behavior, including parentification, may predict family member's well-being (Burton et al., 2018). Parentification is generally negatively related to well-being, but those relations can be differentiated by the type of parentification. Parent-focused and sibling-focused parentification are negatively related to well-being while perceived benefits of parentification present positive association with satisfaction with life (Hooper et al., 2014). Moreover, negative indicators of emotional well-being were found to be linked to both emotional and instrumental parentification in the sample of Polish 16-year-olds (i.e., anger and depressive mood, no correlation with positive mood; Żarczyńska-Hyla et al., 2019). Including quality of life in studies on parentification can help contextualize the results and investigate bimodal consequences of parentification (see the study on parentification, psychopathology, and well-being; Hooper et al., 2014).

Parentification may have relevance to academic achievement too. Parents may burden their children with meeting their high expectations for academic achievement and success (Winton, 2003; Haxhe, 2016). In this case, parentification is often emotional in its nature, as the child appeases the parent by satisfying her or his unmet need for achievement (Winton, 2003). Emotional parentification is often more difficult to detect, and similar to other role reversal situations, parentification can have short- and long-term consequences for the development of the child (Chase et al., 1998). Experiencing parentification, for example, caregiving for a parent who is disabled, substance-dependent, or experiencing a medical or emotional crisis is a very difficult situation for children and thus they often feel shame, isolation, and stigma. This may result in "secret keeping" related to parentification and family functioning, which in turn could prevent children from talking to anyone about what is happening in the family. Such conviction leads to the inability to seek help from people other than family members (Tedgård et al., 2019).

Although there is evidence of the association between parentification and outcomes over the course of a child's lifespan, there is a lack of research on the consequences of the adult task load on the functioning of the child in school (see, for review, Macfie et al., 2015). While investigating the consequences of parent-child role reversal on child and adolescent development at its various stages, problems with learning and peer relationships occurred most often at the school age (Macfie et al., 2015). Studies by Baldwin and colleagues (Baldwin et al., 1982) show that an imbalance in parent-child relationships is associated with lower level of academic competence (as measured by teacher's and parent's assessment) among youth. They contend that the imbalance where there is clear dominance of the child in the parent-child relationship is similar to role reversal seen in parentification. Research on adolescents taking care of parents diagnosed with various mental disorders showed that one-fifth of these adolescents present with school-related problems (Dearden and Becker, 2004), and half of them report difficulties with homework (Thomas et al., 2003). Other studies found that the impact of an imbalance in parent-child relationships on grades can also be observed (e.g., an association between poor grades and the length of time children were caregivers for parents; Cree, 2003). The author explains the results of the study, stating that a child caring for a sick parent has no time for other activities, including homework, and does not receive support from the parent in preparing homework.

One of the few studies in which a direct negative association between parentification and academic outcomes was carried out by Chase et al. (1998). They found that fulfilling the parental role by a child may disrupt the course of high school education and later result in lower academic outcomes among college students. The study, however, was limited in that it required emerging adults to recall their parentification experience retrospectively. Additionally, parentification was measured by a single score (i.e., no measure of the types of parentification). On the other hand, a study by Gilford and Reynolds (2010) showed that Black American emerging adults who grew up in single-parent households and with a history of instrumental and emotional parentification were successful in college and demonstrated a positive outlook, strength, and resilience. Many of the interviewed women were able to use the difficulties from their childhood to motivate themselves to complete college and to pass that motivation and inspiration onto their siblings (Gilford and Reynolds, 2010).

In the Polish cultural context, there is one recent study (Żarczyńska-Hyla et al., 2019) that examined whether Polish

adolescents attending different types of schools have different experiences related to the burden of reversing the roles in the family. Results in this study found no differences in emotional and instrumental parentification and study outcomes, although young people attending vocational schools perceived their situation in the family as being more unfair in terms of the burden of tasks and responsibilities of adults as compared to young people attending other types of schools (technical secondary school, high school). The results are difficult to interpret; however, the authors suggest that parentification experienced in the family may be associated with the choice of school by young people. Young people choosing vocational schools, due to their family situation, could receive less support from their parents in school education and choose at the next stage the apprenticeship, with the possibility of starting full-time work at the age of approximately 18 years (vocational schools in Poland are the last stage of education, usually without the possibility of continuing higher education).

School learning is a task that requires an appropriate level of development—not only cognitive—but also emotional and social. School problems may be a symptom presented by the child as a family delegate, pointing toward other difficulties derived from the functioning of the family as a system (Chase et al., 1998). Effective functioning at school requires children to focus on themselves and school tasks. Consistent parental support aids in this learning context and process. Unfortunately, the resources of parentified children are invested in and directed toward meeting the needs of others: family members, parents, and siblings (Chase et al., 1998; Siskowski, 2006). Children affected by parentification may show deficits in various areas of development, to varying degrees of severity, depending on whether they performed instrumental tasks and emotional tasks, support their parents and siblings, or satisfy their need for success. On the other hand, they may present with confidence, resilience, and high-level task management and coping skills. Instead of underachieving at school, parentified children and adolescents may do well at school and experience depression, anxiety, and low well-being. Therefore, the studied relations between parentification characteristics and school achievement have been put into the broad context of adolescent's general quality of life. Thus, the aim of the study was to explore the relation between types of parentification and school achievement and the extent to which quality of life mediates the association.

MATERIALS AND METHODS

Procedure

Prior to beginning the study, the approval from the University's IRB was received. The study was conducted during the 2017/2018 school year (September to November). There were two public schools invited to join the study. These schools have participated in a broader research project conducted by the University of Gdańsk and the school's administration and teachers offered their assistance with the recruitment and administration phases of the study. The teachers helped to administer the informed consent forms to students' parents or legal guardians. Prior to the administration of the survey, adolescents provided their informed assent for the study. After a brief introduction, the students completed paper-and-pencil questionnaires during one of their classes. The study procedures lasted approximately 25–30 min. After the students completed the survey, they were thanked for their participation.

Participants

The study was performed in two public schools located in two districts of the city of Gdańsk, Poland. There were 191 adolescents who participated in the study. Every class member was invited to join the study but only the students whose parents provided consent and had siblings participated. Girls constituted 55% (n = 105) of the sample, boys 44.5% (n = 85), and 0.5% (n = 1) of the study participants did not provide information on their gender. The participants were aged 12–18 years old, with a median of 14 (M = 14.61; SD = 1.26). All of the participants had siblings and 90.1% of them lived with both their parents. The participants were diverse based on their socioeconomic background. On a scale from 1 to 10, the mean family socioeconomic status was M = 6.6; SD = 1.68.

Measures

The study administered two questionnaires (PQY-Parentification Questionnaire for Youth, Borchet et al., 2020a; Polish version of KidScreen-27, Mazur et al., 2008) and a demographic information sheet.

Demographic Information Sheet

The demographic information sheet asked participants to respond to several questions about their background. We collected information about the participant's gender (considered bivariate: female/male) and age (considered continuously). Information about their families such as socioeconomic status (SES) and family structure was also captured in the demographic sheet. Response options for family SES used a Cantril ladder ranging from 1 (*the poorest families in Poland*) to 10 (*the richest families in Poland*). The participants were also asked about their family structure (i.e., living with both parents, living with mother; living with father, living with a mother and her partner, living with a father and his partner). Students also reported information about their last school year's final mean grade.

Parentification

Parentification Questionnaire for Youth (PQY; Borchet et al., 2020a) is a measure developed for adolescents that captures the multidimensional nature of parentification. The questionnaire consists of 26 items rated on a 1 (*never true*)- to 5 (*always true*)-point Likert-type scale. The scale consists of four subscales (emotional parentification toward parents, instrumental parentification toward parents, sense of injustice, and satisfaction with the role) and two subscales for adolescents who have siblings (i.e., instrumental parentification toward siblings and emotional parentification toward siblings). Scores are calculated as the mean of the ratings for the subscale items.

The questionnaire does not provide a total score (Borchet et al., 2020a). Reliability for the subscale scores was sound (i.e., Cronbach's α from 0.70 to 0.80).

School Achievement

This variable was operationalized as arithmetical mean grade for all the final grades obtained in all the subjects at the end of the former school year (it is reported on their yearly certificate of class completion). Grades that students can get in Poland vary from 1 to 6, with 6 being the best grade possible and 2 is the lowest grade that allows passing a class. In our sample, the mean grade varied from 2 to 6, with a median of 4.52 (M = 4.47; SD = 0.79). The mean final grades were student self-reported. The current study used mean final grades from the 2016/2017 school year.

Quality of Life

To assess the student's overall perception of their lives, the Polish adaptation of KidScreen-27 was used (Mazur et al., 2008). It is a health-related quality of life measure that was developed in 13 countries by the KIDSCREEN Research Group (Robitail et al., 2007). The scale consists of 27 items referring rated from 1 to 5, with 1 meaning "*never*" and 5 meaning "*always*." The KidScreen-27 measures five dimensions of quality of life, which are physical well-being, psychological well-being, parent relationships and autonomy, social support and peers, and school environment. The scale provides a total score that is generated by summing up all item responses (see Berman et al., 2016). The reliability coefficient for the quality of life total score was sound (Cronbach's α = 0.777).

Data Analytic Procedures

In order to explore the association between types of parentification and school achievement, and the mediating role of the quality of one's own life in this relation, an analysis of direct and indirect effects in SEM models was carried out using the Amos 25 package. Model fit was judged using the comparative fit index (CFI), goodness-of-fit index (GFI), chi-square value (CMIN), as well as root mean square error of approximation (RMSEA). With respect to the fit indices, GFI and CFI values greater than 0.90 were considered as well-fitted (Konarski, 2010). RMSEA values lower than or equal to 0.08 indicate acceptable fit (Hu and Bentler, 1999). Ideally, CMIN would be statistically insignificant, but this value is sensitive to the sample size (Konarski, 2010). Full mediation was recognized consistent with Baron and Kenny's (1986) criteria.

RESULTS

Descriptive results, Pearson correlations between variables, and the reliability of the measures were assessed with Statistical Package for Social Science (SPSS) 24. They are presented in **Table 1**.

Zero-Order Correlation Analysis

The correlation matrix (see **Table 1**) revealed statistically significant associations between school achievement, quality of life (r = 0.17, p < 0.05), and most of the PQY subscales, although the effect sizes of these associations were low. Instrumental parentification toward parents (r = 0.18, p < 0.05), instrumental parentification toward siblings (r = 0.21, p < 0.01), and satisfaction with family role (r = 0.17, p < 0.05) were positively related to school achievement. Sense of injustice was negatively related to school achievement (r = −0.16, p < 0.05). Emotional parentification, neither focused on the parents nor focused on the siblings, was associated with school achievement. Quality of life was positively related to satisfaction with the family role (r = 0.65, p < 0.01) and negatively associated with sense of injustice (r = −0.53, p < 0.01).

Mediation Analyses

Six mediation models were tested, with school achievement serving as the dependent variable, quality of life was the mediator, and one of the six parentification dimensions served the role of the independent variable. The results showed acceptable fitted and interpretable models in two cases related to instrumental parentification. Four of the six tested models did not present satisfactory model fit (see **Table 2**). The analysis revealed that the level of instrumental parentification toward both parents (B = 0.15, p = 0.001) and siblings (B = 0.19, p = 0.001) was significantly positively related to school achievement.

TABLE 1 | Summary statistics and correlations between study variables (N = 191).

Variable	*M*	*SD*	Min	Max	*K-S*	α	1	2	3	4	5	6	7	8
SA	4.47	0.79	2.00	6.00	0.064	-	1							
QoL	93.59	17.03	37.00	130.00	0.052	0.777	0.172*	1						
IPTP	2.74	0.80	1.00	5.00	0.083**	0.710	0.176*	0.209*	1					
EPTP	1.82	0.62	1.00	3.75	0.156**	0.692	–0.070	–0.010	0.228**	1				
SI	2.16	0.92	1.00	4.60	0.135**	0.803	–0.160*	–0.528**	–0.228**	0.098	1			
SWR	3.43	0.93	1.00	5.00	0.095**	0.756	0.173*	0.649**	0.398**	0.033	–0.602**	1		
IPTS	2.45	0.89	1.00	5.00	0.089**	0.700	0.206**	0.156*	0.411**	0.240**	–0.001	0.282**	1	
EPTS	2.25	0.79	1.00	4.50	0.134**	0.767	0.138	0.138	0.250**	0.311**	0.072	0.225**	0.611**	1

*SA, school achievement; QoL, quality of life; IPTP, instrumental parentification toward parents; EPTP, emotional parentification toward parents; SI, sense of injustice; SWR, satisfaction with the role (played in the family system); IPTS, instrumental parentification toward siblings; EPTS, emotional parentification toward siblings; K-S, Kolmogorov-Smirnov test; α, Cronbach's alpha coefficient; *p < 0.05; **p < 0.01.*

TABLE 2 | Model fits for tested mediation models by the independent variable.

Independent variable	CMIN	RMSEA	GFI	CFI
IPTP	**110.751 (39), p = 0.01**	**0.071, p = 0.017**	**0.925**	**0.879**
EPTP	101.388 (39), p = 0.00	0.091, p = 0.001	0.919	0.889
SWR	129.963 (39), p = 0.00	0.089, p = 0.001	0.910	0.884
SI	190.613 (39), p = 0.00	0.101, p = 0.001	0.869	0.803
IPTS	**140.731 (39), p = 0.01**	**0.083, p = 0.020**	**0.910**	**0.836**
EPTS	142.488 (39), p = 0.00	0.095, p = 0.001	0.907	0.830

IPTP, instrumental parentification toward parents; EPTP, emotional parentification toward parents; SWR, satisfaction with the role (played in the family system); SI, sense of injustice; IPTS, instrumental parentification toward siblings; EPTS, emotional parentification toward siblings. Bold values stand for well-fitted models.

When quality of life was added to these two models, the relation between instrumental parentification, both toward parents and siblings, and academic achievement was statistically insignificant (see **Figures 1, 2**). The analyses of direct and indirect effects for both models indicated full mediation (Baron and Kenny, 1986; see **Table 3**).

DISCUSSION

The study aimed to explore the relation between parentification and school achievement in the context of adolescent's quality of life. First, we explored bivariate relations between study variables.

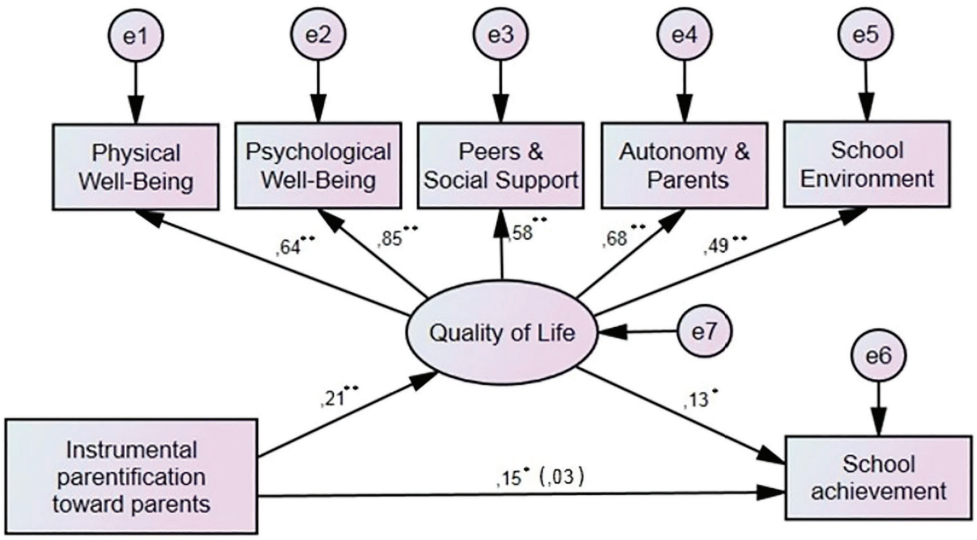

FIGURE 1 | The mediating effect of quality of life on the relation between instrumental parentification toward parents and school achievement. *p < 0.05; **p < 0.01.

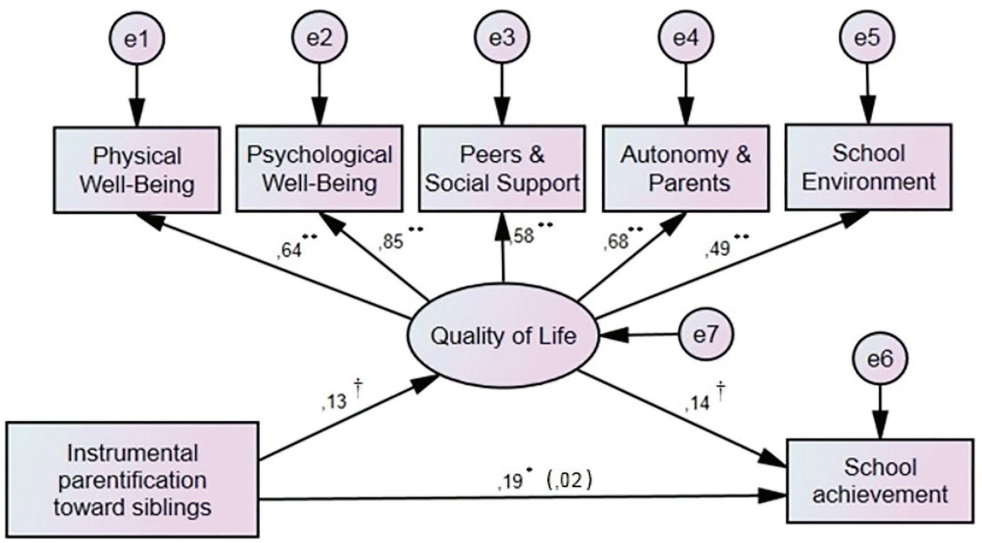

FIGURE 2 | The mediating effect of quality of life on the relation between instrumental parentification toward siblings and school achievement. *p < 0.05; **p < 0.01; †p < 0.1.

TABLE 3 | Direct and indirect effect in the tested mediation models.

Hypothesis	Direct effect	Indirect effect	Results
IPTP -> QoL -> SA	0.148*	0.03	Full mediation
IPTS -> QoL -> SA	0.187*	0.02	Full mediation

*SA, school achievement; QoL, quality of life; IPTP, instrumental parentification toward parents; IPTS, instrumental parentification toward siblings. *$p < 0.05$.*

Second, we performed mediation analyses. The study results indicated that among the six tested mediation models, only two of them were well-fitted and interpretable (i.e., models with instrumental parentification toward parents and instrumental parentification toward siblings as independent variables). Two important findings emerge from this study: (a) instrumental parentification toward parents and instrumental parentification toward siblings were positively related to school achievement and (b) these relations were mediated by adolescent's general quality of life. Not surprisingly, as instrumental parentification can lead to positive outcomes, in our sample, it was positively related to school achievement. Moreover, a positive opinion about one's life and its aspects, along with the circumstances of high level of instrumental parentification toward parents and siblings, may contribute to better fulfillment of other instrumental tasks such as educational tasks and outcomes. From the experience of instrumental parentification, the adolescents could have learned abilities useful at school such as how to manage their tasks effectively, shape task-oriented coping strategies (Hooper et al., 2008; Thastum et al., 2008), and build their self-efficacy (Mayseless et al., 2004).

The current findings are in line with the idea that one risk factor may not be destabilizing enough for the occurrence of any disturbance in the functioning of an individual. It is rather the coexistence of several risk factors that can cause maladjustment. For example, it has been shown that the action of one or two risk factors has a slightly negative effect on one's functioning, while when three or more factors are operating, the impact is already significant (Kumpfer, 1999; Masten and Powell, 2003; Greenberg, 2006). Additionally, according to Rutter (1987), the occurrence of both risk and protective factors is more related to turning points in human life than to factors as such. In other words, it is more important which processes are triggered by a certain risk factor than that factor itself. Nevertheless, the authors of the research on positive adaptation point out that the lack of disturbances at the behavioral level does not mean freedom from problems related to mental health (Luthar et al., 2000; Luthar and Zelazo, 2003). The results of some studies show that adults who coped with adversities in childhood and successfully function in social roles in adulthood are not fully happy and satisfied with their lives (Luthar and Zigler, 1991). It can be presumed that adolescents who perceive their life negatively may also experience additional adversities other than instrumental parentification that can disrupt their development and school achievement (e.g., bullying, low self-esteem). The instrumentally parentified adolescents that took part in the study achieved well at school, but their success still may be a competence gained at the cost of other domains (see Hetherington, 1999). Both Jurkovic (1997) and Winton (2003) contend children and adolescents who experience parentification may present tendencies for overachieving, workaholism, and perfectionism, and those positive outcomes could mask the negative outcomes or go underreported.

Our study did not support the previous findings indicating that emotional parentification is negatively related to school achievement (see Chase et al., 1998; Siskowski, 2006; East, 2010). The lack of this effect may stem from the sample characteristics (i.e., urban and high SES). First, the family SES in the studied sample was rather high. Second, the mean scores achieved in the subscales emotional parentification toward parents and emotional parentification toward siblings were low. Also, the emotional parentification toward parents had a lower score range than other parentification variables. Therefore, students that took part in this study could have been specific and come from families where the level of emotional parentification was rather low. On the other hand, the level of emotional parentification could have been underreported in this sample [e.g., due to adolescents' defense mechanisms aimed to present a positive image of the parent despite the adversities (see Schier et al., 2015)]. The underreporting of emotional parentification in this sample could also be rooted in the culture. Polish culture holds a significant power distance, also in terms of family hierarchy and loyalty (Hofstede et al., 2010). Combined with the tendency to keep family problems in the close circle of relatives in order to protect family reputation, along with reluctance to report family violence (Ipsos Loyalty, 2014), those may be factors that decrease the Polish adolescent's willingness to share their emotional parentification experience.

Similar to previous studies, the sense of injustice, as well as the satisfaction with the family role, showed associations with adolescents' school achievement. The more the adolescents perceived their family roles as unfair, the worse grades at school they had (comp., Jurkovic et al., 2005). Accordingly, the more they were satisfied with their family role, the more school achievement they had (comp., Burton et al., 2018).

Limitations and Future Directions

The findings of this study have to be seen in the light of some limitations. First, the study employed cross-sectional assessment. To address this limitation, it is important to carry out similar studies, including a longitudinal study in the future. This would enable clarification if, while growing up, the instrumentally parentified adolescents who perceive their lives positively are able to have positive school achievements over time. Typically, as youth age, adolescents are assigned more tasks, responsibilities, and developmental roles related to their age. Another design limitation is the fact that the information about last semester's mean school grade could have been distorted in some cases due to the fact that it was self-reported by the participants. Future studies could employ more objective source of information on the school achievement (e.g., retrieve them from the school archives). Also, adding additional informants to the study (e.g., headteachers' assessments) might have given more insight into the child's school performance (see Bauer et al., 2013). The sample might have been biased. Specifically, the study participants lived in the big city of Gdańsk (as measured by Statistics Poland, 2019).

Future studies on the effect of current parentification on adolescents' life should also include the participants of various backgrounds, for example, rural (see American study by Hooper et al., 2012), as well as living in small towns and middle-sized cities and family SES-diverse. That would increase the generalizability of the findings on the broad population of Polish adolescents as almost 40% of the total Polish population lives in rural areas (World Bank, World Development Indicators, 2019). Moreover, controlling for parental employment status (e.g., full time, part time, and more than full time) could provide important insight into the studies on instrumental parentification, as parents working long hours is one of the factors that may put their children in charge of the house (see Schier, 2014). This factor could have been very relevant to our sample as the participants came from rather high-SES families where parents could have been highly engaged in their careers and often absent from home. Therefore, their children could be in charge of many house chores. Also, it would be interesting to consider the adolescent's motives for achieving good grades in future studies, for example, whether it was self-motivated, aimed to impress others or satisfy parent's needs (see Winton, 2003; Haxhe, 2016). Another study limitation may be related to the use of a measure in a state of its infancy. Further studies should examine how does the PQY (Borchet et al., 2020a) act in various samples in order to make sure if future refinement of the questionnaire may be beneficial.

CONCLUSION

The current study casts new light into the studies on the current experience of parentification in Polish adolescents. In contrast to the previous studies (Chase et al., 1998; Siskowski, 2006), the level of instrumental parentification was positively related to academic achievement. Associations with school achievement were also observed for the sense of injustice and the satisfaction with family role, which underlines the importance of how adolescents perceive one's family role in the outcomes of parentification. Surprisingly, emotional parentification was not related to school achievement. We believe that the relation between parentification dimensions and school achievement seems to be complex and should be interpreted with caution and in a broader context (e.g., quality of life and adolescent's motivation for school achievement). This result underlines how important it is for the parentified children and adolescents to belong to environments facilitating their development and to be satisfied with at least some areas of their lives. Those can enable them to perceive their situation positively and foster their development, also in the context of school achievement, despite the task overload and adversities they face at the family home. This buffering role may be served, for example, by the adolescent's good health condition, the school environment, friends, hobbies, and sibling relationships or other family ties (see Chee et al., 2014; Borchet et al., 2020b).

DATA AVAILABILITY STATEMENT

The datasets generated for this study are available on request to the corresponding author.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Komisja Etyki ds. Projektów Badawczych przy Instytucie Psychologii UG. Written informed consent to participate in this study was provided by the participants' legal guardian/next of kin.

AUTHOR CONTRIBUTIONS

JB designed and executed the study. AL-W collaborated with the design of the study. JB and AL-W wrote the manuscript. LH reviewed, revised, and edited the manuscript. PP analyzed the data. AP collaborated with editing of the manuscript. All authors contributed to the article and approved the submitted version.

FUNDING

One of the co-authors received support and funding to conduct this work. JB was financed by the doctoral scholarship from the Polish National Science Centre (Narodowe Centrum Nauki); project number 2019/32/T/HS6/00084.

ACKNOWLEDGMENTS

This work was supported by the Center for Educational Transformation at the University of Northern Iowa, United States.

REFERENCES

Baldwin, A. L., Cole, R. E., Baldwin, C. P., Fisher, L., Harder, D. W., and Kokes, R. F. (1982). The role of family interaction in mediating the effect of parental pathology upon the school functioning of the child. *Monogr. Soc. Res. Child Dev.* 47, 72–80. doi: 10.2307/1166031

Baron, R. M., and Kenny, D. A. (1986). The moderator-mediator variable distinction in social psychological research: conceptual, strategic and statistical considerations. *J. Pers. Soc. Psychol.* 51, 1173–1182. doi: 10.1037/0022-3514.51.6.1173

Bauer, D. J., Howard, A. L., Baldasaro, R. E., Curran, P. J., Hussong, A. M., Chassin, L., et al. (2013). A trifactor model for integrating ratings across multiple informants. *Psychol. Methods* 18, 475–493. doi: 10.1037/a0032475

Berman, A. H., Liu, B., Ullman, S., Jadbäck, I., and Engström, K. (2016). Children's quality of life based on the KIDSCREEN-27: child self-report, parent ratings and child-parent agreement in a Swedish random population sample. *PLoS One* 11:e0150545. doi: 10.1371/journal.pone.0150545

Borchet, J., Lewandowska-Walter, A., Połomski, P., and Peplińska, A. (2020a). Construction of a parentification questionnaire for youth. *Health Psychol. Rep.* 8, 175–188. doi: 10.5114/hpr.2019.89492

Borchet, J., Lewandowska-Walter, A., Połomski, P., Peplińska, A., and Hooper, L. M. (2020b). We are in this together: retrospective parentification, sibling relationships, and self-esteem. *J. Child Fam. Stud.* 29, 2982–2991. doi: 10.1007/s10826-020-01723-3

Boszormenyi-Nagy, I., and Spark, G. (1973). *Invisible loyalties: Reciprocity in intergenerational family therapy*. New York, NY: Harper and Row.

Burton, S., Hooper, L. M., Tomek, S., Cauley, B., Washington, A., and Pössel, P. (2018). The mediating effects of parentification on the relation between parenting behavior and well-being and depressive symptoms in early adolescents. *J. Child Fam. Stud.* 27, 4044–4059. doi: 10.1007/s10826-018-1215-0

Byng-Hall, J. (2002). Relieving parentified children's burdens in families with insecure attachment patterns. *Fam. Process* 41, 375–388. doi: 10.1111/j.1545-5300.2002.41307.x

Byng-Hall, J. (2008). The significance of children fulfilling parental roles: implications for family therapy. *J. Fam. Ther.* 30, 147–162. doi: 10.1111/j.1467-6427.2008.00423.x

Chase, N. D., Deming, M. P., and Wells, M. C. (1998). Parentification, parental alcoholism, and academic status among young adults. *Am. J. Fam. Ther.* 26, 105–114. doi: 10.1080/01926189808251091

Chee, L. P., Goh, E. C. L., and Kuczynski, L. (2014). Oversized loads: child parentification in low-income families and underlying parent–child dynamics. *Fam. Soc.* 95, 204–212. doi: 10.1606/1044-3894.2014.95.26

Cicchetti, D. (2004). An odyssey of discovery: lessons learned through three decades of research on child maltreatment. *Am. Psychol.* 59, 731–741. doi: 10.1037/0003-066X.59.8.731

Cree, V. E. (2003). Worries and problems of young carers: issues for mental health. *Child and Fam. Soc. Work* 8, 301–309. doi: 10.1046/j.1365-2206.2003.00292.x

Dearden, C., and Becker, S. (2004). *Young carers in the UK: The 2004 report*. London: Carers UK.

East, P. L. (2010). Children's provision of family caregiving: benefit or burden? *Child Dev. Perspect.* 4, 55–61. doi: 10.1111/j.1750-8606.2009.00118.x

Gilford, T. T., and Reynolds, A. (2010). My mother's keeper': the effects of parentification on black female college students. *J. Black Psychol.* 37, 55–77. doi: 10.1177/0095798410372624

Greenberg, M. T. (2006). Promoting resilience in children and youth: preventive interventions and their interface with neuroscience. *Ann. N. Y. Acad. Sci.* 1094, 139–150. doi: 10.1196/annals.1376.013

Haxhe, S. (2016). Parentification and related processes: distinction and implications for clinical practice. *J. Fam. Psychother.* 27, 185–199. doi: 10.1080/08975353.2016.1199768

Hetherington, E. M. (ed.) (1999). "Should we stay together for the sake of the children?" in *Coping with divorce, single parenting, and remarriage: A risk and resiliency perspective* (Mahwah, NJ: Erlbaum), 93–116.

Hofstede, G., Hofstede, G. J., and Minkov, M. (2010). *Cultures and organizations: Software of the mind. 3rd Edn*. New York, NY: McGraw-Hill.

Hooper, L. M. (2007). The application of attachment theory and family systems theory to the phenomena of parentification. *Fam. J.* 15, 217–223. doi: 10.1177/1066480707301290

Hooper, L. M. (2009). Parentification inventory (Available form L. M. Hooper, 108 Schindler Education Center, 50614–0410). Cedar Falls, IA: University of Northern Iowa.

Hooper, L. M. (2014). Assessing parentification in South American college students: a factor analytic study of a Spanish version of the parentification inventory. *J. Multicult. Couns. Dev.* 42, 93–106. doi: 10.1002/j.2161-1912.2014.00047.x

Hooper, L. M. (2017). "Parentification" in *Encyclopedia of adolescence*. ed. R. Levesque (Cham: Springer), 12–19.

Hooper, L. M., DeCoster, J., White, N., and Voltz, M. L. (2011a). Characterizing the magnitude of the relation between self-reported childhood parentification and adult psychopathology: a meta-analysis. *J. Clin. Psychol.* 67, 1028–1043. doi: 10.1002/jclp.20807

Hooper, L. M., Doehler, K., Jankowski, P., and Tomek, S. (2012). Patterns of self-reported alcohol use, body mass index, and depressive symptoms in a rural family sample: the buffering effects of parentification. *Fam. J. Counsel. Ther. Couples Fam.* 20, 164–178. doi: 10.1177/1066480711435320

Hooper, L. M., Doehler, K., Wallace, S. A., and Hannah, N. J. (2011b). The Parentification inventory: development, validation, and cross-validation. *Am. J. Fam. Ther.* 39, 226–241. doi: 10.1080/01926187.2010.531652

Hooper, L. M., Marotta, S. A., and Lanthier, R. P. (2008). Predictors of growth and distress following childhood parentification: a retrospective exploratory study. *J. Child Fam. Stud.* 17, 693–705. doi: 10.1007/s10826-007-9184-8

Hooper, L. M., Tomek, S., Bond, J. M., and Reif, M. S. (2014). Race/ethnicity, gender, parentification, and psychological functioning. *Fam. J.* 23, 33–48. doi: 10.1177/1066480714547187

Hu, L., and Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: conventional criteria versus new alternatives. *Struct. Equ. Model.* 6, 1–55. doi: 10.1080/10705519909540118

Jankowski, P. J., Hooper, L. M., Sandage, S. J., and Hannah, N. J. (2013). Parentification and mental health symptoms: mediator effects of perceived unfairness and differentiation of self. *J. Fam. Ther.* 35, 43–65. doi: 10.1111/j.1467-6427.2011.00574.x

Jurkovic, G. J. (1997). *Lost childhoods: The plight of the parentified child*. New York, NY: Brunner/Mazel.

Jurkovic, G. J., Kuperminc, G. P., Sarac, T., Weisshaar, D. (2005). Role of filial responsibility in the post-war adjustment of Bosnian young adolescents. *J. Emot. Abus.* 5, 219–235. doi: 10.1300/J135v05n04_03

Kerig, P. K. (2005). Revisiting the construct of boundary dissolution: a multidimensional perspective. *J. Emot. Abus.* 5, 5–42. doi: 10.1300/J135v05n02_02

Konarski, R. (2010). *Modele równań strukturalnych. Teoria i praktyka [structural equation modelling. Theory and practice]*. Warszawa: Wydawnictwo Naukowe PWN.

Kościelska, M. (2007). *Sens odpowiedzialności: perspektywa psychologa klinicznego [Sense of responsibility: clinical psychologist's perspective]*. Kraków: Oficyna Wydawnicza Impuls.

Kumpfer, K. L. (1999). *Resilience and development: Positive life adaptations*. New York: Kluwer Academic/Plenum Publishers, 179–224.

Kuperminc, G. P., Wilikins, N. J., Jurkovic, G. J., and Perilla, J. L. (2013). Filial responsibility, perceived fairness, and psychological functioning of latino youth from immigrant families. *J. Fam. Psychol.* 27, 173–182. doi: 10.1037/a0031880

Ipsos Loyalty (2014) *Przemoc w rodzinie. Występowanie i częstotliwość zgłaszania. Raport przygotowany dla Ministerstwa Spraw Wewnętrznych* [Violence in the family. Occurrence and frequency of reporting. Report prepared for the Polish Interior Ministry]. Available at: https://www.niebieskalinia.pl/attachments/article/5373/Raport_przemoc_w_rodzinie_MSW_2014.pdf (Accessed February 04, 2021).

Luthar, S. S., Cicchetti, D., and Becker, B. (2000). The construct of resilience: a critical evaluation and guidelines for future work. *Child Dev.* 71, 543–562. doi: 10.1111/1467-8624.00164

Luthar, S. S., and Zelazo, L. B. (2003). "Research on resilience: an integrative review" in *Resilience and vulnerability: Adaptation in the context of childhood adversities*. ed. S. S. Luthar (Cambridge: Cambridge University Press), 510–549.

Luthar, S. S., and Zigler, E. (1991). Vulnerability and competence: a review of research on resilience in childhood. *Am. J. Orthopsychiatry* 61, 6–22. doi: 10.1037/h0079218

Macfie, J., Brumariu, L. E., and Lyons-Ruth, K. (2015). Parent–child role-confusion: a critical review of an emerging concept. *Dev. Rev.* 36, 34–57. doi: 10.1016/j.dr.2015.01.002

Macfie, J., and Swan, S. A. (2009). Representations of the caregiver-child relationship and of the self, and emotion regulation in the narratives of young children whose mothers have borderline personality disorder. *Dev. Psychopathol.* 21, 993–1011. doi: 10.1017/S0954579409000534

Masten, A. S., and Powell, J. L. (2003). "A resilience framework for research, policy and practice" in *Resilience and vulnerability: Adaptation in the context of childhood adversities*. ed. S. S. Luthar (New York: Cambridge University Press), 1–26.

Mayseless, O., Bartholomew, K., Henderson, A., and Trinke, S. (2004). "I was more her mom than she was mine:" role reversal in a community sample. *Fam. Rel.* 53, 78–86. doi: 10.1111/j.1741-3729.2004.00011.x

Mazur, J., Małkowska-Szkutnik, A., Dzielska, A., and Tabak, I. (2008). *Polska wersja kwestionariuszy do badania jakości życia związanej ze zdrowiem dzieci i młodzieży (KIDSCREEN) [Polish version of Health-Related Quality of Life Questionnaire for Children and Adolescents]*. Warszawa: Instytut Matki i Dziecka.

McMahon, T. J., and Luthar, S. S. (2007). Defining characteristics and potential consequences of caretaking burden among children living in urban poverty. *Am. J. Orthopsychiatry* 77, 267–281. doi: 10.1037/0002-9432.77.2.267

Montalvo, B., Guerney, B. G., Rosman, B. L., Schumer, F., and Minuchin, S. (1967). *Families of the slums: An exploration of their structure and treatment*. New York: Basic Books.

Obsuth, I., Hennighausen, K., Brumariu, L. E., and Lyons-Ruth, K. (2014). Disorganized behavior in adolescent–parent interaction: relations to attachment state of mind, partner abuse, and psychopathology. *Child Dev.* 85, 370–387. doi: 10.1111/cdev.12113

Ohntrup, J. M., Pollack, E., Plass, A., and Wiegand-Grefe, S. (2011). "Parentifizierung–Elternbefragung zur destruktiven Parentifizierung von Kindern psychisch kranker Eltern" in *Kinder mit psychisch kranken Eltern. Klinik und Forschung*. eds. S. Wiegand-Grefe, F. Mattejat and A. Lenz (Göttingen: Vandenhoeck and Ruprecht), 375–398.

Pasternak, P., and Schier, K. (2014). Life without childhood–parentification of women with ACoA syndrome. *Psychiatr. Pol.* 48, 553–562.

Peris, T. S., Goeke-Morey, M. C., Cummings, E. M., and Emery, R. E. (2008). Marital conflict and support seeking by parents in adolescence: empirical support for the parentification construct. *J. Fam. Psychol.* 22, 633–642. doi: 10.1037/a0012792

Robitail, S., Ravens-Sieberer, U., Simeoni, M.-C., Rajmil, L., Bruil, J., et al. (2007). Testing the structural and cross-cultural validity of the KIDSCREEN-27 quality of life questionnaire. *Qual. Life Res.* 16, 1335–1345. doi: 10.1007/s11136-007-9241-1

Rutter, M. (1987). Psychosocial resilience and protective mechanisms. *Am. J. Orthopsychiatry* 57, 316–331. doi: 10.1111/j.1939-0025.1987.tb03541.x

Schier, K. (2014). *Dorosłe dzieci. Psychologiczna problematyka odwrócenia ról w rodzinie [adult children. Psychological aspects of reversing roles in the family]*. Warszawa: Wydawnictwo Naukowe SCHOLAR.

Schier, K., Herke, M., Nickel, R., Egle, U. T., and Hardt, J. (2015). Long-term sequelae of emotional parentification: a cross-validation study using sequences of regressions. *J. Child Fam. Stud.* 24, 1307–1321. doi: 10.1007/s10826-014-9938-z

Siskowski, C. (2006). Caregiving youth: effect of family health situations on school performance. *J. Sch. Nurs.* 22, 163–169. doi: 10.1177/10598405060220030701

Statistics Poland (2019). *Demographic yearbook of Poland*. Warsaw: Statistics Poland [Główny Urząd Statystyczny].

Tedgård, E., Råstam, M., and Wirtberg, I. (2019). An upbringing with substance-abusing parents: experiences of parentification and dysfunctional communication. *Nordisk Alkohol Nark.* 36, 223–247. doi: 10.1177/1455072518814308

Thastum, M., Johansen, M. B., Gubba, L., Olesen, L. B., and Romer, G. (2008). Coping, social relations, and communication: a qualitative exploratory study of children of parents with cancer. *Clin. Child Psychol. Psychiatry* 13, 123–138. doi: 10.1177/1359104507086345

Thomas, N., Stainton, T., Jackson, S., Cheung, W. Y., Doubtfire, S., and Webb, A. (2003). Your friends don't understand': invisibility and unmet need in the lives of 'young carers. *Child Fam. Soc. Work* 8, 35–46. doi: 10.1046/j.1365-2206.2003.00266.x

Tompkins, T. L. (2007). Parentification and maternal HIV infection: beneficial role or pathological burden. *J. Child Fam. Stud.* 16, 113–123. doi: 10.1007/s10826-006-9072-7

Toro, R. I., Schofield, T. J., Calderon-Tena, C. O., and Farver, J. M. (2019). Filial responsibilities, familism, and depressive symptoms among Latino young adults. *Emerg. Adulthood* 7, 370–377. doi: 10.1177/2167696818782773

Wallerstein, J. S. (1985). The overburdened child: some long-term consequences of divorce. *Soc. Work* 30, 116–123.

Walsh, S., Schulman, S., Bar-On, Z., and Tsur, A. (2006). The role of parentification and family climate in adaptation among immigrant adolescents in Israel. *J. Res. Adolesc.* 16, 321–350. doi: 10.1111/j.1532-7795.2006.00134.x

Wasilewska, M., and Kuleta, M. (2014). "Charakterystyka systemów rodzinnych, w których występuje zjawisko parentyfikacji [Characteristics of family systems in which Parentification occurs]" in *Higiena i środowisko a zdrowie człowieka [Hygene, envirinment and human's health]*. ed. A. Borzęcki (Lublin: Wyd. Druk Norbertinum), 46–54.

Winton, C. A. (2003). *Children as caregivers: Parental and parentified children*. Boston, MA: Allyn and Bacon.

World Bank, World Development Indicators (2019). Rural population (% of total population) – Poland [Data file]. Available at: https://data.worldbank.org/indicator/SP.RUR.TOTL.ZS?end=2019&locations=PL&start=1960&view=chart (Accessed February 04, 2021).

Żarczyńska-Hyla, J., Zdaniuk, B., Piechnik-Borusowska, J., and Kromolicka, B. (2019). Parentification in the experience of polish adolescents. The role of socio-demographic factors and emotional consequences for parentified youth. *New Educ. Rev.* 55, 135–146. doi: 10.15804/tner.2019.55.1.11

Conflict of Interest: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

frontiers in Psychology

ORIGINAL RESEARCH
published: 13 April 2021
doi: 10.3389/fpsyg.2021.533141

How the Language of Instruction Influences Mathematical Thinking Development in the First Years of Bilingual Schoolers

Vicente Bermejo[1,2], Pilar Ester[2]* and Isabel Morales[2]**

[1] Evolutionary Psychology, Universidad Complutense de Madrid, Madrid, Spain, [2] Facultad de Educación, Universidad Camilo José Cela, Madrid, Spain

OPEN ACCESS

Edited by:
Edgar Galindo,
University of Evora, Portugal

Reviewed by:
Rachel George,
University of Greenwich,
United Kingdom
Teresa Pozo-Rico,
University of Alicante, Spain

***Correspondence:**
Vicente Bermejo
vbermejo@ucm.es
Pilar Ester
pester@ucjc.edu
Isabel Morales
imorales@ucjc.edu

Specialty section:
This article was submitted to Educational Psychology, a section of the journal Frontiers in Psychology

Received: 06 February 2020
Accepted: 17 March 2021
Published: 13 April 2021

Citation:
Bermejo V, Ester P and Morales I (2021) How the Language of Instruction Influences Mathematical Thinking Development in the First Years of Bilingual Schoolers. Front. Psychol. 12:533141. doi: 10.3389/fpsyg.2021.533141

The present research study focuses on how the language of instruction has an impact on the mathematical thinking development as a consequence of using a language of instruction different from the students' mother tongue. In CLIL (*Content and Language Integrated Learning*) academic content and a foreign language are leant at the same time, a methodology that is widely used in the schools in the present times. It is, therefore, our main aim to study if the language of instruction in second language immersion programs influences the development of the first formal mathematical concepts. More specifically, if the learning of mathematical concepts in the early ages develops in a similar way if it is taught in the students' mother tongue and is not influenced by the language used for teaching. Or else, if it can influence the development of the first skills only in the students' general performance or in certain areas. The results of both the analysis of variance and multiple regression confirm how influencing the language of instruction is when mathematical thinking is developed teaching formal contents in a non-coincidence language. The second language is affecting the resolution of daily life problems, being more competent those students in 1st grades whose language of instruction matched with their mother tongue.

Keywords: bilingual programs, mathematical thinking development, language of instruction, mother tongue, content and language integrated learning

INTRODUCTION

The importance of learning and becoming proficient in an additional language has become a milestone in educational policies, and subsequently in the pedagogical lines of many educational institutions in recent years. Consequently, English as the language for international scientific-technical communication keeps away from the rest of the languages of the European Community, becoming the core of bilingual policies based on the so-called CLIL educational approach.

Despite the criticism that bilingual programs have gone through and are still currently suffering, the students of such programs are demonstrating how beneficial it is to obtain very good results in the university entrance exams (Fiedu and Haro, 2017).

On many occasions, mathematics has not been considered a suitable subject to be taught in a language other than the mother tongue, a decision made sometimes because of the complexity and abstraction that this subject possesses in itself. However, there are international schools that implement immersion programs where the second language is acquired naturally and tend to teach the entire curriculum in that language, with the exception of Spanish language instruction.

Therefore, we find it interesting to study if subjects such as mathematics, and more specifically, the learning of mathematical concepts in the early years develops in a similar way regardless of the language of instruction, or else if it can influence the development of the first skills only in general performance or in certain areas. In other words, does the language of instruction influence the development of the first formal mathematical concepts?

In order to find an answer to this question, the present work analyzes various mathematical tasks such as counting, number line, resolution of algorithms and verbal problems in students who are studying in first and second grades of elementary education in different international schools of the same educational institution. In each grade, one group of students is taught mathematics in Spanish and another group in English. We have analyzed the execution of activities in two differentiated groups: the group whose mother tongue coincides with the language of instruction and the group whose mother tongue does not coincide with the language of instruction.

TEACHING IN BILINGUAL CONTEXTS

It is unquestionable that there exists a relationship between mathematics and language. But how, when and in which tasks is language more straightforwardly influential?

To answer this question, it is necessary to delve into the different levels of language acquisition, and not only to rely on the superficial advantages or disadvantages that bilingual teaching offers, but also assessing to what extent the development of mathematical thinking can be constrained if it is taught in an additional language or a 'non-dominant language.'

Therefore, it is essential to highlight the existing difference between Second Language Learning (SLL) and (SLA) Second Language Acquisition and the way these concepts directly influence the action of facing new content and learning naturally. Acquisition as a natural and unconscious approach is close to the phenomenon that take place when the first language is acquired. We can identify a consecutive bilingualism, either due to a linguistic immersion through an educational program, or as a product of what is known as submersion in a communicative context where the child lives with native speakers (Snow, 1999). Concerning language learning, we should not fall for the instruction of a L2 as it was carried out in many educational environments applying traditional methodologies, focusing on learning vocabulary and reading comprehension.

It is also relevant to remember and emphasize that not all bilinguals have become bilingual in the same way, and for that reason their degree or type of bilingualism is also different. We must then differentiate between 'balanced bilingualism,' that is, individuals using two languages on a regular basis, and 'dominant bilingualism' referring to those bilinguals who are more proficient in one language as compared to the other language. We resort to this taxonomy of bilinguals, because it is the one that fits better with the study and relates to language proficiency and competence development.

Concerning the age of acquisition, we can also distinguish three ways to acquire more than one language, *simultaneously*, when a child learns two languages from birth, or *sequentially*, when one language is acquired after another, and *receptively*, when bilinguals do not have opportunities to use the additional language but are likely to understand a great deal. According to Baker (2011): '. . .simultaneous childhood bilingualism refers to a child acquiring two languages at the same time from birth, sometimes called infant bilingualism, bilingual acquisition and bilingual first language acquisition' (p. 94). In addition, the author points out that sequential acquisition refers to the situation when a child or adult acquires a first language and then acquires the second language or additional languages.

Since a foreign or second language is included in the Infant Education curriculum as a subject-matter like the rest of the contents, we also found necessary for our study to take into account the differences between bilingual education and he application of CLIL methodology. According to Bentley (2010), it consists in applying a form of partial immersion where half of the curriculum or more is taught in the non-native language known as 'hard CLIL.' Or else, 'soft CLIL', it is a methodology more suitable for early ages, since second language teachers work or teach any curricular content as part of language teaching in a more holistic way (Ball, 2009). This will allow learners to explore any content from a different perspective while they are also improving the foreign language. For instance, teachers can work on transport in history and mathematics, carry out multidisciplinary and global projects, and reconceptualize the curriculum in an integrated way (Garciìa, 2015).

The implementation of CLIL approach in 'partial immersion' is increasingly widespread in schools, where Spanish language and mathematics are taught in Spanish as the first language. However, a 'total immersion' in an additional language is the methodology that is causing many schools to teach mathematics in that language. As it is the case in the present study.

A fact of special interest for our research is related to the results obtained by students in other subjects within the immersion programs (Sotoca, 2014). These are not affected by the fact that these subjects are taught in a second language. And, if there is any delay in reading, writing and mathematics in immersion students, it disappears later at sixth grade (Turnbull et al., 2003).

MATHEMATICS AND LANGUAGE

Various studies on how the linguistic structure of a problem can favor or block the resolution of the problem by the students makes clear the extraordinary relationship between language and resolution of verbal problems (Carpenter and Moser, 1984; Verschaffel et al., 2000; Bermejo et al., 2002, 2021).

It is also worth mentioning the advantages of the cognitive function in bilingual children compared to monolinguals. Ellen Bialystok (2009) showed how bilingual children between 4 and 8 years old have great advantages over monolinguals when solving problems because they controlled their attention; they were not distracted by more confusing and misleading aspects, and they even better discerned the appearing reality and by demonstrating an improved cognitive function. Bialystok (2018) suggests that the bilingual experience leads to an adaptation of the central executive component of Baddeley (1986) WM (Working Memory) model even in young children. However, authors such as Volmer et al. (2018) suggest that certain skills depend on the language through which they were developed and acquired at least partially, which does not mean that they always represent an advantage.

Nonetheless, when we talk about the development of mathematical thinking in the early ages, we refer to a great deal of constructions of basic concepts as well as the acquisition of mathematical procedures that allow us to develop problem solving, which is one of the most complex tasks (NCTM, 2000). Tasks such as counting, calculation, measurement approximation, comparison of magnitudes and problem solving are some of the mathematical contents that the child learns and develops throughout his childhood. Some authors (McCloskey, 1992; McCloskey and Macaruso, 1995) state that any number we perceive is recoded in an 'amodal representation' prior to performing its processing. This theory would rule out that some of the concepts developed have had a direct relationship with language. However, Dehaene (1992) and Dehaene and Cohen (1995) propose three types of internal representations that can be involved in solving tasks: an analog magnitude, an arabic visual code and a verbal system (see **Figure 1**). This leads them to conclude that there are great connections between the internal representations performed and the language in all the mathematical tasks that are carried out.

Campbell and Epp (2004) clarify that the numerical processing is carried out in different codes, therefore they are more inclined to use different codes, depending on the task, which would rule out a unique relationship with language in all tasks made.

First, the child develops a concrete or perceptual arithmetic that later becomes abstract through the use of oral language, and second, he develops the writing based on the representation of the number with the help of digits. This step from perceptual to abstract arithmetic is far from being scientifically described at the moment, but it is assumed that there exists an activation of different parts of the brain. What is still unclear at the moment is how this transition from concrete-perceptual to an abstract-symbolic arithmetic is realized and then concretized by digits. Some studies carried out through neuroimaging techniques show how working memory is highly important in complex calculation tasks, and indicate the way working memory uses visual or verbal procedures depending on the strategies that individuals use (Delazer et al., 2003).

Concerning calculus operations, Colomé et al. (2010) conducted a study in Italian monolinguals and Basque-Spanish bilinguals. These authors departed from the hypothesis in which, if the language influenced the calculation even when the presentation was in arabic numbers, the Basque-Spanish bilingual participants would have an advantage over the Italians because the linguistic structure of the numbers, focused on the base 10 and 20, matched with that of its dominant language (Basque). The results of these studies indicated that there were specific effects due to the language use. As the authors indicate: "it seems that the word that designates a number has an effect on the processing of a number" (p. 967).

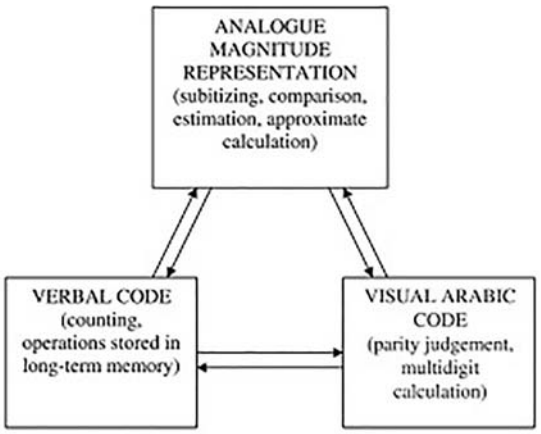

FIGURE 1 | Dehaene triple code model (1992).

In this sense, neuroimaging studies have shown how specific areas of language are activated when calculation tasks are performed, sustaining the existence of a language-dependent system as opposed to independent numerical systems (Pesenti et al., 2000; Benn et al., 2012). Therefore, it seems clear that quite a few authors propose different approaches to show the high influence of language on mathematical thinking. However, the studies carried out by Swanson et al. (2019) show how the influence of certain aspects such as reading and vocabulary does not have as much influence on problem solving as working memory does, where a great correlation between these results is obtained in bilingual children, in contrast with monolingual children, also shown in the studies by Swanson et al. (2018). Bernardo and Calleja (2005) also showed how the students' linguistic competence in the language of instruction directly influenced the development of their own competences, specifically in mathematics. We find such an ability similar to that of counting.

Other studies show how German–French bilingual students could transfer their capabilities in approximate calculation tasks from one language to another, but they could not perform this transfer for exact calculations (Saalbach et al., 2013). However, Salillas and Wicha (2012) show that bilingual students of higher courses can perform calculations more effectively in the non-mother tongue, if this has been the language of instruction used in the classroom.

We should also consider the fact of how instruction is developed in a second language. Some studies show how direct instruction and training teachers through programs based on visualization and guided by the choices they can make during

such an instruction, can improve teaching in the early ages and subsequently their students' performance. Other studies such as those of Kraft and Hill (2018) reveal how teacher training allowed them to detect critical points to improve mathematics quality teaching to incorporate them into their day-to-day life; it substantially improved the quality of their classes and their students' performance.

THE PRESENT STUDY

One of the most relevant issues when conducting the research on bilingualism is how each of the students has acquired the second language, or if their learning has occurred simultaneously. Factors such as knowing the time of exposure to the language, the competence shown by the student and the informal experiences they have had, are determining factors that can contribute to make significant differences between them. Our study is conducted in two international schools where linguistic immersion is being carried out from the first years of schooling, that is, from the first years in nursery school, that is, since the age of 4 months. And, although some of the students are incorporated later, we must highlight that a large majority of the sample has been attending school at least since the age of three.

Conducting a study on the influence of the language of instruction in international schools is quite advantageous. On one hand, because a high number of students have had the same time of exposure to the second language, mostly with English native teachers, and on the other, because the teaching method in both groups is quite similar, as it follows the same IB methodology implemented in all international school centers. Furthermore, this research is of special interest because it is carried out in early year students during which the linguistic competence in both the mother tongue and the instructional language is not completely proficient in all students.

As above-mentioned the participants belong to first grades and second grades of elementary education in two international schools in Spain, both being taught through the International Baccalaureate (IB) philosophy and teaching methodology and instructed with the same linguistic immersion in the second language or language of instruction. Along the different years, students are taught 100% immersed in English. Accordingly, one of the schools, school *A* teaches all subjects of elementary grades in English, except for the Spanish language. And the school *B* that uses the Spanish language to teach both Spanish language and mathematics.

MATERIALS AND METHODS

Participants

To carry out the present research, there was a total sample of 169 bilinguals studying in international schools. The sample was made up of 80 first grade students (39 girls, mean age of 7.1 years and 41 boys, mean age of 7.3 years); and 89 second grade students (38 girls, mean age 8.2 years, and 51 boys, mean age 8.2 years).

All participants had the same linguistic immersion in the second language. They spoke both Spanish and English. However, as it is an international school there are students from different countries, origins and nationalities: Brazil, United States, Portugal, England, and Italy. Each of these schools was characterized by the use of a different language of instruction in the subject-matter of mathematics. School *A* taught it in English whereas School *B* taught it in Spanish. For this reason, for the analysis we decided to form two differentiated groups, not by school, but by their mother tongue, that is, if their mother tongue matched or not with their language of instruction and how the students used it. Hence, we formed four different groups. Group 1 would be formed by first grade students whose mother tongue coincided with the language of instruction, and group 2 would be formed by first grade students whose mother tongue did not match with the language in which mathematics is taught. Group 3 would be made up of students whose mother tongue did not match with the language of instruction, and finally group 4 would be formed by students whose mother tongue matched with the language of instruction. In this way, the sample was as follows: out of the 80 students in first grade 44 students made up group 1 (24 girls and 20 boys), and 36 students made up group 2 (15 girls and 21 boys). The sample of second grade students is formed by 49 students in group 3 (20 girls and 29 boys) and 40 students in group 4 (18 girls and 22 boys).

Materials

Students performed several mathematical tests to assess their mathematical proficiency and several tests to assess the homogeneity of the groups. In first grade groups, we used a chronometer to measure the time devoted to solving mathematical verbal problems and find out that there were time differences in their resolution, since one of the groups received instruction in the Spanish Language for the first time.

The tests that were applied were the following:

1. The *Raven CMP* test (Raven et al., 1996). This test measures general intelligence and the "g" factor. It is a collective application test that consists of a booklet with three series of matrices called A, Ab, and B. The series Ab discovers the student's ability to establish relationships between isolated figures, and the series A and B cover the whole cognitive process of children up to 11 years of age. Our main purpose was to assess whether there were significant differences in this factor among participants. The reliability and validity of this test presents a reliability of 0.87–0.81, while in validity an index of 0.86 was obtained. These data were obtained with the Kuder–Richardson formulas and with the Terman Merrill criteria.
2. The *Difference Perception Test* (TPD) (Thurstone and Yela, 2012). It is based on the following measurements: (1) right (A) correct face crossed out; (2) errors (E) faces crossed out without being correct; (3) net (A − E), the part that measures the student's real effectiveness once the errors have been penalized. It is calculated by subtracting the total number of errors from the total number of correct answers; and (4) the Impulsivity Control Index (ICI) that

measures the cognitive style of the reflexive-impulsive subject and is calculated by using the following formula: ICI = $A - E/A + E$. The result shows the evaluation of the attentional processes in the participants. This instrument has an internal validity = α = 0.76, and the test-retest reliability of 17 out of the 20 items with a coefficient greater than 0.6, and 14 of them greater than 0.8 implying an excellent test-retest reliability.

3. *Tema-3* consists of several tests that are used to evaluate the mathematical proficiency. It is an individual test carried out with pencil and paper to assess formal and informal skills. These items are distributed according to age and divided into several aspects that value both informal (41 items) and formal concepts (31 items). The 41 items that assess the most informal aspects of mathematical thinking are divided into four large fields: (1) numbering (i.e., mastering the numerical sequence through counting, numbering, etc.); (2) comparison of quantities and establishing the distances between different numbers; (3) informal calculation, such as simple additions and subtractions, and mental calculation tests using manipulable materials; (4) basic concepts such as the application of superior counting strategies, distribution with concrete objects, the cardinality rule, etc. The formal part is evaluated by using 31 items that are divided into four large groups: (1) reading-writing of quantities; (2) strategy of numerical facts; (3) formal calculation; and (4) basic concepts related to the decimal number system. The application of this test provides us with individual information to assess the level of mathematical competence, as well as the percentile in which the student is ranked, but it is especially useful concerning the information it offers on the difficulties and potentialities per individual. (Test of Basic Mathematical Competence; Ginsburg and Baroody, 2003). The test is validated in the Spanish population with a reliability index (Cronbrach's alpha = 0.92), a validity backed up as a measure of early mathematical competence (Ginsburg and Baroody, 2007).
4. *Tedi-Math* operation subtests complement those areas evaluated with *TEMA-3* tests. It is another standardized test that measures the mathematical competence. It is made up of 25 subtests grouped in different areas: Counting, numbering, understanding the number system, doing operations and solving verbal problems. We decided to use only the subtest of operations as an adequate complement of the areas evaluated with *TEMA-3* tests. *Tedi-Math*'s operation subtests consist of eighteen simple additions and four additions with gaps, two of them with the unknown in first place and two of them with the unknown in the second, without exceeding number ten. It also contains fourteen simple subtractions, four subtractions with gaps, two with the unknown in the minuend and two in the subtrahend, and similarly as in additions, none exceeds number 10. And the test was completed by giving fourteen simple multiplications. The Cronbach's alpha corresponding to the test was (α = 0.93). For the subtest used, the reliability indices are as follows: arithmetic operations (α = 0.99) and size estimation (α = 0.95).
5. Twenty addition and subtraction verbal problems were also administered individually. None of the problems exceeded number twenty in the expected answer. The answer was recorded as correct when the student knew how to explain the result provided. When the answer was given at random, they were considered invalid. The problems were selected and extracted from the investigations carried out by Bermejo et al. (2002), and were sequenced in ascendent difficulty according to the classification carried out in the above-mentioned study: 8 change problems (four addition operations and four subtraction operations with the unknown in the beginning, middle and end of the equation); 6 comparison problems (three additions with the unknown in the referent and in the comparison, and three subtractions with the unknown in the referent and in the difference); 2 combination problems (one with the unknown in the beginning and one in the middle) and four equalization problems (two additions with the unknown in an unknown set, in the unknown equalization, and two subtractions with the unknown in the unknown equalization, in the known set). This subtest was conducted in the language of instruction used to teach the subject of mathematics: in Spanish to students who received mathematical instruction in Spanish, and in English to students who were taught in English. The translation of the problems was carried out following the established procedure (Muñiz et al., 2013).

Procedure

Two collective tests (1 and 2) were given first to the groups in their reference classrooms during their school day. Then, the students were assessed individually according to the language of instruction in which mathematics was taught in their school during the day. It took place in a room close to their reference classroom. First, we evaluated the groups formed by 1st grade students and then 2nd grade students. The tests were passed individually during two consecutive days approximately during 30–60 min each session, depending on each student's performance.

The mathematical proficiency test (Tema-3) was developed only orally, but the students used a pencil and paper to carry out the operations they deemed appropriate to find the result, as stated in the instructions followed to carry out this test. Meanwhile, algorithm tests and problems were presented orally and visually by using several cards. The algorithms were written in numbers, for example_+3 = 5, and the verbal problems were written in Spanish or English depending on the student's language of instruction, and the numbers that made up the problem were written in figures. In addition, the order of presentation of the tests in both groups was counterbalanced across all participants.

The tests took place subsequently by grades: first grade students were evaluated in April and second grade students in May.

Results

The analysis of variance was carried out considering two variables: language (not coincident with the language of

instruction *group 1* vs. coincident with the language of instruction *group 2*), and grade (first grade vs. second grade). This creates a variable with four possible categories according to group and grade. Once the sample is segmented, we create four groups: first grade when the language of instruction matches their mother tongue and first grade if the language of instruction does not match their mother tongue, and the other two second grades segmented in the same way.

The analysis of the variance between the variable resulting from the tests of Raven and attentional matrices according to the categories indicated above demonstrate that there are differences in mean $F(3,165) = 10{,}370$, and an MSE = 0.183. with a p-value = 0.00, $n^2 = 0.15$

When comparing the groups by means of the Bonferroni test, we can see how in first and second grades there are no significant differences with a p-value in first grade coincident language and first grade not coincident language p-value = 1.00, and in second grade coincident language with second grade not coincident language with a $p > 226$. Therefore, the differences can be seen between the first and second grades. For example, first grade not coincident language with second grade not coincident language, and second coincident language have a p-value = 0.00 and p-value = 0.02, respectively.

The attention test evaluated with the 'face tests' showed us again that first grade groups are similar $T_{167} = 1$, 251, and an MSE = 0.424 we find a $p > 0.213$, assuming equal variances.

In second grades, we found similar results $T_{87} = 0.607$ and an MSE = 0.217 we found a $p > 0.84$, assuming equal variances.

We would like to highlight that students in first grade whose mother tongue matches with the language of instruction and the other that do not match the language of instruction are quite similar in the IC level and attentional processes. In the same way, we found similar results between second grade students, when they are segmented in terms of the language of instruction.

The different mathematical tests have been subsequently analyzed. Once the relevant statistics were applied, we obtained three different types of analysis.

In the analysis carried out on mathematical competence × language of instruction, we find two categories in accordance with the grade, given that the items in such a test are different for first and second grade students. We have verified that in first grades there are significant differences $T_{76} = -4$, 44 with a p-value $p = 0.00$. However, in second grades $T_{87} = -0.593$ with p-value of $p = 0.554$, there would be no significant differences in this competence.

Observing the higher effect of the language of instruction regarding mathematical competence, we carried out the analysis with Cohen's D that in first grades $r = 0.45$, and in second grades $r = 0.06$. Although none of them have a moderate effect, we see a clear decrease in second grade with respect to first grade, as it was the case with problem solving.

Regarding the resolution of algorithms, language of instruction and grade, we found significant differences between the grades. The ANOVA performed showed us the following results $F(3,165) = 22.56$; MSE = 0.634. With a p-value = 0.00 and $n^2 = 0.29$.

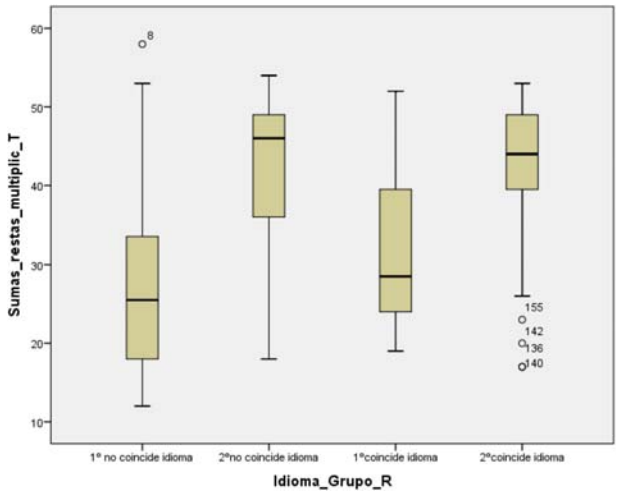

FIGURE 2 | Algorithm resolution × instruction language × grade. Source: Prepared by the authors on the basis of data.

Specifically, according to Bonferroni test, in first grade groups, there are no significant differences with p-value = 0.404, and in second grade groups there are no significant differences with a p-value = 1.00. Statistically relevant differences occur between first grade groups and second grade groups. There are significant differences with a p-value = 0.00 in first grade groups whose language is non-coincident with the second-grade groups non-coincident language, and there are differences with a p-value = 0.00 in the first grade group does not match language with the second grade group matches language. Therefore, we found the same p-value = 0.00 when first grade groups coincident language is compared with second grade group non-coincident language and second grade group coincident language (**Figure 2**).

In problem solving, language of instruction, grade we find significant differences in first grade. $F(3,165) = 8.15$ and an MSE = 0.107 with $p = 0.005$ and $n^2 = 0.12$, therefore, the first grade group whose language of instruction does not match with their mother tongue would differ from the rest, according to the Bonferroni test showing us some p-value in first grade $p < 0.05$. Among the other groups there are no indications that there are significant differences.

As a complement to what has been pointed out, we can see in the following graph how the mean of first grade (non-coincident language) clearly differs from the average of the rest of the groups (**Figure 3**).

Observing the size of the problem-solving effect with respect to the language of instruction, we obtain through the completion of Cohen's D that, in first grade the language of instruction has an effect $R = 0.32$ and in second grade the $R = 0$, 15. Although none of them have a moderate effect, we see a clear decrease in second grade group with respect to first grade group, which is consistent with the results obtained in the previous paragraph, since the effect is trivial.

In the following table we provide a summary of the exploratory statistics referring to problem solving depending on their

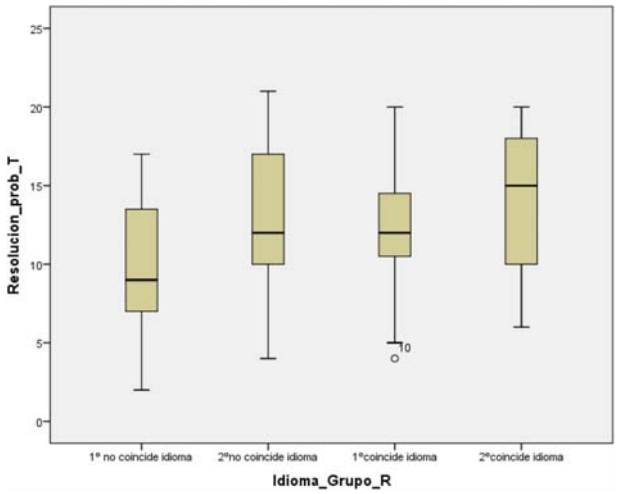

FIGURE 3 | Problem solving × language of instruction × grade. Source: Prepared by the authors on the basis of data.

classification, grade and language of instruction used. We can see that the results at a global level are better when the language of instruction coincides with the mother tongue than when it does not coincide.

Along the study, we also measured the time it took first grade students to carry out the verbal problems. The average time was higher in the group in which the language of instruction did not coincide with their mother tongue. In order to accomplish it, we performed the statistical analyses: instruction, group x time in which we verified that there are significant differences $T_{78} = 6$, 76 with $p < 0.00$. Subsequently, a linear regression is performed in which the time in minutes is on the vertical axis and the resolution of problems on the horizontal axis. As you can see in **Table 1**.

There is a significant relationship between the variables with p-value = 0.00. The correlation coefficient between the time variables and the result of the problem solving is $R^2 = 0.44$. With a positive R it shows that there is a direct correlation between time and resolution.

Table 1 shows the coefficients obtained from the multiple linear regression, which simultaneously considers independent variables, resolution according to language, resolution language and resolution problems and as a dependent variable time only language resolution is significant to explain time with a p-value = 0.02. Proving 67% of the variance of the model.

Here we can also check problem-solving effects when it coincides with time, being at a lower time when a higher resolution of problems occurs (**Table 2**).

DISCUSSION

The main aim of the present study is to analyze if the language of instruction used in a particular subject-matter, in this case mathematics, can influence the development of concepts, and consequently, the student's math performance at early ages. The results found in this study are in line with those developed by De Corte and Verscheffel (1991), where the influence of language on mathematical processes is evidenced. However, this research allows us to further clarify these results by selecting samples of different ages (first and second grades in elementary education), and evaluating different mathematical tasks (mathematical competence, operations or algorithms and verbal problems).

We performed the measurement by using the same language of instruction in which mathematics is developed, that is, in the school where math is taught in English the measurement was in this language, and in the school where Spanish is used as the language of instruction, the evaluation was carried out in the same way. Prior to these tasks, each student was provided with a series of instructions on the development of the test in the same language of the measurement, which allowed a previous activation of Spanish or English in each case.

The results show how the influence of the language of instruction is different depending on both the task and the grade. First-graders score lower in mathematical proficiency, algorithm solving, and problem solving when their language of instruction does not coincide with their mother tongue. However, these differences begin to decrease in the following year. In second graders, we see that there are not significant differences in any of the three previous blocks. Nevertheless, it must be pointed out that the performance is still lower than the reference 2nd grade group whose language of instruction coincides with the mother tongue.

In those tasks related to the mathematical competence (i.e., numbering, comparison of quantities, informal calculation, basic concepts, literacy of quantities, strategy of numerical facts, and formal calculation) we find statistically significant differences in first grades in accordance with their language of instruction. The students who show more competent are those taught in the language of instruction coinciding with their mother tongue, but these differences diminish in second grade groups. In this case, the students whose mother tongue coincides with the language of instruction continue to have higher performance than the students of the same grade whose language of instruction does not match; however, in this case these differences are no longer significant.

In the tests given to evaluate arithmetic operations, they had a similar developmental execution. In first grade groups, the resolution of tasks is similar and in the second grade group whose mother tongue does not match with the language of instruction has a slightly higher performance, but there are no significant differences. This indicates that there are no differences in those tasks in which language is not as relevant when it comes to successfully solving the task. Concerning problem-solving tasks, the groups in which their mother tongue matched their language of instruction, solved the tasks more quickly and more efficiently. In first grade groups they obtained significant differences in the mean, however, those differences were reduced in second grade groups.

The results lead us to think that the language of instruction has a direct influence on the development of mathematical thinking, but we see that it is not revealed similarly in all learning. We find

TABLE 1 | Descriptive statistics by language coincidence (yes/no) (M, mean; SD, standard deviation).

			n	*M*	*SD*	Mín.	Máx.
1st grade							
Type	Change	No language of instruction	44	5.27	1.65	2	8
		Language of instruction	36	6.67	1.15	4	8
	Equalization	No language of instruction	44	1.70	1.27	0	4
		Language of instruction	36	2.06	1.07	0	4
	Combination	No language of instruction	44	0.55	0.76	0	2
		Language of instruction	36	0.86	0.80	0	2
	Comparison	No language of instruction	44	2.14	1.86	0	6
		Language of instruction	36	2.69	1.67	0	6
	Result	No language of instruction	44	4.57	1.39	2	7
		Language of instruction	36	4.83	1.28	2	7
2nd grade							
Type	Change	No language of instruction	49	6.24	1.61	3	8
		Language of instruction	40	6.78	1.48	3	8
	Equalization	No language of instruction	49	2.20	1.12	0	4
		Language of instruction	40	2.35	1.23	0	4
	Combination	No language of instruction	49	0.98	0.72	0	2
		Language of instruction	40	1.38	0.77	0	2
	Comparison	No language of instruction	49	3.22	1.62	0	6
		Language of instruction	40	3.50	1.65	0	6
Unknown	Result	No language of instruction	49	5.22	1.48	2	7
		Language of instruction	40	5.48	1.22	2	7

TABLE 2 | Summary of the results of the multiple linear regression with all the predictor variables.

	β_i	*p*	R^2	*F*	*df*	f^2	$1-\beta$
Dependent variable: time							
Complete model	0.000**	0.44	22.34	3.76	1.05	1.00	
Constant		0.000					
Resolution_ language	−0.745	0.020**					
Language	2.22	0.420**					
Resolution_ Problem_time	0.081	0.571**					

*β_i, standardized regression coefficient; R^2, R fitted square; df, degrees of freedom; f^2, effect size; 1−β, statistical power. *p < 0.05, **p < 0.01. Source: Prepared by the authors on the basis of data.*

tasks such as solving algorithms where the difference between all the groups is quite shorter. One of the reasons we can argue is that students could perform the calculation tasks in their dominant language, regardless of the language in which they were taught. This comes to corroborate what was stated by Van Rinsveld et al. (2015), who affirms that the domain of calculus in the first language seems to follow a continuous development regardless of the language in which formal mathematics is taught. Or else, it could be due to students learning new facts about numbers in one language that retrieve them as efficiently in both languages. It seems that learning responses to logarithms is based on representations that are independent of the language (Spelke and Tsivkin, 2001). While data were being collected, both questions were observed, since there were students who calculated in the dominant language and subsequently translated the result into the English language, and other students, in contrast, executed in the language of instruction in a similar way to those evaluated in the non-coincident language of instruction.

However, problem solving where language has a fundamental role for concept understanding as well as working memory (Swanson et al., 2019), performance is always better when the dominant language is the mother tongue. This reaffirms the idea that children exposed to two languages in which one of them is not a dominant language, will have difficulties in alternating between them when they need it (Costa and Santesteban, 2004). We have to take into account that problem-solving tasks are the most complex since they demand more processes at a cognitive level, a situation that must added to the fact that students must do them in a second language. This reasserts the findings found by Swanson et al. (2019) that suggest how the students who did not master the language, experienced delays in accessing the language concerning the contexts shown in the problems since they had to inhibit the other language. The results show that first grade students whose language of instruction coincides with their mother tongue solve problems faster and are more successful than students with non-coincident language. This result is in line with the results found in Frenck-Mestre and Vaid (1993), Geary et al. (1993), Van Rinsveld et al. (2016) in which the resolution of mathematical tasks was faster and more precise when it is performed in the dominant language. This may indicate that students who have a greater command of the language and understanding of the situation presented, fewer complex procedures were required in their resolution (Van Rinsveld et al., 2016).

We can observe that the previous situation is very frequent and happens independently of the type of problem, and that in all classes of problems students' performance in the non-dominant language of instruction is lower. However, we can see how the

differences vary as the task is becoming simpler. For example, in exchange problems that students find easier than comparison problems, the difference between groups within the same grade is bigger. In contrast, the differences between groups tend to be shortened in comparison problems, since all of them find this task more complex and the error occurs more frequently in all groups. Neither should we forget the learning factor, for this would explain why in first grade groups the differences in problem solving are greater than in second grade groups. The tasks have been solved more effectively by the students in second grade groups than those in first grades, although this result could be expected due to the maturity that students experience during a school year. This has been studied and analyzed in a multitude of investigations from Piaget (1946) to the present-day Bermejo (2018).

Based on Van Rinsveld et al. (2016) students' performance when solving problems may be due, partly, to the fact that, during the previous school year they had been training in the same type of tasks that allowed them to come up with resolution schemes according to the different structures or else, due to their improved command of the second language committing minor mistakes. Moreover, concerning language, second grade students have better linguistic command, which let conclude that both the language of instruction and being proficient influences the resolution of the tasks, as Van Rinsveld et al. (2015) also explains. We find studies in the same line demonstrating that the greater the linguistic competence, the more the arithmetic performance is promoted (Frenck-Mestre and Vaid, 1993; Geary et al., 1993). Another question that could explain this fact is the one argued by Bialystok (2018) in relation to bilingual models, whose bilingual experience leads to an adaptation of the central executive component of the working memory model, knowing that this component is essential in problem solving, as stated by Swanson et al. (2019), hence the longer the immersion time in these programs, the better the improvement in performing these tasks.

It is relevant to note that when the differences between first and second grades are smaller, it reinforces the results found in various investigations in which it is indicated that some factors such as the age language acquisition, as well as that of the language of instruction seems to be decisive in the use of language when solving mathematical problems in bilingual contexts (Bernardo, 2002; Campbell and Epp, 2004; Salillas and Wicha, 2012; Van Rinsveld et al., 2015).

Theoretical Implications

From our point of view, the results obtained would have at least two main relevant theoretical applications.

First, our results support the models in which the influence of the instructional language is determined by the type of task that is performed. Although in our results we see that performance is lower on almost all occasions, we can observe that even in the same task such as problem solving that involves the same cognitive processes in the resolution, we can find differences associated with its complexity.

Second, and very importantly, age influences on how information is retrieved according to the language of instruction. The verbal component of Dehaene's triple code model in the early ages has a greater influence of the dominant language than that of instruction. In the algorithm-solving tasks, the students who were evaluated in the non-dominant language carried out the task in the dominant language to subsequently modify their response in the non-dominant or second language. Therefore, this task was solved more successfully in these groups than others implying an improved linguistic component. Although previous research confirm that a person accesses mathematical concepts more efficiently when they are retrieved in the language of instruction (Dehaene et al., 1999; Spelke and Tsivkin, 2001), in this case it is different depending on the language used, that is if it is the dominant language or not, as it has been found in the results obtained. Some of these studies have been carried out in adult population, which would indicate that at an early age the dominant language may be much more influencing than the language of instruction. However, we see that these differences draw closer in higher grades, which may indicate a tendency to minimize the effects as language proficiency increases compared to mathematical learning.

Finally, we can remark that another implication pulled out from the present study is that the differences in mathematical performance are shortened as time progresses when the language of instruction is different from the mother tongue. This reinforces Bialystok (2018) suggesting that the bilingual experience leads to an adaptation of the central executive component of the working memory model; therefore, some tasks such as problem solving improve as there is greater adaptation.

Practical Implications

We believe that learning mathematics in bilingual environments is a far more challenging than in monolingual classrooms, but perhaps, we must accept certain aspects related to the child's language development that will let them reach a learning stage where the language of instruction comes in and becomes more influential than the individual's dominant language.

One of the practical implications of our results lets us establish the appropriate differences in the mathematical tasks with a lower performance of the students in programs in which the language of instruction is not the dominant one, since in this way we could detect the learning difficulties associated with mathematical concepts as well as those associated with second language acquisition. This could set the course for educational interventions since, depending on the differential diagnosis in both areas, it will allow us to carry out more individualized programs.

We think that it would be important to keep these aspects in mind when developing bilingual programs for the teaching of mathematics, and we completely agree with the criticism given to the bilingual programs by Van Rinsveld et al. (2015), since many language immersion programs assume that the contents are linguistically independent to be transferred in what they call "*Learners' mental language*."

Accordingly, any subject could be taught in an additional language without having any effect on the development of the

concepts, and as we have presented in the results of this research, we should take into account certain implications. From our point of view, daily life mathematical problems in which the influence of language is very high, could be worked in workshops, in order to reinforce transfers between the different linguistic structures that define the mathematical problems and the representations that are deduced from them until the student fully understands the problems worked.

Nevertheless, we also find highly relevant that students do not carry them out with the algorithmic form since they have an abstract visual representation that can be the link between both representations. In addition to this, as Van Rinsveld et al. (2015) suggests, the recovery of arithmetic facts can be independent of verbal codes or as sufficiently automated in both languages so as to have a similar competence in either of them. As Cerezci (2020) exposes, improving the quality of early-year instruction in mathematics will allow us not only to improve student's results but also fill in the existing gap in the theoretical approach. In this way, it will permit to identify and document the main characteristics of quality instruction in teaching mathematics to early year students within bilingual programs.

Limitations

In the present study there are at least two limitations that need to be mentioned. On the one hand, we mean that the design used in this research is transversal rather than longitudinal. We think that in order to study the development of language skills and how they influence the performance of certain subjects, such as mathematics, it is more enriching to carry out longitudinal studies that analyze the complicated changes that may occur in schoolchildren over a few years. However, we are all aware of the advantages and disadvantages of both designs. And on the other, the study has had a limitation on the linguistic data collection, as there are no data on the students' linguistic competence which could let us establish correlations on their mathematical competence, whether or not their language of instruction coincides.

GENERAL CONSIDERATIONS

Previous research has shown diverse results on the influence of language on the development of mathematical thinking in bilingual people, but virtually none of them has studied it at an early age when the development of language, number and arithmetic occur simultaneously and during the same period of time.

In the resolution of algorithms, it has been possible to verify how the students who were taught mathematics in a second language had a similar resolution to those that the teaching language coincided with their mother tongue, but it was not the case in the resolution of verbal problems or in the tests of mathematical competence. We could further say that, in both verbal problems and mathematical competence tests, the differences between the two groups were shorter in higher grades. The time of language acquisition, the language of instruction and the individual's competence affects the resolution of mathematical problems (Salillas and Wicha, 2012; Van Rinsveld et al., 2015). This fact should be taken into account when implementing bilingual programs in schools to focus on looking for ways to minimize the risks of learning the subjects and face the subsequent evident benefit.

This study would open several lines of research. On one hand, it would open a line to conduct longitudinal studies allowing us to know in depth the learning of mathematics in a second language and the resulted implications in all academic years. On the other hand, it could also lead to study whether actions such as the reformulation and simplification of the structure of daily life verbal problems can improve their resolution in a second language in the same way as it is performed in the mother tongue. Finally, from the educational point of view, complementary programs could be developed to allow students to overcome mathematic learning limitations when solving daily life problems within bilingual programs.

DATA AVAILABILITY STATEMENT

The datasets generated for this study are available on request to the corresponding author.

ETHICS STATEMENT

Ethical review and approval was not required for the study on human participants in accordance with the local legislation and institutional requirements. Written informed consent to participate in this study was provided by the participants' legal guardian/next of kin.

AUTHOR CONTRIBUTIONS

VB, PE, and IM contributed to give life, conception and shape to the study. PE and IM conducted the study and collected the data. PE organized the database and performed the statistical analysis. PE wrote the first draft. IM complemented the second draft with further theoretical support. IM wrote the English version. VB, PE, and IM wrote sections, read and approved the submitted section. All authors contributed to the article and approved the submitted version.

REFERENCES

Baddeley, A. D. (1986). *Working Memory*. Oxford: Oxford University Press.

Baker, C. (2011). *Foundations of Bilingual Education and Bilingualism*, 3rd Edn. Bristol: Multilingual Matters Ltd.

Ball, P. (2009). "Does CLIL work?," in *The Best of Both Worlds? International Perspectives on CLIL*, eds D. Hill and P. Alan (Norwich: Norwich Institute for Language Education), 32–43.

Benn, Y., Zheng, Y., Wilkinson, I. D., Siegal, M., and Varley, R. (2012). Language in calculation: a core mechanism? *Neuropsychology* 50, 1–10. doi: 10.1016/j.neuropsychologia.2011.09.045

Bentley, K. (2010). *The TKT Course CLIL Module*. Cambridge: Cambridge University Press.

Bermejo, V. (2018). *Cómo y Cuándo el Niño Aprende las Matemáticas*. Barcelona: EAE.

Bermejo, V., Ester, P., and Morales, I. (2021). A constructivist intervention program for the improvement of mathematical performance based on empiric developmental results (PEIM). *Front. Psychol.* 11:582805. doi: 10.3389/fpsyg.2020.582805

Bermejo, V., Lago, M. O., Rodríguez, P., Dopico, C., and Lozano, J. M. (2002). *PEM. Un Programa de Intervención Para la Mejora del Rendimiento Matemático*. Madrid: Editorial Complutense.

Bernardo, A., and Calleja, M. (2005). The effects of stating problems in bilingual students' first and second languages on solving mathematical word problems. *J. Genet. Psychol.* 166, 117–128. doi: 10.3200/GNTP.166.1.117-129

Bernardo, A. B. I. (2002). Language and mathematical problem solving among bilinguals. *J. Psychol.* 136, 283–297. doi: 10.1080/00223980209604156

Bialystok, E. (2009). Bilingualism: the good, the bad, and the indifferent. *Biling. Lang. Cogn.* 12, 3–11. doi: 10.1017/S1366728908003477

Bialystok, E. (2018). "Bilingualism and executive function: what's the connection?," in *Bilingual Cognition and Language: The State of the Science Across its Subfields*, eds D. Miller, F. Bayram, J. Rothman, and L. Serratrice (Amsterdam: John Benjamins Publishing Company), 283–305. doi: 10.1075/sibil.54.13bia

Campbell, J. I. D., and Epp, L. J. (2004). An encoding-complex approach to numerical cognition in Chinese-english bilinguals. *Can. J. Exp. Psychol. Rev. Can. Psychol. Exp.* 58, 229–244. doi: 10.1037/h0087447

Carpenter, T. P., and Moser, J. M. (1984). The acquisition of addition and subtraction concepts in grades one through three. *J. Res. Math. Educ.* 15, 179–202. doi: 10.5951/jresematheduc.15.3.0179

Cerezci, B. (2020). Measuring the quality of early mathematics instruction: a review of six measures. *Early Childhood Educ. J.* 48, 507–520. doi: 10.1007/s10643-019-01013-8

Colomé, À, Laka, I., and Sebastián-Gallés, N. (2010). Language effects in addition: how you say it counts. *Q. J. Exp. Psychol.* 63, 965–983. doi: 10.1080/17470210903134377

Costa, A., and Santesteban, M. (2004). Lexical accessing in bilingual speech production: evidence from language switching in highly proficient bilinguals and L2 learners. *J. Mem. Lang.* 50, 491–511. doi: 10.1016/j.jml.2004.02.002

De Corte, E., and Verscheffel, L. (1991). "Some factors influencing the solution of addition and subtraction word problems," in *Language in Mathematical Education*, eds K. Durkin and B. Shier (Milton Keynes: Open University Press), 117–130.

Dehaene, S. (1992). Varieties of numerical abilities. *Cognition* 44, 1–42. doi: 10.1016/0010-0277(92)90049-n

Dehaene, S., and Cohen, L. (1995). Towards an anatomical and functional model of number processing. *Math. Cogn.* 1, 83–120.

Dehaene, S., Spelke, E., Pinel, P., Stanescu, R., and Tsivkin, S. (1999). Sources of mathematical thinking: behavioral and brain-imaging evidence. *Science* 284, 970–974. doi: 10.1126/science.284.5416.970

Delazer, M., Domahs, F., Bartha, L., Brenneis, C., Lochy, A., Trieb, T., et al. (2003). Learning complex arithmetic- an fMRI study. *Cong. Brain Res.* 18, 76–88. doi: 10.1016/j.cogbrainres.2003.09.005

Fiedu, L., and Haro, M. J. (2017). Matemáticas y bilingüismo. *Rev. Enseñanza Aprendizaje* 85, 9–20.

Frenck-Mestre, C., and Vaid, J. (1993). Activation of number facts in bilinguals. *Mem. Cogn.* 21:809e818. doi: 10.3758/BF03202748

Garcìa, S. (2015). Teaching CLIL with digital literacies. *Verbeia* 47–63.

Geary, D. C., Cormier, P., Goggin, J. P., Estrada, P., and Lunn, M. C. E. (1993). Mental arithmetic: a componential analysis of speed-of-processing across monolingual, weak bilingual, and strong bilingual adults. *Int. J. Psychol.* 28, 185–201. doi: 10.1080/00207599308247184

Ginsburg, H. P., and Baroody, A. J. (2003). *The Test of Early Mathematics Ability*, 3rd Edn. Austin, TX: Pro Ed.

Ginsburg, H. P., and Baroody, A. J. (2007). *Tema-3: Test de Competencia Matemática Básica*. Madrid: TEA Ediciones.

Kraft, M. A., and Hill, H. C. (2018). Developing ambitious mathematics instruction through web-based coaching: a randomized field trail. *Am. Educ. Res. J.* 57, 2378–2414.

McCloskey, M. (1992). Cognitive mechanism in numerical processing: evidence from acquired dyscalculia. *Cognition* 44, 107–157.

McCloskey, M., and Macaruso, P. (1995). Representing and using numerical information. *Am. Psychol.* 50, 351–363.

Muñiz, J., Elosua, P., and Hambleton, R. K. (2013). Directrices para la traducción y adaptación de los tests: segunda edición. *Psicothema* 25, 151–157.

NCTM (2000). *Principles and Standards for School Mathematics*. Reston: NCTM.

Pesenti, M., Thioux, M., Seron, X., and Volder, A. D. (2000). Neuroanatomical substrates of Arabic number processing, numerical, comparison and simple addition: a PET study. *J. Cogn. Neurosci.* 12, 461–479. doi: 10.1162/089892900562273

Piaget, J. (1946). *La Formation du Symbole Chez Venjant*. Lonay: Delachaux et Niestlé.

Raven, J. C., Court, J. H., and Raven, J. (1996). *Raven Matrices Progresivas. Escalas: Color (CPM), General (SPM), Superior (APM). Manual*. Madrid: TEA Ediciones S.A.

Saalbach, H., Eckstein, D., Andri, N., Hobi, R., and Grabner, R. H. (2013). When language of instruction and language of application differ: cognitive costs of bilingual mathematics learning. *Learn. Instruc.* 26, 36–44. doi: 10.1016/j.learninstruc.2013.01.002

Salillas, E., and Wicha, N. Y. Y. (2012). Early learning shapes the memory networks for arithmetic: evidence from brain potentials in bilinguals. *Psychol. Sci.* 23, 745–755. doi: 10.1177/0956797612446347

Snow, C. (1999). "Bilinguüismo y adquisicioìn de una segunda lengua," in *Psicolinguüüìstica*, eds J. Berko and H. Berstain (New York, NY: McGraw-Hill).

Sotoca, E. (2014). The impact of bilingual education in academic achievement of students enrolled in public schools in the Autonomous Community of Madrid. *Rev. Comp. Educ.* 25, 481–500. doi: 10.5209/rev_RCED.2014.v25.n2.41732

Spelke, E. S., and Tsivkin, S. (2001). Language and number: a bilingual training study. *Cognition* 78, 45–88.

Swanson, H. L., Kong, J. E., and Petcu, S. (2019). Individual differences in math problem solving and executive processing among emerging bilingual children. *J. Exp. Child Psychol.* 187:104653. doi: 10.1016/j.jecp.2019.06.006

Swanson, H. L., Olide, A. F., and Kong, J. E. (2018). Latent class analysis of children with math difficulties and/or math learning disabilities: are there cognitive differences? *J. Educ. Psychol.* 110, 931–951.

Thurstone, L. L., and Yela, M. (2012). *CARAS-R. Test de Percepción de Diferencias-Revisado*. Madrid: Tea Ediciones.

Turnbull, M., Hart, D., and Lapkin, S. (2003). Grade 6 French immersion students' performance on large-scale reading, writing, and mathematics tests: building explanations. *Alberta J. Educ. Res.* 49, 6–23.

Van Rinsveld, A., Brunner, M., Landerl, K., Schiltz, C., and Ugen, S. (2015). The relation between language and arithmetic in bilinguals: insights from different stages of language acquisition. *Front. Psychol.* 6:265.

Van Rinsveld, A., Schiltz, C., Brunner, M., Lander, K., and Ugen, S. (2016). Solving arithmetic problems in first and second language: does the language context matter? *Learn. Instruc.* 42, 72–82.

Verschaffel, L., Greer, B., and De Corte, E. (2000). *Making Sense of Word Problems*. Lisse: Swets & Zeitlinger.

Volmer, E., Grabner, R. H., and Saalbach, H. (2018). Language switching costs in bilingual mathematics learning: transfer effects and individual differences. *Z. Erziehwiss.* 21, 71–96. doi: 10.1007/s11618-017-0795-6

Conflict of Interest: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

frontiers in Psychology

ORIGINAL RESEARCH
published: 28 April 2021
doi: 10.3389/fpsyg.2021.635725

The Role of Social Media Use in Peer Bullying Victimization and Onset of Anxiety Among Indonesian Elementary School Children

Dian Veronika Sakti Kaloeti[1], Rouli Manalu[2], Ika Febrian Kristiana[1] and Mariola Bidzan[3]*

[1] Faculty of Psychology, Diponegoro University, Semarang, Indonesia, [2] Faculty of Social and Political Sciences, Diponegoro University, Semarang, Indonesia, [3] Institute of Psychology, University of Gdansk, Gdansk, Poland

Objectives: This study explored a multidimensional model of the relationships between social media use, gender, peer bullying victimization experiences, and the onset of anxiety symptoms among children. We hypothesized that greater experience of bullying would be associated with greater onset of anxiety. We also expected that gender and social media use (specifically Instagram and YouTube) would be linked with anxiety among elementary school children. To test this hypothesis, a structural equation modeling approach was used.

Methods: A total of 456 elementary children aged 11–13 years from nine schools were recruited for this research. We used two psychological measures: The Screen for Child Anxiety Related Emotional Disorders (SCARED) and the Personal Experience Checklist (PECK) as well as a sociodemographic questionnaire (general demographic information and social media-related information).

Results: The social media usage survey found that all participants (100%) used social media. Instagram (52.42%) and YouTube (47.58%) were the platforms most used by the participants. The Structural Equation Model results suggest that bullying victimization and gender predicted the onset of anxiety in elementary school children. The model explained 32.1% of the variance of the outcome with very adequate fit indicators based on most indices, $\chi^2 = 173.56$, df = 52, $p < 0.001$; CFI = 0.92; TLI = 0.94; RMSEA = 0.07 (90% CI: 0.06–0.08). Instagram use was correlated positively with generalized anxiety disorder. Gender was negatively correlated with Instagram use and positively correlated with YouTube use. Girls were found to use Instagram more and boys were found to use YouTube more. It was also found that girls had higher scores onSCARED dimensions, except for school avoidance. Girls were more prone to onset of anxiety than boys, except for school avoidance, which was not related to gender. Boys were found to experience significantly more physical bullying than girls. On the other hand, girls were found to experience more panic disorder, generalized anxiety disorder, separation anxiety disorder, and social anxiety than boys.

Conclusion: This study found that bullying victimization significantly influences the onset of anxiety in children. Particular attention should be paid to cyberbullying in this

OPEN ACCESS

Edited by:
Edgar Galindo, University of Evora, Portugal

Reviewed by:
Norzarina Mohd-Zaharim, Universiti Sains Malaysia (USM), Malaysia
Evelin Ingrid Witruk, Leipzig University, Germany
Vahid Delshad, University of Social Welfare and Rehabilitation Sciences, Iran

****Correspondence:***
Dian Veronika Sakti Kaloeti
dvs.kaloeti@live.undip.ac.id

Specialty section:
This article was submitted to Educational Psychology, a section of the journal Frontiers in Psychology

Received: *30 November 2020*
Accepted: *11 March 2021*
Published: *28 April 2021*

Citation:
Kaloeti DVS, Manalu R, Kristiana IF and Bidzan M (2021) The Role of Social Media Use in Peer Bullying Victimization and Onset of Anxiety Among Indonesian Elementary School Children. Front. Psychol. 12:635725. doi: 10.3389/fpsyg.2021.635725

context. This study also found a link between gender and anxiety—girls had a greater tendency to experience the onset of various types of anxiety, including panic disorder, generalized anxiety disorder, separation anxiety disorder, and social anxiety. Gender was also correlated with the form of bullying victimization. The findings of this study suggest that boys were more likely to experience physical bullying than girls. Interestingly, we found that Instagram use was significantly correlated with developing separation anxiety. In particular, children demonstrated school avoidance when experiencing cyberbullying. Limitations and future directions are discussed.

Keywords: social media, bullying victimization, gender, anxiety, children

INTRODUCTION

According to Internet World Stats (2020), released in September 2020, Asia is the region of the world with the greatest number of Internet users–2.5 billion people, amounting to 51.8% of total users of the Internet. Indonesia is the third-largest user of the Internet in the world (Internet World Stats, 2020).

Based on the results of a survey by the Indonesian Internet Service Providers Association (APJII) and the Indonesia Survey Center, the number of Indonesian Internet users in 2019–2020 was 196.7 million, meaning that around 73.7% of Indonesians were connected to the Internet; the Java province dominates, with 55.7% of the total users. Furthermore, the number of social media users in Indonesia is 106 million out of a total population of 262 million (Triastuti et al., 2017). Based on the APJII survey (2020), the number of children using social media from year to year is increasing in line with the increasing number of Internet users in Indonesia. In Indonesia in 2019, 25.2% of children aged 5–9 years and 66.2% of children aged 10–14 years were active Internet users [Indonesian Internet Service Providers Association (APJII), 2020]. The use of the Internet in schools and online learning requires that children be connected to the digital world. In the same year, the majority of Internet users in Indonesia accessed online media for education and school content [Indonesian Internet Service Providers Association (APJII), 2020]. The lifestyles of various age groups, including children, especially in their late childhood, have changed in recent years. In contrast to children a few decades ago, children today are leading increasingly sedentary lifestyles that involve greater time spent on computers and watching TV (Bidzan-Bluma and Lipowska, 2018; Jochimek and Łada, 2019; Cornelius et al., 2020). In the last 15 years, the Internet has grown very fast: 40% of the world's population use the Internet, and the population of children is no exception. This generation is called the post-millennial and digital native generation because they are growing up in a wireless, hyper-networked environment that prefers communication over the Internet (Holton and Fraser, 2015). The reasons children use the Internet and social media include seeking information, to connect with friends (old and new), and for entertainment (Kominfo, 2014; Supratman, 2018).

This group spends 41% of their time in front of screens (Molter, 2020) and likes to share photos and videos via Instagram, YouTube, and Snapchat (Dolot, 2018). Furthermore, the types of social media most frequently used by children of the digital native generation are YouTube, Instagram, WhatsApp, FB, and Twitter (We Are Social, 2017; Supratman, 2018). In addition, Triastuti et al. (2017) noted that YouTube and Instagram are the most popular social media for children and adolescents. Furthermore, Triastuti et al. (2017) identified the following reasons for this group favoring these platforms, among others: their peers use these platforms; they have features that allow users to monitor each other, leave comments, share information (post daily activities), and communicate (message features); and entertainment.

Digital technology can positively impact children and adolescents in many ways, such as by improving their literacy and math skills, increasing socialization skills, by providing intellectual benefits such as problem-solving and critical thinking skills, as well as increasing imagination, art, and modeling skills (Undiyaundeye, 2014). Social media such as Facebook, Twitter, and YouTube can expand social connections and learning opportunities (McDool et al., 2016) and provide opportunities to connect with peers and for self-development (Ólafsson et al., 2013; Dyer, 2018). However, the Internet is a double-edged sword: Research has noted the negative impacts of digital technology on children, including poor self-esteem, mental health problems, and social difficulties (Wood et al., 2016). The use of social media, such as Instagram and YouTube, is also one of the leading causes of self-harm (McDool et al., 2016), cyberbullying, poor body image, and decreased academic performance (Wallsten, 2013; Akram and Kumar, 2017). Excessive use of social media generates anxiety (Sagioglou and Greitemeyer, 2014), addiction (Van Rooij and Prause, 2014), and can affect sleep behavior (Hisler et al., 2020). The increasing use of social media by children exposes them to various forms of bullying. This has increased the likelihood of children being perpetrators or victims, with multiple models or types of cyberbullying, ranging from gossip, ridicule, or coercion to bullying or violence from friends through electronic media. Some studies have documented the forms of bullying experienced by elementary school students through cyberspace or social media, for example, receiving unpleasant, nasty, or threatening text messages or emails (Noret and Rivers, 2006; Smith et al., 2008). Other studies have found that more students self-report having experienced traditional bullying than cyberbullying

(Olweus and Limber, 2017; Bleam, 2018). Both forms of bullying contribute to emotional difficulties experienced by elementary school students. Cyberbullying is defined as violence, threats, coercion, or attempts to aggressively harass, humiliate, intimidate, or dominate another person using electronic media. It usually manifests as repetitive and hostile behavior shown by groups or individuals (Chatzakou et al., 2017). Previous research has considered the dimensions of cyberbullying from multiple perspectives. For example, Griezel et al. (2008) observed that traditional bullying consists of physical, verbal, and social dimensions, whereas cyberbullying consists only of visual and textual dimensions. Abeele and Cock (2013) reviewed previous research and identified two different types of cyberbullying: direct virtual bullying of the victim (e.g., sending threatening messages directly to the victim) and indirect or relational cyber bullying (e.g., gossiping without the victim's knowledge). Furthermore, Qing (2015) suggests that new forms of technology pose further challenges for defining cyberbullying. Inconsistencies in study results can lead to inaccurate estimates of the prevalence of cyberbullying. Some studies have found that there is an increase in the type of bullying from traditional bullying to cyberbullying as children aged (early to mid-adolescent students; Ortega et al., 2009; Charalampous et al., 2018). It is important to watch out for technological developments that increase the likelihood of students being bullied beyond what happens in schools, namely, in the cyber world or virtual space. Students' actions in this virtual space are often overlooked and are difficult for adults to monitor (Diamanduros et al., 2008; Rideout et al., 2010). Unsurprisingly, students who use the Internet are at risk of having experienced at least some virtual bullying (Smith et al., 2008; Kowalski et al., 2014).

Studies have reported adverse effects of bullying on children and adolescents (Lamarche et al., 2007; Merrell et al., 2008; Cardoos and Hinshaw, 2011; Cornell and Mehta, 2011). Victims of bullying tend to experience increased anxiety, depression, socio-emotional problems, low self-esteem, feelings of social inadequacy, behavioral difficulties, impaired academic performance, school avoidance, absenteeism, and increased dropout rates. Moreover, students with high social anxiety show poorer adjustment to school, manifesting avoidance behaviors in response, thereby contributing to them underperforming and putting them at risk of prematurely leaving the educational system (Delgado et al., 2019). A meta-analysis by Cunningham et al. (2015) identified a link between childhood bullying and psychotic symptoms. Stapinski et al. (2014) also found that adolescents who experienced bullying in childhood were two to three times more likely to have anxiety disorders.

In addition, Calleja and Rapee (2020) found an association between adolescents who self-reported victimization by their peers and internalizing symptoms (i.e., anxiety and depression). Adolescents who experience anxiety or depression are more sensitive to social threats when this correlates with self-reported victimization by their peers. Other studies have shown that anxious and depressed adolescents consistently interpret ambiguous social stimuli as threats and social rejection (Miers et al., 2008).

Furthermore, students with high social anxiety exhibit greater school absenteeism, are more stressed by academic tasks (Van-Roy et al., 2009), and are involved in fewer extracurricular activities than students without social anxiety (Delgado et al., 2019). Research conducted in several provinces in Indonesia shows that elementary school children in Yogyakarta province experience moderate anxiety (Naen, 2019) and that as many as 48% of elementary school children in the city of Bogor experience anxiety, and 84.7% experience depression (Utami et al., 2019).

In addition, gender differences have been found to have an effect on social media use. Mazman and Usluel (2011) identified that it is mostly men who use Facebook to make new friends, while it is mostly female users who use Facebook to maintain existing relationships, for academic purposes, and to pursue specific agendas. In addition, women are more selective when adding friends on social media than men (Kasahara et al., 2019). A study conducted by Booker et al. (2018) showed that the use of social media in girls at the age of 10 has the potential to reduce psychological well-being compared with boys.

In this study, we hypothesize that social media, bullying victimization, and gender will predict the onset of anxiety. Also, this research examines the strength and direction of the relationships of social media, bullying victimization, and gender with the onset of anxiety among Indonesian elementary school children.

MATERIALS AND METHODS

Participants

A total of 456 elementary students from six grades, aged 11–13 years old ($M = 11.17$, $SD = 0.43$), from nine schools (five schools in Semarang, Central Java; four in Yogyakarta) were recruited for this research (52.41% of whom were male). These schools are located in the city center, and the students have adequate Internet access both at school and home. The students completed paper-and-pencil surveys in their classrooms during a single class period (50 min) under the supervision of trained research assistants (**Table 1**).

Research Instruments

This study used two instruments: The Screen for Child Anxiety Related Emotional Disorders (SCARED) and the Personal Experience Checklist (PECK).

The SCARED was first developed by Birmaher et al. (1997). It measures anxiety disorders in children and adolescents and consists of 41 question items with five dimensions: 10 items concerning Panic Disorder or Significant Somatic Symptoms (e.g., *when I get frightened, I feel like passing out*); nine items concerning Generalized Anxiety Disorder (e.g., *I worry about other people liking me*); eight items concerning Separation Anxiety Disorder (e.g., *I get scared if I sleep away from home*); seven items concerning Social Anxiety Disorder (e.g., *I feel nervous with people I don't know well*); and four items concerning School Avoidance (e.g., *I get stomach aches at school*; Birmaher et al., 1999). The SCARED uses a Likert scale that ranges from 0 (*never*) to 2 (*frequently*). The scale is interpreted by adding up

TABLE 1 | Participant demographics.

Aspect	Frequency ($N = 456$)	
	n	%
Gender		
Male	239	52.41%
Female	217	47.58%
Age		
10	9	1.97%
11	356	78.07%
12	88	19.29%
13	3	0.65%

scores on all items: a score of more than 25 indicates the presence of an anxiety disorder. The reliability coefficient for panic disorder or significant somatic symptoms was 0.744, generalized anxiety disorder was 0.886, separation anxiety disorder was 0.76, social anxiety disorder was 0.732, and school avoidance was 0.752. The SCARED reliability coefficient in this study was 0.878.

The PECK is used to explore bullying and cyberbullying experienced by children and adolescents. It consists of 32 question items and four factors: relational–verbal bullying (e.g., *other kids say mean things behind my back*); cyberbullying (e.g., *other kids threaten me over the phone*); physical bullying (e.g., *other kids tell people to hit me*); and bullying based on culture (e.g., *other kids tease me about my accent*; Hunt et al., 2012). Relational–verbal bullying focuses on all forms of verbal abuse, for example, being called mean names, being made fun of, or being teased in a hurtful way (Hunt et al., 2012). Cyberbullying is negative behaviors that take place on mobile phones and the Internet, such as threats, spreading rumors, and being malicious (Grigg, 2010). Physical bullying is direct physical violence, for example, kicking or damaging the victim's property (Fu et al., 2015). Bullying based on culture occurs due to cultural factors, including differences in skin color, country of origin, culture, and/or religion (Rodríguez-Hidalgo et al., 2019). Respondents were asked to answer each question on a five-point Likert scale: 1 (*never*), 2 (*rarely*), 3 (*sometimes*), 4 (*once a week*), and 5 (*almost every day*). The total of all the respondents' answers indicates the individual's experience of bullying and cyberbullying and can be sorted into five categories: *not at all*, *somewhat bad*, *bad*, *very bad*, or *terrible*. The reliability coefficient of the PECK in this study was 0.889, and the subscale's reliability coefficient for relational–verbal bullying was 0.821, for cyberbullying was 0.762, for physical bullying was 0.765, and for bullying based on culture was 0.849.

Data Collection Process

This study was approved by the Research Ethics Committee of the first author's institution and complied with the ethical standards for research involving human subjects. Before the survey was administered, students were provided with consent forms.

Participants were elementary school children. Based on predetermined age criteria, schools selected classes that could be accessed by researchers. In the early stages, the researchers conducted a meeting with the school and the parents/guardians in which they explained the study. The parents were then asked to provide their informed consent to the school within a maximum period of 1 week. Parents/guardians who gave their consent continued with the data collection process. All parents contacted agreed to give consent for the study.

They were fully informed that participation is voluntary, and they could either refuse to participate or withdraw from the study. Students' answers were confidential.

Social Media Usage Survey

The social media usage survey showed that all participants were social media users. Instagram (52.42%) and YouTube (47.58%) were the primary platforms used by participants. More than half of the participants (56.79%) reported that the time spent on social media each day was 1–3 h. Detailed results of this survey can be found in **Table 2**.

Data Analysis

All variables were screened for data entry accuracy, missing values, multivariate outliers, normality, linearity, and homoscedasticity. The association between continuous variables was tested utilizing Pearson correlations. Structural equation modeling (SEM) was used to test the hypothesized model. The study followed the two-step approach to SEM (Kline, 2005): first testing the measurement model to establish a statistically reliable measure for each construct and then testing the structural model to examine the multivariate relationships among the constructs. Model fit was assessed with the chi-square goodness-of-fit statistic (nonsignificant chi-square value), χ^2/df, comparative fit index (CFI), where values above 0.90 indicate good fit and root mean square error of approximation (RMSEA) values <0.8 (Tabachnick and Fidell, 2001) or 0.05 indicate a "close fit" (Kline, 2005). These indices were used to evaluate whether the estimated covariance matrix was an adequate representation of the sample covariance matrix. All maximum likelihood estimations for the model were computed using IBM SPSS AMOS 24.0.

RESULTS

Descriptive Statistics and Relations Among the Variables

Table 3 presents the means and standard deviations of the variables assessed, and **Table 4** displays the matrix of correlations among social media types, gender, and PECK and SCARED dimensions. In the analyses, gender was made a dummy variable. Instagram use was correlated positively with generalized anxiety disorder. Gender was negatively correlated with Instagram use and positively with YouTube use. Girls were found to use Instagram more, and boys were found to use YouTube more. Additionally, it was also found that girls scored higher on SCARED dimensions, except for school avoidance. Girls were more prone to onset of anxiety than boys, except for school avoidance, which was not related to gender. Boys were found to

TABLE 2 | Social media usage survey.

Aspect	Frequency ($N = 456$)	
	N	%
Do you use social media?		
Yes	456	100%
Social media platform		
Instagram	239	52.42%
YouTube	217	47.58%
Length of time spent on social media each day (hours)		
1–3	259	56.79%
4–6	62	13.59%
>6	135	29.60%

TABLE 3 | Mean and standard deviations of bullying victimization and anxiety ($N = 456$).

	Mean	Standard deviation
PECK		
Relational–verbal Bullying	7.71	5.57
Cyberbullying	1.09	1.92
Physical bullying	5.56	4.25
Bullying based on Culture	1.07	1.41
SCARED		
Panic disorder	5.13	3.41
Generalized anxiety disorder	6.28	3.05
Separation anxiety disorder	6.57	2.91
Social anxiety	5.47	2.94
School avoidance	1.46	1.24

experience significantly more physical bullying than girls. On the other hand, girls were found to experience more panic disorder, generalized anxiety disorder, separation anxiety disorder, and social anxiety than boys.

The PECK items were all highly and positively correlated with each other. SCARED domains also showed moderate and positive relationships among each other. Relational–verbal bullying and physical bullying were positively correlated with all SCARED dimensions. Cyberbullying was positively correlated with general anxiety disorder and school avoidance domains; it was also significantly correlated with bullying based on culture, panic disorder, generalized anxiety disorder, and school avoidance.

Figure 1 presents the structural equation model results, suggesting that bullying victimization and gender predicted the onset of anxiety in elementary school children. The figure includes all the path coefficients that are significant at and beyond the 0.05 level. Based on the model and **Table 5**, anxiety was directly influenced by bullying victimization ($\beta = 0.50$) and gender ($\beta = -0.27$). The model explained 32.1% of the variance with very adequate fit indicators based on most indices, $\chi^2 = 173.56$, $df = 52$, $p < 0.001$; CFI = 0.92; TLI = 0.94; RMSEA = 0.07 (90% CI: 0.06–0.08).

Gender Differences in Bullying Victimization and Anxiety

Table 6 presents the differences between boys and girls in terms of several aspects of bullying victimization and anxiety. There were significant differences in physical bullying, panic disorder, generalized anxiety disorder, separation anxiety disorder, social anxiety disorder, and school avoidance.

Boys tended to experience more physical bullying than girls. On the other hand, girls tended to experience more panic disorder, generalized anxiety disorder, separation anxiety disorder, social anxiety, and school avoidance than boys.

DISCUSSION

This study found that bullying victimization significantly affected anxiety onset in children. Being a victim of bullying was associated with several mental health issues, such as poor self-esteem, depression and anxiety, externalizing disorders, and even suicidal behavior, especially in girls. Bullying was closely related to externalizing disorders such as ADHD, conduct disorders, and oppositional defiant disorder. A meta-analysis by Cunningham et al. (2015) found that bullying in childhood is related to the development of psychotic symptoms. Copeland et al. (2013) found that students who are victims of bullying have higher prevalences of generalized anxiety disorder, panic disorder, and antisocial personality disorder than perpetrators. The relationship between social problems and the onset of panic attacks begins with poor social skills and difficulties in peer relationships, which in turn can lead to lower self-esteem and feelings of lack of control and helplessness (Mathyssek et al., 2012). Research in Indonesia has found that school-age children are very susceptible to bullying because this is the time at which children start to move out of the family environment and to mix and interact with peers (Wakhid et al., 2017). Peer groups play a large role in the school environment, as children spend most of their time with peers. As children want to be liked by their friends generally, they will do whatever their peers tell them to in order to be accepted by the group. Bullying in peer groups can often result in anxiety, loneliness, decreased sense of security, fear, depression, poorer school grades, and even running away from home. The onset of anxiety can be one significant effect of bullying, especially if the perpetrators are peers who should be a source of support and help meet the victim's socialization needs (Xie and Ngai, 2020).

Furthermore, this study also found that Cyberbullying was significantly correlated with generalized anxiety disorder, and school avoidance. This is in line with previous studies (Xantus et al., 2015) that found that children who experience significant bullying victimization have higher generalized anxiety scores. This can be due to such children feeling that school and school friendships are not a safe environment. In Indonesian culture, negative stigma from one's environment is considered to be very shameful (Budirahayu et al., 2018), so the relationship between friends is very important, in some cases, even greater than other needs (Lubis et al., 2019). An Indonesian study by Waliyanti and Kamilah (2019) found that teenagers can have high tolerances

TABLE 4 | Correlation matrix of social media types, gender, bullying victimization, and anxiety ($N = 456$).

	1	2	3	4	5	6	7	8	9	10	11	12
(1). Instagram	1											
(2). YouTube	−0.59**	1										
(3). Gender (boy = 1, girl = 0)	−0.21**	0.24**	1									
PECK												
(4). Relational–verbal bullying	−0.04	0.05	−0.06	1								
(5). Cyberbullying	0.03	−0.08	0.03	0.35**	1							
(6). Physical bullying	−0.04	0.06	0.10*	0.71**	0.48**	1						
(7). Bullying based on culture	0.01	−0.05	0.07	0.48**	0.27**	0.44**	1					
SCARED												
(8). Panic disorder	0.04	−0.02	−0.14**	0.44**	0.09	0.29**	0.22**	1	1			
(9). Generalized anxiety disorder	0.06	−0.04	−0.20**	0.42**	0.13*	0.27**	0.22**	0.63**	1			
(10). Separation anxiety disorder	0.10*	−0.03	−0.23**	0.29**	0.09	0.18**	0.09	0.53**	0.51**	1		
(11). Social anxiety	0.07	−0.03	−0.24**	0.22**	0.04	0.11*	0.04	0.40**	0.52**	0.42**	1	
(12). School avoidance	0.02	0.01	−0.08	0.31**	0.14**	0.19**	0.16**	0.38**	0.32**	0.33**	0.26**	1

***Correlation is significant at the 0.01 level (two tailed).*
**Correlation is significant at the 0.05 level (two tailed).*

TABLE 5 | Maximum likelihood estimates of the model.

Path	Unstandardized estimate	Standardized estimate	Standard errors	Critical ratio
Bullying victimization → anxiety	0.27	0.50	0.03	8.96
Instagram → anxiety	0.45	0.08	0.32	1.38
YouTube → anxiety	0.28	0.05	0.29	0.95
Gender → anxiety	−1.37	−0.27	0.25	−5.54

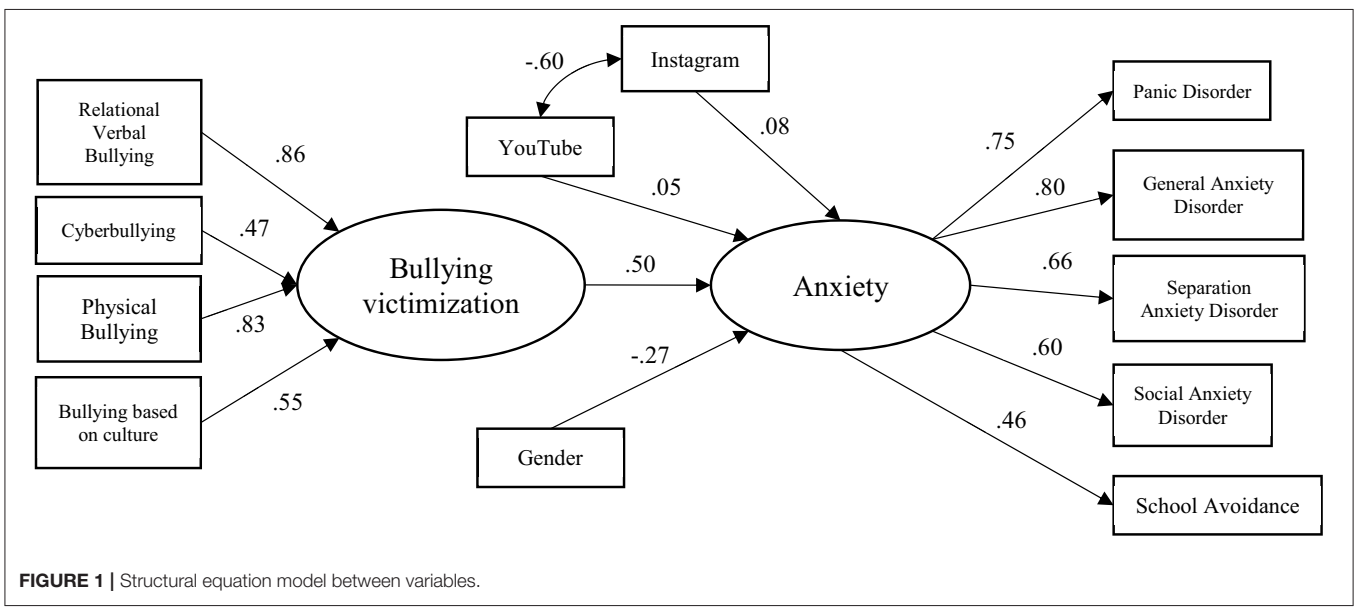

FIGURE 1 | Structural equation model between variables.

for acts of violence committed against their friends because bullies tend to dominate peer groups, causing teenagers to fear that they themselves will be bullied if they speak up. This can lead to the emergence of excessive anxiety among victims of bullying, including concerns about themselves experiencing acts of violence from others in their environment and the prospect of pain in the future (Pontillo et al., 2019). Thus, it is important that teachers provide a safe classroom environment and clearly

TABLE 6 | Differences between genders.

		N	Mean	*t*
Relational–verbal bullying	Girls	217	8.078	1.354
	Boys	239	7.372	1.358
Cyberbullying	Girls	217	1.083	−0.074
	Boys	239	1.096	−0.074
Physical bullying	Girls	217	5.111	−2.144**
	Boys	239	5.962	−2.170**
Bullying Based on Culture	Girls	217	0.963	−1.492
	Boys	239	1.159	−1.508
Panic disorder	Girls	217	5.636	3.039**
	Boys	239	4.674	3.044**
Generalized anxiety disorder	Girls	217	6.926	4.417**
	Boys	239	5.686	4.401**
Separation anxiety disorder	Girls	217	7.272	5.032**
	Boys	239	5.933	5.025**
Social anxiety disorder	Girls	217	6.203	5.176**
	Boys	239	4.816	5.181**
School avoidance	Girls	217	1.567	1.777*
	Boys	239	1.360	1.774*

***Difference is significant at the 0.01 level (two tailed).*
**Difference is significant at the 0.05 level (two tailed).*

communicate to students that bullying is a negative behavior that must be avoided, even though the perpetrator may be a member of their peer group.

Cyberbullying increases feelings of isolation and helplessness (Wang et al., 2012). Children who experience cyberbullying have fewer friends (Price and Dalgleish, 2010) and experience emotional and peer relationship problems (Sourander et al., 2015; Nicolai et al., 2018) as well as increased social anxiety (Dempsey et al., 2009; Fredstrom et al., 2011). Some studies (Randa, 2013; Randa and Reyns, 2014) have found that cyberbullying victimization positively correlates with fear of victimization in school and adaptive avoidance behavior at school.

This study also found that gender significantly affected anxiety onset and that boys experience more physical bullying than girls. The literature on bullying reveals that boys are more prone to be bullies and victims of bullying, especially physical bullying. At the same time, girls are more likely to be involved in emotional or indirect bullying, such as teasing or spreading falsehoods about their peers (Carbone-Lopez et al., 2010; Romera Félix et al., 2011; Clarke et al., 2012; AlBuhairan et al., 2017). This can be related to differences in characteristics between genders. The stereotypical characteristics of masculinity are closely related to acts of intimidation and violence, while feminine characteristics are related to victimization and verbal forms of aggression (Iossi Silva et al., 2013). In Indonesian culture, parents tend to instill the spirit of "*Kesatria*" in boys, represented by strong personal characteristics and a strong and dignified physical appearance, so that strength and physical appearance have a distinct value for boys (Fitri and Waluyo, 2019).

In line with this, indirect forms of bullying that often occur in boys are related to testing physical strength as an indication of dominance and power over other individuals (Iossi Silva et al., 2013). Bullies tend to feel proud and strong after "defeating" their "opponents" (Iossi Silva et al., 2013).

Interestingly, we found that using Instagram was significantly correlated with the onset of separation anxiety. Depressive symptoms, adverse moods, low self-esteem, and anxiety are marginally positively associated with Instagram (Lup et al., 2015; Marengo et al., 2018; Sherlock and Wagstaff, 2018). Furthermore, one longitudinal study (Vannucci and Ohannessian, 2019) found that children who frequently use Instagram are more likely to manifest delinquent and school avoidance behavior. Many school-age children learn about Instagram and then become active users based on the influence of people around them, including their parents, family members other than their parents (e.g., older siblings), and friends (Kurnia et al., 2017). They become active and enjoy sharing photos, commenting, and getting to know lots of new friends. However, it is very unfortunate that children can lack the technical skills, knowledge, and emotional maturity to navigate social media like Instagram, making them vulnerable to its negative effects.

Limitations and Future Directions

No study is without limitations. All study variables were individual level, and further work is required across various levels of data. The study was carried out in a limited geographical area, Java Province, the largest in Indonesia, which has greater access to technology and facilities than other provinces. Consequently, the generalizability of results to different contexts is limited. Future investigations should explore and include the type and quality of schools, parental education level, SES indicators, and comparisons with the parents' perspective. Qualitative research could help obtain in-depth data regarding children's activity on Instagram and the experience of bullying and its effect on anxiety onset in relation to their social media behaviors. Our study also identifies the need to develop interventions and prevention strategies aimed at bullying victimization in children who use social media, such as teaching children digital literacy skills, digital resilience skills, and steps that can be taken when faced with situations that could potentially lead to bullying. Another strategy would be to develop programs that involve the active participation of schools and parents in creating a positive digital environment for children.

CONCLUSION

This study found that bullying victimization significantly influenced onset of anxiety in children. Particular attention should be paid to cyberbullying in this context. This study also found a link between gender and anxiety—girls had a greater tendency to experience the onset of a variety of types of anxiety, including panic disorder, generalized anxiety disorder, separation anxiety disorder, and social anxiety. Gender was also correlated with the form of bullying victimization, with boys being more likely to experience physical bullying than girls. Interestingly, we found that Instagram use was significantly correlated with developing separation anxiety and that children demonstrated school avoidance when experiencing cyberbullying. However, further investigation is needed to

explain the underlying psychological dynamics. The data presented in this paper on elementary school children who use social media can provide crucial insights for those who take care of them, namely, parents/guardians, teachers, and the government. These parties should pay careful attention to the digital well-being of elementary school children, for example through mentoring and social media literacy, to prevent bullying and, by extension, anxiety.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Faculty of Psychology, Diponegoro University, Semarang, Indonesia. Written informed consent to participate in this study was provided by the participants' legal guardian/next of kin.

AUTHOR CONTRIBUTIONS

DK conceptualized the study, acquired the funding, and analyzed the data. DK, RM, IK, and MB made substantial and direct intellectual contributions to the work, provided feedback, and approved the final version of the manuscript. All authors contributed to the article and approved the submitted version.

FUNDING

This work was supported by the LPPM UNDIP under the International Scientific Publications schema (grant number 391-10/UN7.P4.3//PP).

ACKNOWLEDGMENTS

We wish to thank the participants, parents, and the schools who participated in and cooperated with our project. We are also grateful to the research assistants for contributing to the data collection process.

REFERENCES

Abeele, M. V., and Cock, R. (2013). Cyberbullying by mobile phone among adolescents : the role of gender and peer. *Communications* 38, 107–118. doi: 10.1515/commun-2013-0006

Akram, W., and Kumar, R. (2017). A study on positive and negative effects of social media on society. *Int. J. Comput. Sci. Eng.* 5, 351–354. doi: 10.26438/ijcse/v5i10.351354

AlBuhairan, F., Abbas, O., Sayed, D., Badri, M., Alshahri, S., and Vries, N. (2017). The relationship of bullying and physical violence to mental health and academic performance: a cross-sectional study among adolescents in Kingdom of Saudi Arabia. *Int. J. Pediatr. Adolesc. Med.* 4, 61–65. doi: 10.1016/j.ijpam.2016.12.005

Bidzan-Bluma, I., and Lipowska, M. (2018). Physical activity and cognitive functioning of children: a systematic review. *Int. J. Environ. Res. Public Health* 15:800. doi: 10.3390/ijerph150408

Birmaher, B., Brent, D. A., Chiappetta, L., Bridge, J., Monga, S., and Baugher, M. (1999). Psychometric properties of the Screen for Child Anxiety Related Emotional Disorders (SCARED): a replication study. *J. Am. Acad. Child Adolesc. Psychiatry* 38, 1230–1236. doi: 10.1097/00004583-199910000-00011

Birmaher, B., Khetarpal, S., Brent, D., Cully, M., Balach, L., Kaufman, J., et al. (1997). The screen for child anxiety related emotional disorders (SCARED): Scale construction and psychometric characteristics. *J. Am. Acad. Child Adolesc. Psychiatry* 36, 545–553. doi: 10.1097/00004583-199704000-00018

Bleam, S. (2018). *The Role of Traditional and Cyberbullying Victimization in Predicting Emotional Difficulties in Elementary Schools [Mahurin Honors College Capstone Experience, Western Kentucky University]*. Thesis Projects. Available online at: https://digitalcommons.wku.edu/stu_hon_theses/742 (accessed May 7, 2020).

Booker, C. L., Kelly, Y. J., and Sacker, A. (2018). Gender differences in the associations between age trends of social media interaction and well-being among 10-15 year olds in the UK. *BMC Public Health* 18:321. doi: 10.1186/s12889-018-5220-4

Budirahayu, T., Wijayanti, M. M., and Baskoro, K. (2018). Understanding the multiculturalism values through social media among indonesian youths. *Masyarakat Kebudayaan Politik* 31, 427–439. doi: 10.20473/mkp.V31I42018.427-439

Calleja, R. L., and Rapee, R. M. (2020). Social threat sensitivity and its relationships with peer victimisation and internalising symptoms among adolescent girls. *Behav. Res. Ther.* 133, 1–7. doi: 10.1016/j.brat.2020.103710

Carbone-Lopez, K., Esbensen, F., and Brick, B. T. (2010). Correlates and consequences of peer victimization: gender differences in direct and indirect forms of bullying. *Youth Violence Juvenile Justice* 8, 332–350. doi: 10.1177/1541204010362954

Cardoos, S. L., and Hinshaw, S. P. (2011). Friendship as protection from peer victimization for girls with and without ADHD. *J. Abnorm. Child Psychol.* 39, 1035–1045. doi: 10.1007/s10802-011-9517-3

Charalampous, K., Demetriou, C., Tricha, L., Ioannou, M., Georgiou, S., Nikiforou, M., et al. (2018). The effect of parental style on bullying and cyber bullying behaviors and the mediating role of peer attachment relationships: a longitudinal study. *J. Adolesc.* 64, 109–123. doi: 10.1016/j.adolescence.2018.02.003

Chatzakou, D., Kourtellis, N., Blackburn, J., De Cristofaro, E., Stringhini, G., and Vakali, A. (2017). "Mean birds: detecting aggression and bullying on twitter," in *Proceedings of the 2017 ACM on Web Science Conference - WebSci'17* (New York, NY).

Clarke, C. M., Kane, D. J., Rajacich, D. L., and Lafreniere, K. D. (2012). Bullying in undergraduate clinical nursing education. *J. Nurs. Educ.* 51, 269–276. doi: 10.3928/01484834-20120409-01

Copeland, W. E., Wolke, D., Angold, A., and Costello, E. J. (2013). Adult psychiatric outcomes of bullying and being bullied by peers in childhood and adolescence. *JAMA Psychiatry* 70, 419–426. doi: 10.1001/jamapsychiatry.2013.504

Cornelius, C., Fedewa, A., and Toland, M. (2020). A classroom-based physical activity intervention for adolescents: is there an effect on self-efficacy, physical activity, and on-task behavior?. *Health Psychol. Rep.* 8, 408–427. doi: 10.5114/hpr.2020.99002

Cornell, D., and Mehta, S. B. (2011). Counselor confirmation of middle school student self-reports of bullying victimization. *Profes. School Couns.* 14:2156759X1101400402. doi: 10.1177/2156759X1101400402

Cunningham, C., Rimas, H., Mielko, S., and Mapp, C. (2015). What limits the effectiveness of antibullying programs? A thematic analysis of the perspective of teachers. *J. School Violence.* 15, 460–482. doi: 10.1080/15388220.2015.1095100

Delgado, B., Martinez-Monteagudo, M. C., Ruiz-Esteban, C., and Rubio, E. (2019). Latent class analysis of school refusal behavior and its

relationship with cyberbullying during adolescence. *Front. Psychol.* 10:1916. doi: 10.3389/fpsyg.2019.01916

Dempsey, A. G., Sulkowski, M. L., Nichols, R., and Storch, E. A. (2009). Differences between peer victimization in cyber and physical settings and associated psychosocial adjustment in early adolescence. *Psychol. Schools* 46, 962–972. doi: 10.1002/pits.20437

Diamanduros, T., Downs, E., and Jenkins, S. J. (2008). The role of school psychologists in the assessment, prevention, and intervention of cyberbullying. *Psychol. Schools* 45, 693–704. doi: 10.1002/pits.20335

Dolot, A. (2018). The characteristics of Generation Z. *E-Mentor* 2, 44–50. doi: 10.15219/em74.1351

Dyer, T. (2018). The effects of social media on children. *Dalhousie J. Interdiscipl. Manag.* 14, 1–16. doi: 10.5931/djim.v14i0.7855

Fitri, S. N., and Waluyo, E. (2019). Implementation of ksatria story book in embedding leadership character values in children 5-6 years old. *BELIA Early Childhood Educ. Paper* 9, 7–12. doi: 10.15294/belia.v9i1.28381

Fredstrom, B. K., Adams, R. E., and Gilman, R. (2011). Electronic and school-based victimization: unique contexts for adjustment difficulties during adolescence. *J. Adolesc. Health* 40, 405–415. doi: 10.1007/s10964-010-9569-7

Fu, Q., Land, K. C., and Lamb, V. L. (2015). Violent physical bullying victimization at school: has there been a recent increase in exposure or intensity? An age-period-cohort analysis in the United States, 1991 to 2012. *Child Indic. Res.* 9, 485–513. doi: 10.1007/s12187-015-9317-3

Griezel, L., Craven, R. G., and Yeung, A. S. (2008). "The development of a multi-dimensional measure of cyber bullying," in *Australian Association for Research in Education Annual Conference* (Australian Association for Research in Education), 1–13.

Grigg, D. W. (2010). Cyber-aggression: definition and concept of cyberbullying. *Aust. J. Guidance Counsel.* 20, 143–156. doi: 10.1375/ajgc.20.2.143

Hisler, G. C., Hasler, B. P., Franzen, P. L., Clark, D. B., and Twenge, J. M. (2020). Screen media use and sleep disturbance symptom severity in children. *Sleep Health* 6, 731–732. doi: 10.1016/j.sleh.2020.07.002

Holton, T., and Fraser, B. (2015). *Generation Z and Technology*. Toronto Research Center

Hunt, C., Peters, L., and Rapee, R. M. (2012). Development of a measure of the experience of being bullied in youth. *Psychol. Assess.* 24, 156–165. doi: 10.1037/a0025178

Indonesian Internet Service Providers Association (APJII). (2020). *APJII Internet Survey Report 2019-2020 (Q2)*. Jakarta: APJII

Internet World Stats. (2020). *Internet user distribution in the world-2020 Q3*. Retrieved from: https://www.internetworldstats.com/stats.htm.

Iossi Silva, M., Pereira, B., Mendonça, D., Nunes, B., and Oliveira, W. (2013). The involvement of girls and boys with bullying: an analysis of gender differences. *Int. J. Environ. Res. Public Health* 10, 6820–6831. doi: 10.3390/ijerph10126820

Jochimek, M., and Łada, A. (2019). Help or hindrance: the relationship of physical activity with aggressiveness and self-esteem in 16-year-old adolescents. *Health Psychol. Rep.* 7, 242–253. doi: 10.5114/hpr.2019.86698

Kasahara, G. M., Houlihan, D., and Estrada, C. (2019). Gender differences in social media use and cyberbullying in belize: a preliminary report. *Int. J. Psychol. Stud.* 11, 32–41. doi: 10.5539/ijps.v11n2p32

Kline, R. (2005). *Methodology in the Social Sciences: Principles and Practice of Structural Equation Modeling, 2nd edn.* New York, NY: Guilford Press.

Kominfo. (2014). *Press Release no 17 of Indonesian Ministry of Communication and Information*. Jakarta: Kominfo. Available online at: https://kominfo.go.id/content/detail/3834/siaran-pers-no-17pihkominfo22014-tentang-riset-kominfo-dan-unicef-mengenai-perilaku-anak-dan-remaja-dalam-menggunakan-internet/0/siaran_pers

Kowalski, R. M., Giumetti, G. W., Schroeder, A. N., and Lattanner, M. R. (2014). Bullying in the digital age: a critical review and meta-analysis of cyberbullying research among youth. *Psychol. Bull.* 140, 1073–1137. doi: 10.1037/a0035618

Kurnia, N., Wendratama, E., Adiputra, W. M., and Poerwaningtias, I. (2017). *Literasi Digital Keluarga, Teori Dan Praktik Pendampingan Orangtua Terhadap Anak Dalam Berinternet*. Yogyakarta: Center for Digital Society Fakultas Ilmu Sosial dan Ilmu Politik Universitas Gadjah Mada Yogyakarta.

Lamarche, V., Brendgen, M., Boivin, M., Vitaro, F., Dionne, G., and Perusse, D. (2007). Do friendships and sibling relationships provide protection against peer victimization in a similar way? *Soc. Dev.* 15, 373–393. doi: 10.1111/j.1467-9507.2006.00347.x

Lubis, K., Daharnis, D., and Syukur, Y. (2019). Interpersonal relationships of students in junior high school. *Int. J. Res. Counsel. Educ.* 3, 103–108. doi: 10.24036/00112za0002

Lup, K., Trub, L., and Rosenthal, L. (2015). Instagram #Instasad?: exploring associations among Instagram use, depressive symptoms, negative social comparison, and strangers followed. *Cyberpsychol. Behav. Soc. Netw.* 18, 247–251. doi: 10.1089/cyber.2014.0560

Marengo, D., Longobardi, C., Fabris, M. A., and Settanni, M. (2018). Highly-visual social media and internalizing symptoms in adolescence : the mediating role of body image concerns. *Comput. Hum. Behav.* 82, 63–65. doi: 10.1016/j.chb.2018.01.003

Mathyssek, C. M., Olino, T. M., Verhulst, F. C., and van Oort, F. V. (2012). Childhood internalizing and externalizing problems predict the onset of clinical panic attacks over adolescence: the TRAILS study. *PLoS One* 7:e51564. doi: 10.1371/journal.pone.0051564

Mazman, S. G., and Usluel, Y. K. (2011). Gender differences in using social networks. *Turk. Online J. Educ. Technol.* 10, 133–139.

McDool, E., Powell, P., Roberts, J., and Taylor, K. (2016). Social media use and well-being. *Soc. Media Use Childrens Wellbeing*, 11, 253–271. doi: 10.4324/9781351231879-12

Merrell, K. W., Gueldner, B. A., Ross, S. W., and Isava, D. M. (2008). How effective are school bullying intervention programs? A meta-analysis of intervention research. *School Psychol. Q.* 23, 26–42. doi: 10.1037/1045-3830.23.1.26

Miers, A. C., Blote, A. W., Bogels, S. M., and Westenberg, P. M. (2008). Bias and social anxiety in adolescents. *J. Anxiety Disord.* 22, 1462–1471. doi: 10.1016/j.janxdis.2008.02.010

Molter, C. (2020). *Understanding Gen Z: Engaging Digital Natives*. Morning Consult, 100–104. Retrieved from: https://cstoredecisions.com/2015/05/26/marketing-to-genz/%0Ahttp://web.a.ebscohost.com.pxz.iubh.de:8080/ehost/pdfviewer/pdfviewer?sid=ba88fb81-b664-44cf-a2bc-ad425d3620cd%40sessionmgr4005andamp;vid$=$1andamp;hid$=$4114 (accessed October 11, 2020).

Naen, K. B. R. (2019). *Survei Kecemasan Aspek Emosi Untuk Siswa Kelas IV di SD Negeri se-Kecamatan Jetis (Emotional Aspect Anxiety Survey for Fourth Grade Students in Public Elementary Schools in Jetis Sub-District)*.Thesis, Universitas Sanata Dharma. Available online at: http://repository.usd.ac.id/36017/

Nicolai, S., Geffner, R., Stolberg, R., and Yaruss, J. S. (2018). Retrospective experiences of cyberbullying and emotional outcomes on young adults who stutter. *J. Child Adolesc. Trauma* 11, 27–37. doi: 10.1007/s40653-018-0208-x

Noret, N., and Rivers, I. (2006). "The prevalence of bullying by text message or e-mail: results of a four year study," in *Poster Presented at the British Psychological Society Annual Conference* (Cardiff).

Ólafsson, K., Livingstone, S., and Haddon, L. (2013). *Children's Use of Online Technologies inEurope*. A review of the European evidence base. LSE, London: EU Kids Online.

Olweus, D., and Limber, S. P. (2017). Some problems with cyberbullying research. *Curr. Opin. Psychol.* 19, 139–143. doi: 10.1016/j.copsyc.2017.04.012

Ortega, R., Elipe, P., Mora-merchán, J. A., Calmaestra, J., and Vega, E. (2009). The emotional impact on victims of traditional bullying and cyberbullying a study of Spanish adolescents. *J. Psychol.* 217, 197–204. doi: 10.1027/0044-3409.217.4.197

Pontillo, M., Tata, M. C., Averna, R., Demaria, F., Gargiullo, P., Guerrera, S., et al. (2019). Peer victimization and onset of social anxiety disorder in children and adolescents. *Brain Sci.* 9:132. doi: 10.3390/brainsci9060132

Price, M., and Dalgleish, J. (2010). Cyberbullying experiences, impacts and coping strategies as described by Australian young people. *Youth Stud. Aust.* 29, 51–59.

Qing, L. (2015). When cyberbullying and bullying meet gaming: a systemic review of the literature. *J. Psychol. Psychother.* 5, 1–11. doi: 10.4172/2161-0487.1000195

Randa, R. (2013). The influence of the cyber-social environment on fear of victimization: cyberbullying and school. *Secur. J.* 26, 331–348. doi: 10.1057/sj.2013.22

Randa, R., and Reyns, B. W. (2014). Cyberbullying victimization and adaptive avoidance behaviors at school. *Victims Offenders* 9, 255–275. doi: 10.1080/15564886.2013.877411

Rideout, V. J., Foehr, U. G., and Roberts, D. F. (2010). G*eneration M2: Media in the Lives of 8-18-Year-Olds*. Menlo Park, CA: Henry J. Kaiser Family Foundation. Available online at: http://www.kff.org/ entmedia/upload/8010.pdf (November 7, 2020).

Rodríguez-Hidalgo, A., Calmaestra, J., Casas, J., and Ortega-ruiz, R. (2019). Ethnic-cultural bullying versus personal bullying: specificity and measurement of discriminatory aggression and victimization among adolescents. *Front. Psychol.* 10:46. doi: 10.3389/fpsyg.2019.00046

Romera Félix, E. M., Del Rey Alamillo, R. and Ortega Ruiz, R. (2011). Prevalence and differentiating aspects related to gender with regard to the bullying phenomenon in poor countries. *Psichotema* 23, 624–629.

Sagioglou, C., and Greitemeyer, T. (2014). Facebook's emotional consequences: why Facebook causes a decrease in mood and why people still use it. *Comput. Hum. Behav.* 35, 359–363. doi: 10.1016/j.chb.2014.03.003

Sherlock, M., and Wagstaff, D. L. (2018). Exploring the relationship between frequency of Instagram use, exposure to idealised images, and psychological wellbeing in women. *Psychol. Popul. Media Cult.* 18, 482–490. doi: 10.1037/ppm0000182

Smith, P. K., Mahdavi, J., Carvalho, M., Fisher, S., Russell, S., and Tippett, N. (2008). Cyberbullying : its nature and impact in secondary school pupils. *J. Child Psychol. Psychiatry* 49, 376–385. doi: 10.1111/j.1469-7610.2007.01846.x

Sourander, A., Klomek, A. B., Ikonen, M., Lindroos, J., Luntamo, T., Koskelainen, M., et al. (2015). Psychosocial risk factors associated with cyberbullying among adolescents. *Arch. Gen. Psychiatry* 67, 720–728. doi: 10.1001/archgenpsychiatry.2010.79

Stapinski, L. A., Araya, R., Heron, J., and Montgomery, A. A. (2014). Peer victimization during adolescence: concurrent and prospective impact on symptoms of depression and anxiety. *Anxiety Stress Coping* 2, 105–120. doi: 10.1080/10615806.2014.962023

Supratman, L. P. (2018). Penggunaan sosial media oleh digital natives (The use of social media by digital natives). *J. Komun.* 15, 47–60. doi: 10.24002/jik.v15i1.1243

Tabachnick, B. G., and Fidell, L. S. (2001). *Using Multivariate Statistics, 4th edn*. Boston, MA: Allyn and Bacon.

Triastuti, E., Prabowo, D. A. I., and Nurul, A. (2017). *Impact Assessment of the Use of Social Media for Children and Adolescents*. Jakarta: Pusat Kajian Komunikasi FISIP Universitas Indonesia.

Undiyaundeye. (2014). Impact of social media on children, adolescents and families. *Glob. J. Interdiscipl. Soc. Sci.* 3, 1–4

Utami, T. W., Astuti, Y. S., and and, P. H., L. (2019). Hubungan kecemasan dan perilaku bullying anak sekolah dasar (The relationship between anxiety and bullying behavior in elementary school children). *J. Keperawatan* 2, 6–11. doi: 10.32584/jikj.v2i1.264

Van Rooij, A., and Prause, N. (2014). A critical review of "Internet addiction" criteria with suggestions for the future. *J. Behav. Addict.* 3, 203–213. doi: 10.1556/JBA.3.2014.4.1

Vannucci, A., and Ohannessian, C. M. (2019). Social media use subgroups differentially predict psychosocial well-being during early adolescence. *J. Youth Adolesc.* 48, 1469–1493. doi: 10.1007/s10964-019-01060-9

Van-Roy, B., Kristensen, H., Groholt, B., and Clench-Aas, J. (2009). Prevalence and characteristics of significant social anxiety in children aged 8 - 13 years. *Soc. Psychiatry Epidemiol.* 44, 407–415. doi: 10.1007/s00127-008-0445-7

Wakhid, A., Andriani, N. S., and Saparwati, M. (2017). Perilaku bullying siswa usia 10-12 tahun [The bullying behavior and social interaction capabilities of student aged 10-12 year sold]. *J. Keperawatan* 5:25. doi: 10.26714/jkj.5.1.2017.25-28

Waliyanti, E., and Kamilah, F. (2019). Bullying of adolescent in Yogyakarta: responses and impacts. *J. Kedokteran Kesehatan Indonesia* 10, 265–270. doi: 10.20885/JKKI.Vol10.Iss3.art9

Wallsten, S. (2013). "What are we not doing when we're online?," in *NBER Working Paper 19549* (Cambridge).

Wang, J., Nansel, T. R., and Iannotti, R. J. (2012). Cyberbullying and traditional Bullying: Differential association with depression. *J, Adolesc. Health* 48, 415–417. doi: 10.1016/j.jadohealth.2010.07.012

We Are Social. (2017). *Digital in 2017 Global Overview*. Retrieved from: https://wearesocial.com/special-reports/digital-in-2017-global-overview

Wood, M., Bukowski, W., and Lis, E. (2016). The digital self: how social media serves as a setting that shapes youth's emotional experiences. *Adolesc. Res. Rev.* 1, 163–173. doi: 10.1007/s40894-015-0014-8

Xantus, A., Saltz, S. B., and Shaw, J. A. (2015). The relationship between social media bullying and the adolescent's self report of emotional health: a study of urban youth on an acute inpatient psychiatric unit. *J. Depress. Anxiety* 04, 2–7. doi: 10.4172/2167-1044.1000186

Xie, H., and Ngai, S. S. (2020). Participant roles of peer bystanders in school bullying situations: evidence from Wuhan, China. *Child. Youth Serv. Rev.* 110:104762. doi: 10.1016/j.childyouth.2020.104762

Conflict of Interest: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

frontiers in Psychology

ORIGINAL RESEARCH
published: 06 May 2021
doi: 10.3389/fpsyg.2021.607329

Student Self-Efficacy and Aptitude to Participate in Relation to Perceived Functioning and Achievement in Students in Secondary School With and Without Disabilities

Karin Bertills[1], Mats Granlund[2] and Lilly Augustine[1]*

[1] School of Education and Communication, CHILD, SIDR, Jönköping University, Jönköping, Sweden, [2] School of Health and Welfare, CHILD, SIDR, Jönköping University, Jönköping, Sweden

School-based Physical Education (PE) is important, especially to students with disabilities whose participation in physical activities out of school is limited. The development over time of participation-related constructs in relation to students' perceived functioning and achievement is explored. Students in mainstream inclusive secondary school self-rated their PE-specific self-efficacy, general school self-efficacy, aptitude to participate in PE, and perceived physical and socio-cognitive functional skills at two timepoints, year 7 and year 9. Results were compared between three groups of students with: disabilities (n = 28), high grades (n = 47), or low grades (n = 30) in PE. Over time, perceived physical skills of students with disabilities became strongly associated with self-efficacy and aptitude to participate. Perceived socio-cognitive skills in the study sample improved and had a positive effect on PE-specific self-efficacy. Efforts should be made to limit the accelerated negative impact of perceived restricted functioning of students with disabilities. Grading criteria need to be developed to comply with standards adapted to fit abilities of students with disabilities. Meaningful learning experiences appear to be created when participation is promoted and capacity beliefs (PE-specific self-efficacy) are boosted. Allocating resources to support the development of students' socio-cognitive skills seem to have potential for overall positive school outcome.

Keywords: self-efficacy, participation, functioning, achievement, disability, physical education, secondary school

OPEN ACCESS

Edited by:
Óscar Conceição De Sousa, Universidade Lusófona, Portugal

Reviewed by:
Martín-Lobo Pilar, Universidad Internacional De La Rioja, Spain
Raul Reina, Miguel Hernández University of Elche, Spain

****Correspondence:***
Karin Bertills
Karin.bertills@ju.se

Specialty section:
This article was submitted to Educational Psychology, a section of the journal Frontiers in Psychology

Received: *16 September 2020*
Accepted: *22 March 2021*
Published: *06 May 2021*

Citation:
Bertills K, Granlund M and Augustine L (2021) Student Self-Efficacy and Aptitude to Participate in Relation to Perceived Functioning and Achievement in Students in Secondary School With and Without Disabilities. Front. Psychol. 12:607329. doi: 10.3389/fpsyg.2021.607329

INTRODUCTION

Functional limitations in an educational setting may cause doubts about the self-efficacy and participation of students with disabilities. Self-perceptions of capacity and competence are aspects important for learning and whether a person makes an effort, practices skills, and persists on task until finished (Bandura, 1993). Self-efficacy beliefs predict learning outcomes and play an important role for the development, functioning, and achievement of adolescents (Bandura, 1993). Participating in physical activity is a fundamental right (UNESCO, 2015a), but owing to restricted functioning, the participation of persons with disabilities in extracurricular activities is limited (King et al., 2009). Compulsory secondary school in Sweden is mainstream, and inclusive school-based Physical Education (PE)

is a context where *all* students must partake. School-based PE is therefore an important context for students with disabilities to share the benefits of physical activities with their typically functioning peers (Block and Obrusnikova, 2007; Bailey et al., 2009; Seymour et al., 2009; Grenier et al., 2014). The Swedish National Agency for Education (2018) curriculum states the equal value of all people, and the task of school is directed toward successful participation in society. However, irrespective of functional restrictions, grading criteria are the same for all students, and although support should be provided to students facing the risk of failing a subject, aide and assistance in PE is scarce (Morley et al., 2005; Tant and Watelain, 2016; Bertills et al., 2019). Apart from participatory gains in inclusive PE practices, self-efficacy beliefs may be boosted in PE by providing adolescents with an opportunity to acquire experiences and skills different to those achieved in typically academic school subjects (UNESCO, 2015b). Additional support, curricular adaptations, activity modifications, and individual accommodations may be needed to create meaningful learning experiences that students with disabilities will want to attend (Haegele and Sutherland, 2015). Developmental processes of self-efficacy (PE-specific and general), aptitude to participate, and perceived functioning are the focus of this study.

Self-Efficacy Beliefs

Encountering new challenges, individuals consider whether they *can*, i.e., have the capability or not to succeed with the task. Self-efficacy refers to expectations of successful future performance in specific tasks (Bandura, 1997). Causal attribution, beliefs regarding the causes of events (Weiner, 1985), affects motivation, performance, and affective reactions mainly through beliefs of self-efficacy (Bandura, 1993). According to Bandura (1993), highly self-efficacious individuals invest energy into new tasks, choose more difficult tasks, practice persistently despite obstacles, and make great effort to finish the task. Failure is attributed to external factors, e.g., insufficient effort, making them more resilient to failure. Doubting their capacity, individuals with similar ability but with low self-efficacy have low aspirations of success, easily give up, assign failure to their lack of ability, and recover slowly, which gradually undermines their capability.

Self-efficacy beliefs differ from other self or expectancy constructs because they are task- and context-specific, aim for certain goals, and focus on the individuals' own perceptions of capability. Beliefs in one's capability may also spread across domains and influence choices made throughout life (Pajares and Urdan, 2006). Perceived self-efficacy beliefs include emotional, physical, mental, and social skills achieved by practice and interaction and the will to invest effort into engaging in the activity. The sources of self-efficacy beliefs are previous experiences of success, imitating role models, encouragement, and affective states (Bandura, 1994). Transitioning to adolescence in secondary school requires students to control their own learning more independently, and Zimmerman (2000) has shown that perceived self-efficacy, functioning, and learning are closely related. The predictive power of self-efficacy on academic achievement is well established in several subject areas (Pajares, 2003; Schunk, 2003; Gustafsson et al., 2010; Kitsantas et al., 2011). Empathetic self-efficacy predicts prosocial behaviors (Caprara et al., 2012), and students who initially report higher efficacy to self-regulate their actions later experience lower levels of problem behavior, achieve higher grades, and are more popular among their peers (Caprara et al., 2004). Less is known about how individuals' self-efficacy is related to more practical school subjects, such as PE.

Participation

Engagement with school is related to academic success, positive emotions and life satisfaction, and dis-engagement with negative school outcomes, such as ill-being (Upadyaya and Salmela-Aro, 2013). Students with disabilities participate less in physical recreational activities than their typically developing peers (King et al., 2009; Woodmansee et al., 2016). School-based PE offers opportunities for all students to participate in physical activity. However, the aptitude to participate in PE generally declines over time for all students (The Swedish Schools Inspectorate, 2018), unless students are involved in extracurricular physical activities (Säfvenbom et al., 2014). Participation is defined as "involvement in a life situation" in the International Classification of Functioning, Disability and Health for Children and Youth (ICF-CY) (World Health Organization, 2007). Attendance and involvement is the two-dimensional definition of participation used in the family of Participation-Related Constructs framework (fPRC) (Imms et al., 2017). Within this framework, attendance is seen as a primary prerequisite for participation. A second key element is involvement, as in experiencing engagement, persistence, and affect while doing an activity. Participation in the fPRC is related to both internal and external factors. Internal factors are individual activity competence (skills required to perform the activity), sense of self (such as self-efficacy), and preferences. External factors concern the environment, which exists independently of the individual and the context (the actual interaction between the individual and the environment). This framework can be used to describe relationships between personal and environmental factors that are vital for the participation of persons with or without disabilities in PE. All participation in PE occurs in a context (Imms et al., 2017), and experienced participation depends on prerequisites for participation, i.e., what a person can do, wants to do, has the opportunity to do, and is not prevented from doing (Mallinson and Hammel, 2010). For optimal involvement, the activity needs to be perceived as meaningful (Kang et al., 2014). Functioning in complex PE activities also requires physical, social, affective, and cognitive functional skills (Bailey et al., 2009). In this study, *activity competence* is operationalized as self-reported perceived physical and socio-cognitive functional skills. *Sense of self* as PE-specific and general school self-efficacy and prerequisites for participation (named aptitude to participate) in PE is operationalized as *preferences*.

Self-Perceived Functioning

Students with disabilities are over-represented in groups at risk of failing PE in Sweden (Bråkenhielm, 2008). Special educational research consistently reports, e.g., Pijl et al. (2008), that students in need of special support are less popular, have fewer friends,

and are less often members of subgroups. However, self-ratings show that they do have positive perceptions of self-concepts, social acceptance, and academic achievement and their ratings do not differ from their typically functioning peers (Avramidis, 2013). Peer relations may be fewer but seem to be more important to their academic self-concept (Allodi, 2000). Transitioning into secondary school in Sweden means higher educational demands in a criterion-referenced grading system, i.e., to what degree intended learning outcomes are acquired (The Swedish National Agency for Education, 2018). Explicit academic demands may affect student general school self-efficacy, i.e., academic, social, and emotional self-efficacy (Muris, 2001). Adolescents compare physical performance with each other, rather than in relation to a fixed set of grading criteria, which affects student's motivation to participate (Jacobs et al., 2002). High self-efficacy promotes students' participation, motivation, and expectation of future success (Chase, 2001). Amotivation may be caused by personal factors, such as students' low outcome expectancy, low effort, and low capacity beliefs, i.e., PE-specific self-efficacy. Physical self-concepts, encompassing physical functioning, were positively associated with mastery and performance approach goals, as opposed to skill-related goals based on comparisons between peers (Hagger et al., 2011). Functioning in PE is probably related both to perceptions of action (perceived physical functional skills) and to perceptions of interaction (perceived socio-cognitive functional skills).

Adolescent Developmental Processes in a PE Context

As students grow older, student self-efficacy seems to drop during secondary school, despite increased knowledge with age. This might be due to multiple factors, for example, early adolescence is a time where biological, environmental/organizational, and social–cognitive transitions concur (Vaz, 2010). Adapting to a new environment with higher demands is an example of an organizational transition. Adding to the stress of changes associated with school transition, reduced self-efficacy in early adolescence can be explained by environmental factors (Schunk and Pajares, 2010). For example, in secondary school, competition may be more emphasized, and teacher–student social interactions with feedback on student progress become less frequent. There is also a social–cognitive transition, which is connected to a person's functioning, development, and identity (Vaz, 2010). Competence and capacity is commonly appraised in relation to peers, and these personal self-evaluative factors affect the adolescents' motivation to participate in learning (Jacobs et al., 2002). Schunk and Pajares (2010) propose that self-efficacy beliefs in students tend to decline as they advance through school. However, the expanded social reference group, i.e., peers, and higher educational demands require students to reassess their abilities. Self-assessment accuracy improves as students gain task experience and engage in social comparisons, which in turn stabilizes the correspondence between self-efficacy and performance. Providing students with instructions, opportunities to practice self-evaluation, and feedback on their progress can further calibrate this correspondence. According to Jacobs et al. (2002), the decline in self-competence beliefs in sports accelerate during secondary school years. Students inevitably compare their performances in a competitive environment, such as a PE context, where traditional views of "a fit body" are fostered (Fitzgerald, 2005). Due to puberty onset, biological differences between adolescents at this stage are obvious, especially if students have physical disabilities. In Sweden, the entrance to adolescence can be said to take place during the last 3 years of compulsory school, i.e., school years 7–9 (ages 12.5–16.5) referred to as secondary school. Therefore, longitudinal approaches are needed to study the directionality of relationships and stability of scores and provide insight to developmental trends (Sabiston et al., 2014) of students' self-reported experiences in early adolescence. Moreover, students with disabilities need to be studied as a separate group (Bertills et al., 2018a).

Rationale, Aim, and Research Questions

The objectives of this study are to explore the development of participation-related constructs (Imms et al., 2017) as perceived and self-reported by students. The aim is twofold, to explore how processes of students' perceived PE-specific self-efficacy, general school self-efficacy, and aptitude to participate in PE develop over time. Furthermore, the aim is to investigate how these processes are related to perceived physical and socio-cognitive functional skills and achievement (grades in PE). Groups of students with disabilities, high grades (A–C), and low grades (D–F) in PE from year 6 (before transitioning into secondary school) are compared. Research questions are as follows:

1. What changes in self-perceptions of self-efficacy (PE-specific and general) and aptitude to participate between year 7 and 9 are there in the three target groups?
2. How do relationships between perceived functional skills (socio-cognitive and physical), self-efficacy (PE-specific and general), and aptitude to participate change over time in the three target groups?
3. What are the relationships of developmental processes of students' perceived self-efficacy (PE-specific and general) and aptitude to participate in PE with perceived functional skills and achievement (grades in PE)?

MATERIALS AND METHODS

A longitudinal study design was used with student questionnaires distributed and data collected from 25 classes at two timepoints. This study is part of a larger study (n = 450) and based on two separate waves of data collection from Swedish mainstream inclusive secondary school years 7 and 9 in a region of the south of Sweden. Presented in the current study are analyses of student self-reports collected at timepoint 1 (T1), year 7 and timepoint 2 (T2), year 9.

Participants

Students with disabilities were specifically targeted and recruited first. All their classmates were approached thereafter. Classmates who enrolled were assigned to a group of students with either

high (A–C) or low grades (D–F) in PE, depending on their grade in PE the previous year (see **Table 1**). For this study, purpose questionnaire data was analyzed from the 105 students in the target groups (23% of the total sample), who participated at both data collections. The group of students with disabilities was diagnosed with physical (n = 11, 7 boys), neuro-developmental (n = 12, 9 boys), intellectual (n = 2 boys), or a combination of two or more (n = 3, 2 boys) disabilities.

Data Collection Instruments

Student questionnaires (see **Supplementary Material**) were evaluated in a trial study (Bertills et al., 2018a). Internal consistency, factor structure, and relations between measures were investigated. Reliability and validity was analyzed with the first wave of data collection, and the questionnaires were deemed to adequately measure students' perceived self-efficacy (PE-specific and general school self-efficacy), aptitude to participate in PE, and perceived physical and socio-cognitive functional skills. A simplified version was created to make the questionnaires accessible to all and used when needed to include students with mild intellectual disability in regular inclusive schooling. In this version, wording was simplified, the amount of text was reduced, and responses were colored in the PE-specific self-efficacy instrument (shades of orange to green). Assistants supplied with the original version aided these students.

Achievement

The Swedish national grading system is designed to measure knowledge and skills against a fixed set of predetermined criteria on an A–F grading scale. Students are assessed depending on the degree to which the student reaches the intended learning outcomes, A = very well, C = relatively well, E = partly, and F = fail. Grades B and D are rewarded when a student has met a considerable share of knowledge requirements for grade A and grade E, respectively.

Student Questionnaires

PE-specific self-efficacy

Task-specific items matching the PE syllabus with activities commonly occurring in PE lessons were developed according to recommendations concerning how to measure domain specific self-efficacy (Bandura, 2006). The scale created for this study purpose showed strong internal consistency, α = 0.93, at both timepoints. The items covered the three core content syllabus components: movement (gymnastics, team sports, etc., eight items), health and lifestyle (e.g., plan, do, evaluate your own exercise program targeting individually set goals, seven items), and outdoor life and activities (e.g., orienteering, five items). Students responded to exclamations initiated by *report how you perceive your knowledge and skills to...* on a scale ranging from 1 to 6, 1 = not at all good to 6 = very well, corresponding to grades A–F (mean T1 = 4.53, T2 = 4.69). The scale was dichotomized into low = 1–3 and high = 4–6.

Aptitude to participate in PE

Vital components for wanting to participate in PE (student preferences) were measured, e.g., opportunity and ability to participate, safety, support, and grading awareness (seven items). Strong internal consistency, α = 0.81, was seen at both timepoints. Scale range and dichotomization were similar to the instrument PE-specific self-efficacy (mean T1 = 5.02, T2 = 5.04).

Perceived functioning

Focusing on students with disabilities, i.e., with restricted functioning as diagnosed by a doctor, requires measurements of self-perceived functioning. The original proxy-rated index of children's functional abilities (Simeonsson and Bailey, 1991) was adapted into a self-rating instrument (Bertills et al., 2018a). Physical functional skills refer to experienced functioning in the hands, arms, and legs. Moreover, socio-cognitive functional skills refer to experienced elements of general health, communicative, social, behavioral, and problem-solving skills. Perceived skills, relative to peers, were self-rated on a scale of 1–6, indicating 1 = profound difficulties to 6 = no difficulties. Each individual received a total sum, and items were dichotomized into physical functioning (0–7, low = 0–6, typical = 7) and socio-cognitive functioning (0–20, low = 0–14, typical = 15–20). In a total sample where typical functioning is perceived by a majority of the students, typical physical functioning was perceived by 76% of the students at T1 (α = 0.77) and 83% at T2 (α = 0.83), and socio-cognitive functioning by 72% at T1 (α = 0.74) and 76% at T2 (α = 0.75).

General school self-efficacy

A collective measurement of a general sense of school self-efficacy in adolescents was used. The translated instrument showed similar internal consistency as the original version of α = 0.88 (Muris, 2001). The scale initiated by *how well do you perceive that you can/succeed in* included 24 items with eight items each measuring aspects of academic, social, and emotional skills ranging from 1 to 5, 1 = *not at all* to 5 = *very well* (mean T1 = 3.71, T2 = 3.66). Dichotomization was based on the mean.

Procedures

Data collection procedures were elaborated from the trial study to assist students in need of special support, e.g., placement, further explanations, reading aloud, and adult assistance. The simplified version was used when needed, so that all students could complete the questionnaire. Assistants

TABLE 1 | Student participants.

Data	N	M	F	Disability	M	F	A–C	M	F	D–F	M	F
T1	121	55	45	30	73	27	55	40	60	36	64	36
T2	105	55	45	28	71	29	47	42	58	30	60	40

M = percent of male participants, F = percent of female participants.

supplied with the original version aided these students. Questionnaires were distributed to students in their home classrooms or adjacent group room and collected by the researchers approximately one term after transition into secondary school (year 7 = T1) and repeated the last term before graduating (year 9 = T2). Owing to circumstances, the researcher completed the questionnaire in telephone communication with two students with disabilities at T2.

Statistical Analysis

To explore student self-efficacy (PE-specific and general) and aptitude to participate, mean scores were calculated individually for each scale, excluding cases with more than 25% missing values. Analysis of variance (ANOVA) (Bird, 2004) was used to investigate mean differences between average scores in the groups of students with disabilities, high grades (A–C), and low grades (D–F). Paired-sampled *t*-tests were conducted to detect change over time within the scales. Spearman's rho was used to examine correlations (Field, 2013) of perceived self-efficacy (PE-specific and general) and aptitude to participate with physical and socio-cognitive functioning skills and achievement in the study sample and in each group separately. Correlations less than 0.30 were considered as weak, and more than 0.60 as strong. Scale correlations were then compared between T1 and T2 using Fisher's *r* to Z transformations (Siegel and Castellan, 1988) to detect differences between the three student groups. The potential of physical and socio-cognitive functional skills to predict elevated PE-specific self-efficacy, aptitude to participate in PE, and general school self-efficacy was examined. A series of binary logistic regression analyses was performed, using physical and socio-cognitive skills as predictors.

Ethics

All students actively consented to participate in the current study. Written informed consent was obtained from the participants and their parents. The study was approved by the Ethical Review Board, Linköping, Sweden (2013/508-31).

RESULTS

Perceived PE-Specific Self-Efficacy, Aptitude to Participate, and General School Self-Efficacy Over Time

Averages of self-report data from the scales remained relatively stable over time (see **Table 2**). Students with disability reported lower means and larger within group variance than the other groups. Comparisons between timepoint 1 (T1), year 7 and timepoint 2 (T2), year 9 showed significantly elevated PE-specific self-efficacy, mainly due to the significant increase seen in students with low grades.

Students with disabilities reported higher general school self-efficacy (non-significant), less aptitude to participate, and consistent lower perceived physical functional skills than students with either high (A–C group) or low grades (D–F group). Differences increased between students with disabilities and the A–C group and were significant at both timepoints in all scales but two. Socio-cognitive skills were non-significant at T2, and general school self-efficacy did not show significant difference at either timepoint. In the A–C group, there was a significant decline in general school self-efficacy over time ($t = -2.14$, $p = 0.038$).

Interrelationships of Self-Efficacy (PE-Specific and General) and Aptitude to Participate

Partial correlations were investigated between the scales self-efficacy (PE-specific and general) and aptitude to participate, controlling for the third variable at each timepoint (see **Table 3**). Due to interrelationships between the scale, e.g., PE-specific self-efficacy was strongly related to the instrument *aptitude to participate* in PE (T1 $r = 0.764$, T2 $r = 0.752$, $p < 0.01$), the estimated relations would probably be influenced by each other.

The relationship between the different scales was relatively stable within the student groups over the two timepoints. Comparing groups, association differences of scales were non-significant. Students with disabilities showed weaker non-significant association between PE-specific self-efficacy and general school self-efficacy at T2 than the other two groups. Using Fisher's *r* to Z transformations, this association was found to be significantly stronger at T1 in the D–F group than in the other groups [disabilities ($Z = 2.47$, $p = 0.014$), A–C group ($Z = 2.87$, $p = 0.004$)]. Students' perceived PE-specific self-efficacy and aptitude to participate were strongly associated at both timepoints. This association became stronger over time in students with disabilities and in the D–F group than in the A–C group, who reported a weaker association at T2.

Relationships within self-reported PE-specific self-efficacy were stable across the groups (students with disabilities $r = 0.40$, $p = 0.035$; the A–C group $r = 0.53$, $p < 0.01$; and the D–F group $r = 0.76$, $p < 0.01$). A significant difference in the stability of PE-specific self-efficacy over time was found between students with disabilities and students in the D–F group ($Z = 2.09$, $p = 0.037$).

Perceived Physical and Socio-Cognitive Functioning Skills in Relation to Self-Efficacy (PE-Specific and General) and Aptitude to Participate in PE

For students with disabilities, associations between perceived physical functional skills and all other measures changed from being weak at T1 to explaining 31–47% of the variance at T2 (see **Table 4**). Initial self-reports of physical functional skills remained stable over time in this group ($r = 0.577$, $p < 0.01$). Physical functional skills at T2 in the D–F group were close to zero related to their aptitude to participate, and associations with the other measures were relatively small at either timepoint. Physical functional skills had little or no relevance for any of the measures in the A–C group at either timepoint.

Regarding perceived socio-cognitive skills, overall moderate significant associations with all scales were observed in students with disabilities at both timepoints (see **Table 4**). Although associations generally declined in all groups, students with disabilities were found to have stronger association with PE-specific self-efficacy over time. General school self-efficacy was

TABLE 2 | Descriptive scales in the study sample and in each group separately.

		Sample (*n* = 105)		Disability (*n* = 28)		A–C (*n* = 47)		D–F (*n* = 30)	
		T1	T2	T1	T2	T1	T2	T1	T2
PE-specific self-efficacy	Mean	4.53*	4.68*	4.19	4.22	4.81	4.95	4.40**	4.70**
	SD	0.84	0.86	1.05	1.14	0.59	0.64	0.83	0.68
Main effect		$t = 2.004$						$t = 3.064$	
		$p = 0.048$						$p = 0.005$	
Aptitude to participate	Mean	5.02	5.04	4.71	4.60	5.23	5.28	4.98	5.10
	SD	0.86	0.90	1.01	1.23	0.67	0.65	0.89	0.76
General self-efficacy	Mean	3.71	3.66	3.54	3.63	3.83*	3.70*	3.69	3.64
	SD	0.51	0.55	0.51	0.68	0.44	0.46	0.58	0.55
Main effect						$t = -2.135$			
						$p = 0.038$			
Physical function	Mean	6.38	6.49	5.86	5.79	6.68	6.77	6.40	6.70
	SD	1.41	1.39	1.84	2.10	0.89	0.94	1.52	0.92
Socio-cognitive function	Mean	16.05	16.21	14.64	15.21	16.89	17.02	16.03	15.90
	SD	3.41	3.23	3.84	3.51	3.16	2.92	3.00	3.19

***p < 0.01, *p < 0.05. Significant within group difference. PE-specific self-efficacy (ranging 1–5), aptitude to participate (ranging 1–6), general school self-efficacy (ranging 1–6), physical functional skills (ranging 0–7), socio-cognitive functional skills (ranging 0–20).*

TABLE 3 | Partial correlations between self-efficacy (PE-specific and general) and aptitude to participate at T1 and T2, controlling for the third variable.

	Timepoint 1 (year 7)		Timepoint 2 (year 9)	
	PE-specific self-efficacy	Aptitude to participate	PE-specific self-efficacy	Aptitude to participate
Study sample (*n* = 102)				
Aptitude to participate	0.625**		0.666**	
General self-efficacy	0.413**	0.151	0.271*	0.173
Disabilities (*n* = 25)				
Aptitude to participate	0.685**		0.717**	
General self-efficacy	0.212	0.292	0.113	0.391*
A–C (*n* = 44)				
Aptitude to participate	0.643**		0.477**	
General self-efficacy	0.204	0.280	0.327*	0.173
D–F (*n* = 27)				
Aptitude to participate	0.546**		0.591**	
General self-efficacy	0.737**	−0.119	0.436*	−0.032

***p < 0.01, *p < 0.05.*

relatively strongly associated with perceived socio-cognitive skills in all groups at both timepoints. The most affected by socio-cognitive functional skills at T1 was the general school self-efficacy of students in the D–F group (explaining 70% of the variance). Although this impact declined over time, 40% of the variance at T2 was still explained in the D–F group.

Differences of physical functional skills between students with disabilities and the other two groups were significant (see **Table 5**). At T2, students in the study sample who reported better physical functional skills were also five times more likely to report high general school self-efficacy at T2 (see **Table 6**).

Significant effect of perceived socio-cognitive skills on PE-specific self-efficacy had over time increased in the study sample (see **Table 7**). One significant model was found, where students in the study sample with initial high PE-specific self-efficacy were nine times more likely to report high PE-specific self-efficacy at T2, explaining 15.4% of the variance (Nagelkerke R^2). Adding improved socio-cognitive skills (mean value of change) into this model further raised the likelihood of high PE-specific self-efficacy at T2 by three times, explaining 24.4% of the variance (Nagelkerke R^2).

Perceived Self-Efficacy (PE-Specific and General), Aptitude to Participate in PE, and Functioning in Relations to Achievement

Relationships between PE achievement and students' perceived self-efficacy (PE-specific and general), aptitude to participate in PE, and perceived functional skills (physical and socio-cognitive)

TABLE 4 | Correlations over time between students' perceived functional skills (physical and socio-cognitive), self-efficacy (PE-specific and general), and aptitude to participate in the study sample and in each group separately.

	PE-specific self-efficacy		Aptitude to participate		General self-efficacy	
	T1	T2	T1	T2	T1	T2
Physical skills						
Study sample (n = 105)	0.105	0.266**	0.093	0.212*	0.064	0.307**
Disabilities (n = 28)	0.079	0.554**	0.084	0.562**	−0.003	0.687**
A–C (n = 47)	0.038	−0.059	−0.104	−0.067	−0.155	−0.035
D–F (n = 30)	0.050	0.164	0.209	−0.002	0.180	0.205
Socio-cognitive skills						
Study sample	0.521**	0.398**	0.435**	0.260**	0.653**	0.466**
Disabilities	0.330	0.497**	0.518**	0.407**	0.609**	0.411**
A–C	0.426**	0.239	0.208	0.078	0.430**	0.402**
D–F	0.673**	0.346	0.499**	0.186	0.833**	0.635**

*$p < 0.01$, *$p < 0.05$.

TABLE 5 | Fisher's r to Z estimations of group differences at T2 between physical skills and PE-specific self-efficacy (SEinPE), aptitude to participate, and general school self-efficacy (GeneralSE).

	SEinPE			Aptitude to participate			GeneralSE		
Group	**Z**	***R***	***p***	**Z**	***r***	***P***	**Z**	***r***	***p***
Disability	0.554			0.562			0.687		
A–C	−0.059	2.73	0.006	−0.067	2.81	0.005	−0.035	3.50	0.000
D–F	0.164	1.65	0.098	−0.002	2.3	0.022	0.205	2.28	0.022

were investigated (see **Table 8**). Findings showed that PE grades year 7 explained 61% of the variance in the final PE grades of students with disabilities, compared with the A–C group (28%) and the D–F group (40%). In the group of students with disabilities, PE grades were moderately associated with PE-specific self-efficacy (r = 0.461, $p < 0.05$) and aptitude to participate at T1 (r = 0.504, $p < 0.01$) and strongly at T2 (r = 0.679/r = 0.739, $p < 0.01$). Compared with their peers, the A–C group showed weak associations at both timepoints, and the D–F group showed weak associations at T1 and strong at T2. A significant association between PE grade at T1, year 7 and perceived socio-cognitive skills at T2, year 9 was found in the D–F group (r = 0.519, $p < 0.01$).

DISCUSSION

Developmental Processes of PE-Specific Self-Efficacy, Aptitude to Participate, and General School Self-Efficacy

Students with disabilities rate themselves as having lower levels of aptitude to participate and physical functional skills. Relationships between PE-specific self-efficacy and aptitude to participate at both timepoints were relatively strong in all groups. These associations became stronger over time in the group of students with disabilities and the group with low grades. These findings are in line with those of Ntoumanis et al. (2004) regarding causes of amotivation. This group demonstrated that capacity beliefs, i.e., PE-specific self-efficacy, over time become strongly related to whether the groups of students with disabilities and those with low grades were motivated to participate in PE or not.

The finding that PE-specific self-efficacy increased in secondary school, for all groups, is promising. Especially since this contradicts findings that self-competence beliefs in sports decline in secondary school (Jacobs et al., 2002). During the last two decades, PE in Sweden has been increasingly focused on health-directed learning (Lundvall and Brun Sundblad, 2017). The PE-specific questionnaire was constructed in accordance with the Swedish syllabus on a scale corresponding to the A–F grading scale. A report by The Swedish Schools Inspectorate (2018) summarizes that PE is a popular school subject among adolescents in secondary school, but the gap between active and inactive adolescents is increasing. Low grades in PE, occurring in the group of students with low grades but also partly in the group of students with disabilities, are likely associated with less involvement in extracurricular physical activities. In this study, a significant increase of PE-specific self-efficacy was found in the group of students with low grades as compared with the groups of student with disabilities and those with high grades. Self-ratings of PE-specific self-efficacy for students with low grades were consistent and highly correlated between T1 and T2. In addition, aptitude to participate remained high over time in this group. Combined, these findings imply that the students who benefit the most from school-based PE are those with low

TABLE 6 | Binary logistic regression models in the study sample (n = 105) with elevated PE-specific self-efficacy, aptitude to participate, and general school self-efficacy as outcome variables and with socio-cognitive and physical skills as independent variables.

	Elevated PE-specific self-efficacy				Elevated aptitude to participate				Elevated general school self-efficacy			
	T1		T2		T1		T2		T1		T2	
	OR (95% CI)	R^2_N	OR (95% CI)	R^2_N	OR (95% CI)	R^2_N	OR (95% CI)	R^2_N	OR (95% CI)	R^2_N	OR (95% CI)	R^2_N
Elevated socio-cognitive skills	2.647 (1.053–6.656)	0.057*	3.881 (1.355–11.114)	0.094*	4.664 (1.873–11.611)	0.143**	2.086 (0.838–5.194)	0.032	9.583 (3.030–30.307)	0.232**	4.103 (1.401–12.016)	0.096*
Elevated physical skills											4.886 (1.320–18.090)	0.088*

R^2_N = *Nagelkerke's pseudo* R^2. **$p < 0.01$, *$p < 0.05$.

grades. The significantly stronger association with general school self-efficacy found in this group of students at T1, combined with significantly stable ratings and increased PE-specific self-efficacy, further implies that acquired knowledge and skills in PE may compensate for the loss of general school self-efficacy seen in students with low grades.

For students with disabilities, another trend could be discerned. In the present study, this group reported higher general school self-efficacy after 3 years of secondary school (see **Table 2**). This result was non-significant but contradicts what was found in the other two groups and also previous findings that show an overall decline of general school self-efficacy in adolescence (Schunk and Pajares, 2010). Maturity pace, environmental factors, and acceptance may explain the relatively unstable ratings of general school self-efficacy over time in the group of students with disabilities. General school self-efficacy in secondary school may be affected by students with disabilities being more sensitive to environmental factors, such as classroom climate (Bertills et al., 2018b). It is also possible that they develop at a slower pace than their typically functioning peers (Lygnegård et al., 2018). Additionally, acceptance of "being different" by themselves and others, potentially aided by school-based support services, may have contributed to the positive trend of general school self-efficacy. A previous cross-sectional study showed that when PE teachers rated their teaching skills high, students with disabilities reported lower self-efficacy (PE-specific and general) and aptitude to participate in the initial phase of secondary school. In contrast, their peers rated higher self-efficacy (PE-specific and general) and aptitude to participate (Bertills et al., 2018b). One reason for this might be the higher stakes' environment at the transition to secondary school. For a person with lower perceived physical functional skills, grading standards may be set too high to be perceived as achievable. The environment may also hinder the full participation, i.e., attendance and involvement (Imms et al., 2017), of students who do not fulfill traditional views of "a fit body" (Fitzgerald, 2005). The strong association between PE grade year 7 and final PE grade year 9 indicates that students with disabilities are "stuck" in the Swedish criterion referenced grading system. This finding contradicts with the ideal of inclusive, equitable schooling (Nilholm, 2006; Ainscow, 2012). Adding further to our suggestion from previous findings (Bertills et al., 2018b), knowledge and skills of students in need of special support in PE ought not to be assessed according to the fixed set of predetermined criteria seen in the Swedish grading system. Grading criteria need to be adapted and communicated in a way that makes students with disabilities understand that it is ok to do PE activities differently. However, our results also imply that school-based PE provides disadvantaged students with participatory gains. Findings show that PE grades and PE-specific self-efficacy and aptitude to participate are related, and that the strongest associations were found in the group of students with disabilities. Over time these associations became stronger in the group of students with disabilities and in the group of students with low grades. The importance of creating meaningful learning experiences that students with disabilities will want to participate in Haegele and Sutherland (2015) must be emphasized. Our

TABLE 7 | Summary of logistic regression analysis for perceived functional socio-cognitive change (mean value) predicting PE-specific self-efficacy at T2 in the study sample (n = 105).

Variable	Model 1						Model 2					
	B	SE B	Wald χ^2	*p*	OR	95% CI OR	B	SE B	Wald χ^2	*p*	OR	95% CI OR
PE-specific self-efficacy	1.72	0.54	10.22	0.001	5.581	[1.94, 16.01]	2.2	0.61	13.01	0.000	9.114	[2.74, 30.28]
Socio-cognitive skills							1.15	0.47	6.07	0.014	3.172	[1.94, 16.01]

TABLE 8 | Correlations over time of achievement in PE with students' perceived self-efficacy (PE-specific and general), aptitude to participate, and functioning (physical and socio-cognitive).

Achievement	SEinPE T1	SEinPE T2	Apt.part T1	Apt.part T2	GSE T1	GSE T2	Phys T1	Phys T2	Socio-cog T1	Socio-cog T2	Final grade
Study sample											
Year7	0.451**	0.390**	0.387**	0.483**	0.235*	0.214*	0.142	0.154	0.249*	0.365**	0.732**
Final	0.471**	0.524**	0.408**	0.585**	0.281**	0.141	0.181	0.236*	0.274**	0.274**	
Disability											
Year7	0.461*	0.492**	0.504**	0.565**	0.167	0.283	0.044	0.203	0.038	0.173	0.783**
Final	0.656**	0.679**	0.632**	0.739**	0.338	0.311	−0.001	0.291	0.085	0.367	
A–C											
Year7	0.362*	0.126	0.171	0.282	0.151	0.136	0.222	0.024	0.235	−0.001	0.532**
Final	0.209	0.261	0.072	0.392**	0.120	0.030	0.297*	0.230	0.188	0.057	
D–F											
Year7	0.340	0.389*	0.332	0.508**	0.177	0.270	−0.073	0.003	0.033	0.519**	0.635**
Final	0.501**	0.586**	0.511**	0.622**	0.349	0.179	0.003	−0.064	0.171	0.113	

*Achievement = spring grade in PE year 7 (Year7) and final grade in PE year 9 (Final), SEinPE = PE-specific self-efficacy, Apt.part = aptitude to participate, GSE = general school self-efficacy, Phys = physical functional skills, Socio-cogn. = socio-cognitive functional skills, timepoint 1, year 7 (T1) and timepoint 2, year 9 (T2); **$p < 0.01$, *$p < 0.05$.*

study also suggests that promoting PE-specific self-efficacy is yet another aspect to consider. Participation boosts PE-specific self-efficacy, and capacity beliefs boost the desire to join in.

Perceived Functioning in Relation to Self-Efficacy (PE-Specific and General) and Aptitude to Participate in PE

How functioning is perceived to affect performance in PE might change over time. Developmental changes in adolescence occur at different times and paces. Little is known about school transitions for students disadvantaged by disability (Hughes et al., 2013) and the development of student functioning in PE over time. Perceived physical functional skills of students with disabilities seem to limit their aptitude to participate in PE. Ratings of functional restrictions of their physical skills (arms, legs, and hands) were stable over time in students with disabilities. However, moving from close to zero impact at T1 (see **Table 4**), self-rated physical functional skills became strongly related to self-efficacy (PE-specific and general) and aptitude to participate in PE at T2. This change only occurred in students with disabilities (see **Table 5**) and may be due to changes in frame of references for this group, from perceptions of effort as a reward to comparing their physical skills with other students (Jacobs et al., 2002). Previous reports on declining participation in PE in secondary school (Säfvenbom et al., 2014; The Swedish Schools Inspectorate, 2018) seem to be connected to students' perceived functioning. In Sweden, it is legislated that special support should be provided if students risk failing one or more subjects (The Swedish National Agency for Education, 2018). Evidence for beneficial effects of physical activity interventions on overall academic performance is inconclusive (Singh et al., 2019). Ericsson and Karlsson (2014) provided evidence in a 9-year intervention study that adapted motor skills training during compulsory school years had positive effects not only on motor skills but also on final grades. However, special support in PE is rarely provided in secondary school. In a previous observational study, the primary source of support to students with disabilities seemed to consist of closer proximity to the teacher (Bertills et al., 2019). Higher student engagement was observed in the groups of students with disabilities and those with low grades in conditions where PE teachers offered whole group self-sustaining activities. The PE teachers could then compensate for the lack of assistance by allocating teacher support. Closer proximity was achieved in small group activities, where differentiated challenges and individualized support and feed-back/feed-forward could be provided. In the current study, our results show that students perceiving physical restrictions were considerably less likely to experience high general school self-efficacy in the final phase of mainstream inclusive secondary school. This finding highlights the importance of fostering a mastery climate emphasizing effort before physical skills (Valentini and Rudisill, 2004; Harwood et al., 2015).

Self-rated perceived socio-cognitive functional skills, i.e., general health, behavioral, social, communicative, and

problem-solving skills, improved over time in the study sample (see **Table 2**). In line with previous research linking self-regulation to learning (Zimmerman, 2000), our findings show stronger associations over time between socio-cognitive functional skills and perceived PE-specific self-efficacy in the group of students with disabilities (**Table 4**) with the opposite found in the other two groups. Maybe the different patterns of associations imply that elevation of perceived socio-cognitive functional skills occurs at a different pace in each group, with a slower pace in students with disabilities. Consistency in ratings of socio-cognitive functional skills was found in students with high grades, which indicate that they are not as affected as their peers. This may signal early maturity, which supports previous research that initial high efficacy to self-regulate student actions leads the way to future success (Caprara et al., 2004). It is also likely that students with disabilities mature at a slower pace (Lygnegård et al., 2018). Another explanation is the previously mentioned change in frame of reference. At T1, students with disabilities responded negatively to teachers who worked systematically with grading (Bertills et al., 2018b), and stronger associations were identified between functional skills and PE-specific self-efficacy at T2. Partaking regularly in PE and practicing prosocial activities with set rules together with peers may enhance students' ability to regulate socio-cognitive functional skills. Eventually, they would adapt to the new environment, which in turn positively would affect their PE-specific self-efficacy, and probably also their aptitude to participate in PE. A positive learning climate, where effort is promoted before competition, and where students are allowed to perform differently, may also boost self-efficacy, aptitude to participate, and perceived socio-cognitive functional skills. Schunk and Pajares (2010) further argue that as student self-evaluations become more accurate, discrepancies between self-efficacy and performance are leveled out. The group of students with low grades was the most affected by limitations in socio-cognitive functional skills at T1 (**Table 4**). Although improving during secondary school, skills, such as being able to communicate, behave, and solve problems, considerably affect the general school self-efficacy of this group of students. Our results confirm previous findings that initial high self-efficacy remains over time (Chase, 2001), but also that PE-specific self-efficacy is promoted by improved students' socio-cognitive functioning (**Table 7**). The positive association in students with low grades between PE grade at T1 and perceived socio-cognitive functioning at T2 also has implications for how PE teachers should reason about grading. One common direction to take is to initially award a lower grade, for the students to improve toward the intended learning outcomes. Maybe it should be the other way around, as initial PE grades affect future socio-cognitive skills positively in the group of students with low grades. Belief in one's capability may spread across domains and influence future choices (Pajares and Urdan, 2006). We therefore suggest that there seems to be overall gains to be found in supporting the development of students' perceived socio-cognitive skills in a PE environment. This suggestion has implications for the allocation of resources. Empowering students' socio-cognitive skills would probably have direct effects on self-efficacy and aptitude to participate in PE and presumably indirect effects on overall school and future life outcome.

LIMITATIONS

Due to limited sized participant groups in this study, tendencies and patterns of developmental processes were explored, rather than significance. Results should be used with caution. Generally, correlations > 0.30 were taken into consideration. Asking students their perceived age of maturity would have added further nuances of student developmental processes. Two timepoint measures only show bidirectional correlations. Collecting data a third time would have better informed the discussion of maturity pace on how self-efficacy, aptitude to participate, and functioning develop differently in the three groups studied. Gender differences were controlled for at T1 in a sample of 450 students with no significant differences found. It was decided to focus on the target groups rather than gender. However, the fact that there were more boys in the groups of students with disabilities and those with low grades and more girls in the group with high grades may have affected results over time. Group dynamics changed in some of the classes investigated, due to a large number of refugees (not included in the current study) added between T1 and T2 that may indirectly have impacted the results. Students with disabilities are often excluded from partaking in research concerning their experiences (Alderson and Morrow, 2011), due to ethical considerations (Qi and Ha, 2012) and exclusive research methodology (Haegele and Hodge, 2017). To ensure successful completion by students in need of special support, accommodations were made, such as providing a separate room, a simplified version of the questionnaire, and reading aide (Bertills et al., 2018a).

CONCLUSION

The aims were to explore how processes of students' perceived PE-specific self-efficacy, general school self-efficacy, and aptitude to participate in PE develop over time, as well as how these processes were related to students' perceived physical and socio-cognitive functional skills and achievement. Student PE-specific self-efficacy is strengthened over time, and associations between PE-specific self-efficacy and aptitude to participate are consistent. These findings imply that attendance in PE stimulates engagement and learning and confirms that learning takes place in accordance with the current Swedish PE syllabus. Consequently, PE-specific self-efficacy may be considered as a positive outcome of school-based PE and could be used to complement a summative grade. Grades remained consistent over time for students with disabilities, indicating that grading criteria need to be adapted to PE ability, in order to adequately show student progress. The experienced feeling of having physical restrictions accelerates in students with disabilities. School interventions should aim at limiting negative effects of such

negative experiences. Providing adapted motor skills training is one feasible way; another is to adopt an inclusive approach to facilitate participation. Meaningful learning experiences for students with disabilities are created in conditions where inclusive approaches are provided. Students with disabilities are more sensitive to the classroom climate, and it is reasonable to assume that inclusive teaching practices promote participation and boost self-efficacy. Allocating resources to support students' socio-cognitive skills would probably generate positive effects on the classroom climate as well as on student general school self-efficacy, that is, academic, social, and emotional self-competence beliefs.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by The Ethical Review Board, Linköping (2013/508-31). Written informed consent to participate in this study was provided by the participants' legal guardian/next of kin.

AUTHOR CONTRIBUTIONS

KB adapted the instruments, distributed the questionnaires, collected and analyzed the data, and wrote the first draft. All authors interpreted the results and contributed to the writing and revising process.

FUNDING

This study was supported by Stiftelsen Sunnerdahls Handikappfond (grant no. 413/14).

ACKNOWLEDGMENTS

The authors would like to express their gratitude to participants in this study, students in mainstream inclusive secondary school, their PE teachers, and schools who welcomed research into the educational system.

SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpsyg.2021.607329/full#supplementary-material

REFERENCES

Ainscow, M. (2012). *Developing Equitable Education Systems*. London: Routledge.

Alderson, P., and Morrow, V. (2011). *The Ethics of Research With Children and Young People: A Practical Handbook*. London: Sage Publications Ltd.

Allodi, M. W. (2000). Self-concept in children receiving special support at school. *Eur. J. Special Needs Educ.* 15, 69–78. doi: 10.1080/0885625003617 18

Avramidis, E. (2013). Self-concept, social position and social participation of pupils with sen in mainstream primary schools. *Res. Papers Educ.* 28, 421–442. doi: 10.1080/02671522.2012.673006

Bailey, R., Armour, K., Kirk, D., Jess, M., Pickup, I., and Sandford, R. (2009). The educational benefits claimed for physical education and school sport: an academic review. *Res. Papers Educ.* 24, 1–27. doi: 10.1080/0267152070180 9817

Bandura, A. (1993). Perceived self-efficacy in cognitive development and functioning. *Educ. Psychol.* 28, 117–148. doi: 10.1207/s15326985ep2 802_3

Bandura, A. (1994). *Encyclopedia of Human Behavior*, Vol. 4. San Diego, CA: Academic Press, 71–81.

Bandura, A. (1997). *Self-Efficacy: The Exercise of Control*. Basingstoke: W. H. Freeman.

Bandura, A. (2006). "Guide for constructing self-efficacy scales," in *Self-Efficacy Beliefs of Adolescents*, Vol. 5, eds F. Pajares and T. Urdan (Greenwich, CT: Information Age Publishing), 307–337.

Bertills, K., Granlund, M., and Augustine, L. (2018a). Measuring self-efficacy, aptitude to participate and functioning in students with and without impairments. *Eur. J. Special Needs Educ.* 33, 572–583. doi: 10.1080/08856257.2017.1386316

Bertills, K., Granlund, M., and Augustine, L. (2019). Inclusive teaching skills and student engagement in physical education. *Front. Educ.* 4:74. doi: 10.3389/feduc.2019.00074

Bertills, K., Granlund, M., Dahlström, Ö, and Augustine, L. (2018b). Relationships between physical education (pe) teaching and student self-efficacy, aptitude to participate in pe and functional skills: With a special focus on students with disabilities. *Phys. Educ. Sport Pedagogy* 23, 387–401. doi: 10.1080/17408989.2018.1441394

Bird, K. D. (2004). *Analysis of Variance Via Confidence Intervals*. London: SAGE Publications.

Block, M. E., and Obrusnikova, I. (2007). Inclusion in physical education: a review of the literature from 1995-2005. *Adapted Phys. Activity Quarterly* 24, 103–124. doi: 10.1123/apaq.24.2.103

Bråkenhielm, G. (2008). Ingen gympa för mig!en undersökning av skälen till att elever inte deltar i ämnet idrott och hälsa [no gymnastics for me!an investigation of reasons why pupils don't participate in physical education and training]. *Svensk Idrottsforskning* 2, 31–33.

Caprara, G. V., Alessandri, G., and Eisenberg, N. (2012). Prosociality: the contribution of traits, values, and self-efficacy beliefs. *J. Personal. Soc. Psychol.* 102, 1289–1303. doi: 10.1037/a0025626

Caprara, G. V., Barbaranelli, C., Pastorelli, C., and Cervone, D. (2004). The contribution of self-efficacy beliefs to psychosocial outcomes in adolescence: predicting beyond global dispositional tendencies. *Personal. Individ. Diffe.* 37, 751–763. doi: 10.1016/j.paid.2003.11.003

Chase, M. A. (2001). Children's self-efficacy, motivational intentions, and attributions in physical education and sport. *Res. Quart. Exercise Sport* 72, 47–54. doi: 10.1080/02701367.2001.10608931

Ericsson, I., and Karlsson, M. K. (2014). Motor skills and school performance in children with daily physical education in school: a 9-year intervention study. *Scandinavian J. Med. Sci. Sports* 24, 273–278. doi: 10.1111/j.1600-0838.2012.01458.x

Field, A. (2013). *Discovering Statistics Using Ibm Spss Statistics*. Los Angeles, CA: Sage Publications Ltd.

Fitzgerald, H. (2005). Still feeling like a spare piece of luggage? Embodied experiences of (dis)ability in physical education and school sport. *Phys. Educ. Sport Pedagogy* 10, 41–59. doi: 10.1080/1740898042000334908

Grenier, M., Collins, K., Wright, S., and Kearns, C. (2014). Perceptions of a disability sport unit in general physical education. *Adapted Phys. Activity Quart.* 31, 49–66. doi: 10.1123/apaq.2013-0006

Gustafsson, J.-E., Allodi Westling, M., Alin Åkerman, B., Eriksson, C., Eriksson, L., Fischbein, S., et al. (2010). *School, Learning and Mental Health: A Systematic Review*. Stockholm: The Royal Swedish Academy of Sciences.

Haegele, J. A., and Hodge, S. (2017). Current practices and future directions in reporting disability in school-based physical education research. *Quest* 69, 113–124. doi: 10.1080/00336297.2016.1165122

Haegele, J. A., and Sutherland, S. (2015). Perspectives of students with disabilities toward physical education: a qualitative inquiry review. *Quest* 67, 255–273. doi: 10.1080/00336297.2015.1050118

Hagger, M. S., Hein, V., and Chatzisarantis, N. L. D. (2011). Achievement goals, physical self-concept, and social physique anxiety in a physical activity context. *J. Appl. Soc. Psychol.* 41, 1299–1339. doi: 10.1111/j.1559-1816.2011.00761.x

Harwood, C. G., Keegan, R. J., Smith, J. M. J., and Raine, A. S. (2015). A systematic review of the intrapersonal correlates of motivational climate perceptions in sport and physical activity. *Psychol. Sport Exercise* 18, 9–25. doi: 10.1016/j.psychsport.2014.11.005

Hughes, L. A., Banks, P., and Terras, M. M. (2013). Secondary school transition for children with special educational needs: a literature review. *Support Learn.* 28, 24–34. doi: 10.1111/1467-9604.12012

Imms, C., Granlund, M., Wilson, P. H., Steenbergen, B., Rosenbaum, P. L., and Gordon, A. M. (2017). Participation, both a means and an end: a conceptual analysis of processes and outcomes in childhood disability. *Dev. Med. Child Neurol.* 59, 16–25. doi: 10.1111/dmcn.13237

Jacobs, J. E., Lanza, S., Osgood, D. W., Eccles, J. S., and Wigfield, A. (2002). Changes in children's self−competence and values: gender and domain differences across grades one through twelve. *Child Dev.* 73, 509–527. doi: 10.1111/1467-8624.00421

Kang, L.-J., Palisano, R. J., King, G. A., and Chiarello, L. A. (2014). A multidimensional model of optimal participation of children with physical disabilities. *Disabil. Rehabil.* 36, 1735–1741. doi: 10.3109/09638288.2013.863392

King, G., Petrenchik, T., Law, M., and Hurley, P. (2009). The enjoyment of formal and informal recreation and leisure activities: a comparison of school-aged children with and without physical disabilities. *Int. J. Disabil. Dev. Educ.* 56, 109–130. doi: 10.1080/10349120902868558

Kitsantas, A., Cheema, J., and Ware, H. W. (2011). Mathematics achievement: the role of homework and self-efficacy beliefs. *J. Adv. Acad.* 22, 310–339. doi: 10.1177/1932202X1102200206

Lundvall, S., and Brun Sundblad, G. (2017). "Polarisering av ungas idrottande [polarization of youth's sport activities]," in *De Aktiva Och de Inaktiva: Om Ungas Rörelse i Skola och på Fritid [The Active and Inactive: About Youth's Activity in School and in Free Time]*, eds C. Dartsch, J. R. Norberg, and J. Pihlblad (Stockholm: Centrum för idrottsforskning), 45–75.

Lygnegård, F., Augustine, L., Granlund, M., Kåreholt, I., and Huus, K. (2018). Factors associated with participation and change over time in domestic life, peer relations, and school for adolescents with and without self-reported neurodevelopmental disorders. a follow-up prospective study. *Front. Educ.* 3:28. doi: 10.3389/feduc.2018.00028

Mallinson, T., and Hammel, J. (2010). Measurement of participation: intersecting person, task, and environment. *Arch. Phys. Med. Rehabil.* 91, S29–S33. doi: 10.1016/j.apmr.2010.04.027

Morley, D., Bailey, R., Tan, J., and Cooke, B. (2005). Inclusive physical education: Teachers' views of including pupils with special educational needs and/or disabilities in physical education. *Eur. Phys. Educ. Rev.* 11, 84–107. doi: 10.1177/1356336X05049826

Muris, P. (2001). A brief questionnaire for measuring self-efficacy in youths. *J. Psychopathol. Behav. Assessment* 23, 145–149. doi: 10.1023/A:1010961119608

Nilholm, C. (2006). Special education, inclusion and democracy. *Eur. J. Special Needs Educ.* 21, 431–445. doi: 10.1080/08856250600957905

Ntoumanis, N., Pensgaard, A.-M., Martin, C., and Pipe, K. (2004). An idiographic analysis of amotivation in compulsory school physical education. *J. Sport Exercise Psychol.* 26, 197–214. doi: 10.1123/jsep.26.2.197

Pajares, F. (2003). Self-efficacy beliefs, motivation, and achievement in writing: a review of the literature. *Read. Writing Quart. Overcoming Learn. Difficul.* 19, 139–158. doi: 10.1080/10573560308222

Pajares, F., and Urdan, T. C. (2006). *Self-Efficacy Beliefs of Adolescents*. Greenwich: IAP Information Age Pub., Inc.

Pijl, S., Frostad, P., and Flem, A. (2008). The social position of pupils with special needs in regular schools. *Scandinavian J. Educ. Res.* 52, 387–405. doi: 10.1080/00313830802184558

Qi, J., and Ha, A. S. (2012). Inclusion in physical education: a review of literature. *Int. J. Disabil. Dev. Educ.* 59, 257–281. doi: 10.1080/1034912X.2012.697737

Sabiston, C. M., Pila, E., Pinsonnault-Bilodeau, G., and Cox, A. E. (2014). Social physique anxiety experiences in physical activity: a comprehensive synthesis of research studies focused on measurement, theory, and predictors and outcomes. *Int. Rev. Sport Exercise Psychol.* 7, 158–183. doi: 10.1080/1750984X.2014.904392

Schunk, D. H. (2003). Self-efficacy for reading and writing: Influence of modeling, goal setting, and self-evaluation. *Read. Writing Quart.* 19, 159–172. doi: 10.1080/10573560308219

Schunk, D. H., and Pajares, F. (2010). "Self-efficacy beliefs," in *International Encyclopedia of Education*, 3rd Edn, eds P. Peterson, E. Baker, and B. McGaw (London: Elsevier), 668–672.

Seymour, H., Reid, G., and Bloom, G. A. (2009). Friendship in inclusive physical education. *Adapted Physical Activity Quart.* 26, 201–219. doi: 10.1123/apaq.26.3.201

Siegel, S., and Castellan, N. J. (1988). *Nonparametric Statistics for the Behavioral Sciences*, 2nd Edn. New York,NY: McGraw-Hill.

Simeonsson, R. J., and Bailey, D. B. (1991). *The Abilities Index*. University of North Carolina at Chapel Hill: Frank Porter Graham Development Center.

Singh, A. S., Saliasi, E., van den Berg, V., Uijtdewilligen, L., de Groot, R. H. M., Jolles, J., et al. (2019). Effects of physical activity interventions on cognitive and academic performance in children and adolescents: A novel combination of a systematic review and recommendations from an expert panel. *Br. J. Sports Med.* 53, 640–647. doi: 10.1136/bjsports-2017-098136

Säfvenbom, R., Haugen, T., and Bulie, M. (2014). Attitudes toward and motivation for pe. who collects the benefits of the subject? *Phys. Educ. Sport Pedagogy* 20, 1–18. doi: 10.1080/17408989.2014.892063

Tant, M., and Watelain, E. (2016). Forty years later, a systematic literature review on inclusion in physical education (1975–2015): a teacher perspective. *Educ. Res. Rev.* 19, 1–17. doi: 10.1016/j.edurev.2016.04.002

The Swedish National Agency for Education (2018). *Curriculum for the Compulsory School, Preschool Class and School-Age Educare*. Available online at: https://www.skolverket.se/publikationer?id=3984 (accessed April 30, 2018).

The Swedish Schools Inspectorate (2018). *Kvalitetsgranskning av Ämnet Idrott och Hälsa i Årskurs 7–9 [Physical Education Quality Report in Years 7-9]*. Available online at: https://www.skolinspektionen.se/idrott-och-halsa (accessed June 12, 2018).

UNESCO (2015a). *International Charter of Physical Education Revised to Ensure More Inclusive Access to Physical Activity*. Available online at: http://unesdoc.unesco.org/images/0023/002354/235409e.pdf (accessed November 13, 2018).

UNESCO (2015b). *Quality Physical Education*. Available online at: http://unesdoc.unesco.org/images/0023/002311/231101E.pdf (accessed October 24, 2017).

Upadyaya, K., and Salmela-Aro, K. (2013). Development of school engagement in association with academic success and well-being in varying social contexts: a review of empirical research. *Eur. Psychol.* 18, 136–147. doi: 10.1027/1016-9040/a000143

Valentini, N. C., and Rudisill, M. E. (2004). An inclusive mastery climate intervention and the motor skill development of children with and without disabilities. *Adapted Physical Activity Quarterly* 21, 330–347. doi: 10.1123/apaq.21.4.330

Vaz, S. M. A. (2010). *Factors Affecting Student Adjustment as They Transition From Primary to Secondary School: a Longitudinal Investigation. Ph. D, Thesis*. Curtin University of Technology, School of Occupational Therapy and Social Work: Centre for Research into Disability and Society.

Weiner, B. (1985). An attributional theory of achievement motivation and emotion. *Psychol. Rev.* 92, 548–573. doi: 10.1037/0033-295X.92.4.548

Woodmansee, C., Hahne, A., Imms, C., and Shields, N. (2016). Comparing participation in physical recreation activities between children with disability and children with typical development: a secondary analysis of matched data. *Res. Dev. Disabil.* 4, 268–276. doi: 10.1016/j.ridd.2015.12.004

World Health Organization (2007). *International Classification of Functioning, Disability and Health: Children and Youth Version*. Geneva: World Health Organization.

Zimmerman, B. J. (2000). Self-efficacy: an essential motive to learn. *Contemporary Educ. Psychol.* 25, 82–91. doi: 10.1006/ceps.1999.1016

Conflict of Interest: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

frontiers in Psychology

BRIEF RESEARCH REPORT
published: 03 June 2021
doi: 10.3389/fpsyg.2021.652050

Effects of a Teacher-Training Violence Prevention Program in Jamaican Preschools on Child Behavior, Academic Achievement, and School Attendance in Grade One of Primary School: Follow up of a Cluster Randomized Trial

Helen Baker-Henningham[1,2]*, *Yakeisha Scott*[2], *Taja Francis*[2] and *Susan P. Walker*[2]

[1] School of Psychology, Bangor University, Bangor, United Kingdom, [2] Caribbean Institute for Health Research, University of the West Indies, Kingston, Jamaica

OPEN ACCESS

Edited by:
Adelinda Araujo Candeias, University of Evora, Portugal

Reviewed by:
Guadalupe Alba, University of Granada, Spain
Simona Trip, University of Oradea, Romania

***Correspondence:**
Helen Baker-Henningham
h.henningham@bangor.ac.uk

Specialty section:
This article was submitted to Educational Psychology, a section of the journal Frontiers in Psychology

Received: 08 March 2021
Accepted: 11 May 2021
Published: 03 June 2021

Citation:
Baker-Henningham H, Scott Y, Francis T and Walker SP (2021) Effects of a Teacher-Training Violence Prevention Program in Jamaican Preschools on Child Behavior, Academic Achievement, and School Attendance in Grade One of Primary School: Follow up of a Cluster Randomized Trial. Front. Psychol. 12:652050. doi: 10.3389/fpsyg.2021.652050

Objective: We evaluated the effect of a universal, teacher-training, violence-prevention program implemented in preschool, on high-risk children's behavior, achievement, and attendance in grade one of primary school.

Methods: A cluster-randomized trial was conducted in 24 preschools in Kingston, Jamaica. Three children from each class with the highest level of teacher-reported conduct problems were recruited for evaluation of outcomes ($n = 225$ children). For this study, to increase power, we recruited an additional two children from each class with the next highest teacher-reported scores for conduct problems in preschool. In the final term of grade one of primary school, we assessed children's: (1) conduct problems and social skills at home and school, (2) academic achievement, language, and self-regulation skills, and (3) school attendance.

Results: 214/225 (95.1%) of the children evaluated in preschool were assessed in grade one of primary school; an additional 150 children were recruited to give 364 children (181 intervention, 183 control). Significant benefits of intervention were found for child academic achievement (Effect size (ES) = 0.23, $p = 0.02$), oral language (ES = 0.28, $p = 0.006$), self-regulation (ES = 0.25, $p = 0.007$), and school attendance (ES = 0.30, $p = 0.003$). No significant benefits were found for observed conduct problems (ES = −0.13, $p = 0.16$), and parent-reported conduct problems (ES = 0.10, $p = 0.31$) and social skills (ES = −0.07, $p = 0.52$). Benefits to teacher-reported conduct problems and social skills were significant at $p < 0.1$ (ES = −0.16, $p = 0.09$, and ES = 0.19, $p = 0.06$, respectively).

Conclusion: A scalable intervention involving training preschool teachers in classroom behavior management and how to promote child social-emotional competence led to positive outcomes in primary school across multiple child developmental domains for high-risk children.

Keywords: violence prevention, teacher-training, conduct problems, social skills, early childhood, academic achievement, school attendance, low- and middle-income countries

INTRODUCTION

Disruptive behavior disorders (DBDs) include conduct disorder and oppositional defiant disorder are one of the most common childhood mental health problems with a global prevalence of 5.7% (Polanczyk et al., 2015). Conduct problems are more common affecting 7–25% of young children and place children at increased risk for developing later DBDs and for academic underachievement, school dropout, drug use, and crime and violence in adulthood (Webster-Stratton and Hammond, 1998; Scott, 2015). Preventative interventions in early childhood are recommended to prevent the development of serious DBDs (Webster-Stratton and Taylor, 2001). Universal interventions to prevent DBDs are non-stigmatizing, often address multiple risk and protective factors thus leading to benefits across child developmental domains, and have potential for population-level improvements in child functioning as all children are exposed to intervention (Greenberg and Abenavoli, 2017). Universal, school-based, violence-prevention programs have been shown to reduce children's aggressive and disruptive behaviors (Hahn et al., 2007; Wilson and Lipsey, 2007), with some evidence of sustained benefits in adulthood (Hawkins et al., 2008). Common approaches used in these programs involve training teachers in classroom behavior management and/or how to promote children's social-emotional skills. Meta-analyses of classroom behavior management and social-emotional learning programs report benefits to multiple child outcomes including children's behavior, social-emotional skills, and academic skills with significant concurrent benefits across all domains and some evidence that benefits are maintained over time (Korpershoek et al., 2016; Mahoney et al., 2018). Meta-analyses of such interventions in early childhood educational contexts also report benefits to child behavior and social-emotional competence, (Schindler et al., 2015; Werner et al., 2016) with strongest effects from programs with an explicit focus on child social and emotional skills (Schindler et al., 2015).

Despite this large evidence-base for the effectiveness of school-based violence prevention programs for reducing child aggressive and disruptive behaviors and increasing child competencies, there are few trials from low- and middle-income countries (LMIC) (Burkey et al., 2018). This is a concern as: (1) almost 90% of the world's children and adolescents live in LMIC (Keiling et al., 2011), (2) many schools in LMIC have low levels of resources and are staffed by undertrained teachers, and we need evidence that programs can work in these low-resource contexts, (3) risk factors for conduct problems including violence against children by parents and teachers are widespread in LMIC, (Hillis et al., 2016; Gershoff, 2017), and (4) approaches used in high-income countries are often resource intensive and unlikely to be affordable.

We evaluated a teacher-training, violence prevention program in Jamaican preschools that involved training teachers in classroom behavior management and how to promote young children's social and emotional skills. Large and significant benefits were found for teacher practices and the classroom atmosphere at post-intervention and at 6-months follow-up (Baker-Henningham and Walker, 2018). Intervention teachers used more positive and fewer negative strategies with the whole class [mean effect size (ES) = 2.32 SD at post-intervention, 1.84 at follow-up], and with children with high levels of conduct problems on recruitment (mean ES = 0.67 at post-intervention only), and benefits were found for observer ratings of class-wide child appropriate behavior and interest and enthusiasm in learning activities (mean ES = 0.86 at post-intervention, 0.64 at follow-up). Importantly, these benefits were accompanied by significant benefits to conduct problems and social skills at school (mean ES = 0.56) and at home (ES = 0.22), and to school attendance (ES = 0.30) for children with heightened levels of conduct problems at baseline (Baker-Henningham et al., 2012). In the present study, we evaluated whether this preschool teacher-training, violence-prevention programme led to sustained benefits to child outcomes, for children with heightened levels of conduct problems at baseline, when children transitioned to primary school. Specifically, we investigated the effect of the preschool teacher-training program on child conduct problems, social skills, school attendance, school achievement, oral language, and self-regulation skills in the final term of grade one of primary school.

METHODS

Study Design and Participants

The teacher-training, violence-prevention program was evaluated in a cluster-randomized trial in 24 community preschools situated within three educational zones located in disadvantaged, inner-city areas of Kingston and St. Andrew, Jamaica. Community preschools cater to children aged 3–6 years and are provided through community organizations, usually churches, with oversight from government. Over 98% of 3–6-year-old Jamaican children attend an early childhood educational institution, with the majority (over 75%) attending community preschools. All preschools within the three zones were surveyed and those meeting the inclusion criteria were invited to participate. Inclusion criteria were: (1) at least 20

children per class, (2) three to four classes of children, and (3) all teachers consent to participate in the trial. Fifty schools were approached and 24 preschools met all inclusion criteria and were recruited into the study (twenty-six schools were excluded: seven with <3, or more than four classrooms; 18 with <20 children per class; one refusal). In all preschools, children were grouped in same-age classrooms (3, 4, and 5-year-olds). The community preschools were staffed mostly by paraprofessional teachers, and had poor structural conditions, and few resources (Baker-Henningham et al., 2012; Baker-Henningham and Walker, 2018).

Children with heightened levels of conduct problems at baseline were recruited into the evaluation as school-based preventative interventions have been shown to benefit high-risk children the most (Wilson and Lipsey, 2007). Pre-school teachers rated all children in their class on a 10-question screen for conduct problems using a four-point scale (not true, just a little true, pretty much true, very true). Questions were based on age-appropriate items for a diagnosis of conduct disorder from the ICD-10 Classification of Mental and Behavioral Disorders: Diagnostic Criteria for Research (World Health Organization, 1993), (loses temper, back chats, disobedient/breaks rules, annoys others, blames others, easily annoyed, often angry, spiteful to others, fights or bullies, destroys property). Three children from each class, with the highest level of conduct problems were selected for evaluation. Exclusion criteria for children were: (1) school attendance <70%, (2) sibling of an enrolled child, (3) had a developmental disability, and/or (4) lived in an institution. Twenty-four high-scoring children were excluded and replaced by the next highest-scoring child in their class.

A total of 225 children were recruited from the 24 preschools at baseline and after randomization, 113 children attended preschools allocated to intervention and 112 children attended preschools allocated to control; 210 children were evaluated post-intervention (**Figure 1**). For the current study, we tried to locate all 225 children recruited at baseline. In addition, to increase power to detect significant differences between the groups, two additional children per class with the next highest levels of teacher-reported conduct problems on the 10-question screen at baseline were selected. Exclusion criteria were the same as for the original sample. Twenty-two high scoring children were excluded (10 intervention, 12 control), and were replaced by the next high-scoring child in the class (**Figure 1**). A total of 150 additional children (77 intervention, 73 control) were selected giving a total sample size of 364 children (181 intervention, 183 control).

For the current study, we report cross-sectional data collected when children were in the final term of grade one of primary school. Children transition to primary school at age 6 years and the data for this study was collected over 4 years until all children that were screened in preschool had transitioned to primary school.

The University the West Indies Ethics Committee approved the study (approval number: ECP148,10/11). Written informed consent was obtained from all school principals, teachers and parents of the selected children.

Intervention

The intervention involved training all teaching staff and principals in intervention preschools in an adapted version of Incredible Years (IY) Teacher Training Program (Webster-Stratton, 2000). The core content of the program included: (1) developing positive teacher-child relationships, (2) using praise and rewards, (3) preventing and managing child misbehavior, and (4) teaching social and emotional skills. Teachers attended eight full-day teacher-training workshops and received four 1-h sessions of in-class support, conducted monthly for 4 months. Workshops included videotape and live modeling, practice activities, and discussions. In-class support sessions included modeling the use of the strategies, prompting the teachers to use them, providing supportive feedback, and collaborative problem-solving. The in-class support was designed to ensure teachers could utilize the strategies successfully in their individual classroom context and help teachers to generalize their use over the school day. Teachers were given practical classroom assignments after each workshop to encourage use of the strategies taught and were provided with key resources required to implement the program (including visual aids, stickers, a small hand puppet, and behavior planning forms). Adaptations to the IY program included: (1) adding locally developed materials and activities (for example, video vignettes, instructional materials, classroom assignments, lesson plans, visual aids), (2) lengthening the program from 5–6 days to 8 days, (3) including additional practical activities and small-group activities in training workshops, (4) providing in-class support, and (5) designing new content and placing increased emphasis on building positive relationships with children, being proactive to prevent behavior problems, and integrating activities to promote children's social-emotional competence into everyday teaching and learning activities. The intervention was delivered as intended, teachers reported high levels of satisfaction with the training and teacher attendance was high (Baker-Henningham and Walker, 2018). Full details of the intervention and the adaptations made have been described previously (Baker-Henningham and Walker, 2018). Preschool teachers in control schools did not receive the teacher-training workshops, in-class support sessions, or intervention materials. All study schools received a set of educational materials including blocks, manipulatives, and play doh.

Measurements

Outcome measurements included child: (1) conduct problems by observation, teacher-, and parent-report, (2) social skills by teacher- and parent-report, (3) academic achievement and oral language skills by direct testing, (4) self-regulation through ratings during the test, and (5) school attendance from school records (see **Supplementary Table 1**). All outcome measurements have been used previously in Jamaica (Baker-Henningham et al., 2007, 2012) and were collected by data collectors (DCs) masked to group assignment. Teachers were also unaware of children's group assignment. DCs were rotated across classrooms and schools and conducted equal numbers of measurements with each group. Measurements were conducted

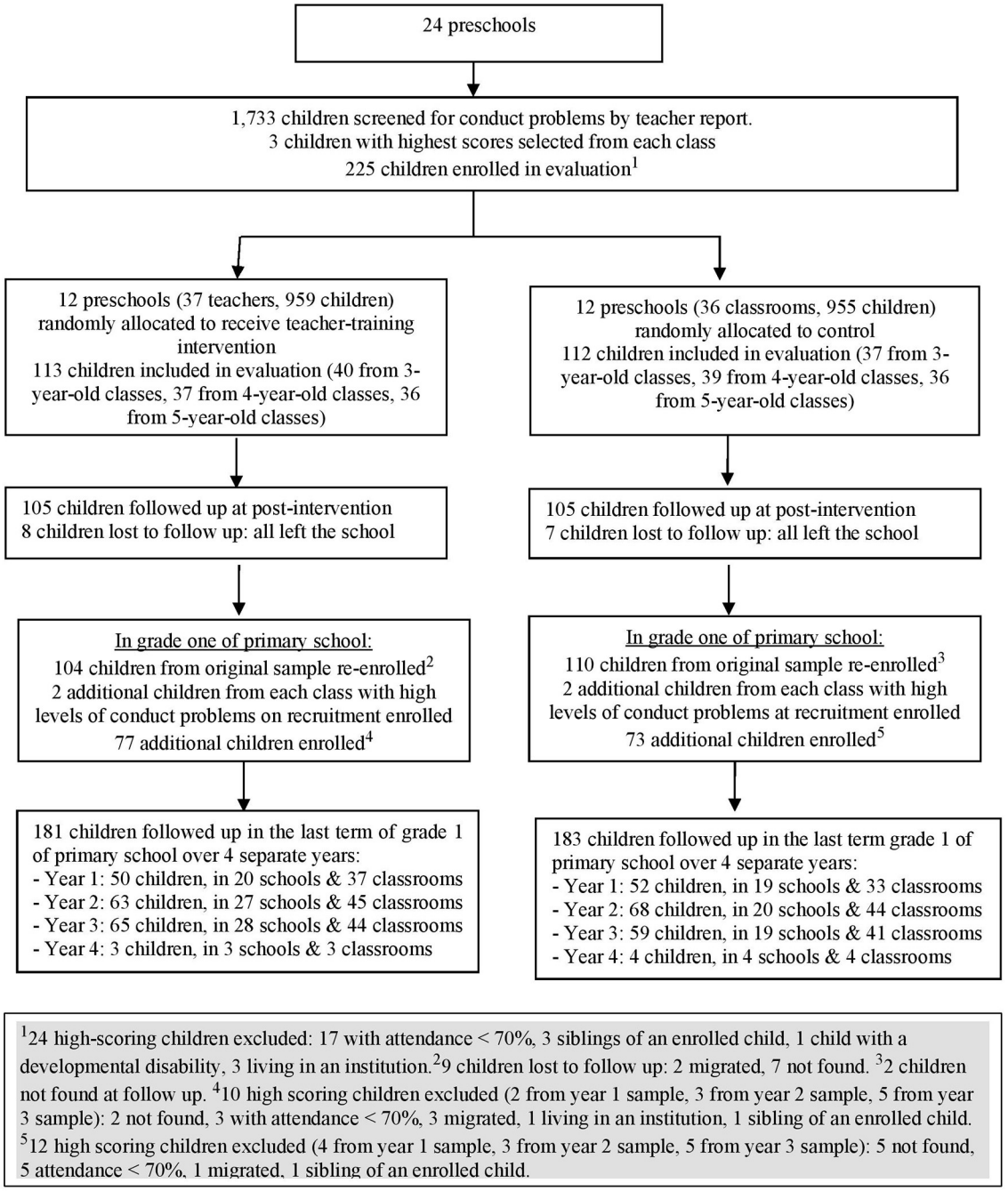

FIGURE 1 | Study profile.

in the final term of the school year when the children were in grade one of primary school.

Observations of Child Behavior

Children were observed for 5-min intervals, for 30 min a day, over two school days to give a total of 1 h of observation. When there was more than one target child in a class, children were observed for 5 min each on a rotational basis with a maximum of three children observed at one time. When there was only one target child per class, the child was observed for 5 min out of every 10 min. Event sampling was used to record each discrete act of aggressive/destructive behavior (e.g., hitting, throwing objects) and expressed as frequency per hour. Disruptive behavior (e.g., shouting, out of seat) was measured by recording whether the behavior occurred or not at 15 s intervals with a maximum possible

score of 240. After each 5-min interval, observers also rated child behavior on four 7-point rating scales measuring the frequency and intensity of child conduct problems (e.g., displaying anger/frustration, non-compliance), activity level (e.g., inappropriate gross-motor and fine-motor movements), on-task behavior (e.g., engagement in learning activities), and follows classroom rules/expectations (e.g., obeys rules/follows routines). The mean score over 12 5-min intervals was used in the analyses. Higher scores indicate more of the characteristic. All behaviors were defined in a manual and were based on observational assessments used previously in preschools, operationalized for the primary school environment (Baker-Henningham et al., 2012).

Teacher- and Parent-Reported Child Behavior

All questionnaires were interviewer-administered. For teacher-reported behavior, we used the Sutter-Eyberg Student Behavior Inventory (SESBI) frequency scale (Rayfield et al., 1998) to measure child conduct problems and the School Social Behavior Scales-Social Competence Scale (SSBS) (Merrell, 2002) to measure child social skills. For parent-reported child behavior, we used the Eyberg Child Behavior Inventory (ECBI) frequency scale (Eyberg and Ross, 1978) to measure child conduct problems and the Strengths and Difficulties (SDQ) Prosocial Scale (Goodman, 1999) to measure child social skills. All measures had good internal consistency (Cronbach's alpha: median 0.87, range 0.71–0.97) and test-retest over 2 weeks (ICC: median 0.88, range 0.75–0.97) (**Supplementary Table 2**).

Child Academic Achievement, Oral Language, and Self-Regulation Skills

Reading and spelling were measured with the Letter-Word Identification, Passage Comprehension, and Spelling subscales of the Woodcock-Johnson III Tests of Achievement (Woodcock et al., 2001). Maths was measured with the Calculation and Reasoning and Concepts subscales of the Woodcock-McGrew-Werder Mini-Battery of Achievement (Woodcock et al., 1994). Receptive and expressive oral language skills were measured using the Understanding Directions and Story Recall subscales of the Woodcock-Johnson III Tests of Achievement (Woodcock et al., 2001). Test-retest over 2 weeks were ICC: median = 0.97 for child academic achievement tests and ICC = 0.82 for child language skills (**Supplementary Table 2**).

Children's self-regulation during the testing session was rated using ten 4-point scales from the Preschool Self-Regulation Assessment (PSRA) (Smith-Donald et al., 2007). Five items rated child attention (pays attention, careful, concentrates, daydreams, distracted) and five items rated child impulse control (thinks and plans, refrains from touching testing materials, does not interrupt tester, difficult waiting, remains in seat). Negative items were reverse coded and scores from the 10 scales were summed to form a total score with a minimum score of zero and a maximum of thirty. Internal reliability was Cronbach's alpha = 0.88, and test-retest over 2 weeks was ICC = 0.85.

School attendance for the first two school terms in grade one was calculated from classroom registers and expressed as a percentage.

Procedure and Quality Control

Ten DCs collected the outcome data for this study. Three DCs conducted observations of child behavior at school, three DCs conducted teacher interviews and child tests, and two DCs conducted parent interviews. Teacher questionnaires and child tests were administered at school and parent questionnaires at home. Child observations were conducted over two school days in each classroom. Only one child observer was present in a class at a time, with a maximum of two child observers present in a school. Child tests and teacher interviewers were conducted after all child observations in a classroom were completed. DCs were trained over a 3–4-week period prior to each year of data collection including 1-week in-office training, 1–2-weeks field training, and 1-week field reliabilities. Inter-observer reliabilities were calculated between the trainer and each DC prior to data collection and for a minimum of 10% of measurements during ongoing data collection. For child observations, interobserver reliabilities were calculated for 5-min observations intervals and the intraclass correlation coefficients (ICC) were median 0.93 (range 0.90–0.95) prior to data collection, and ICC = 0.93 (0.84–0.97) during the study (**Supplementary Table 3**). For child tests and teacher and parent interviewers, ICCs were >0.95 throughout.

Statistical Analysis

For the sample size calculation, we assumed an average of sixteen children per cluster, and an intra-cluster correlation coefficient of 0.05. With a minimum of 175 children per group, we could detect an effect of 0.4 SD, with 80% power and at a 0.05 level of significance.

All variables were checked for normality. Multilevel multiple regression analyses were used to determine the effect of intervention on child outcomes to take into account the clustered nature of the data. Exploratory factor analysis of the observed child behavior variables produced one factor; factor analysis of the academic achievement test scores produced one factor, and factor analysis of the oral language test scores produced one factor (**Supplementary Table 4**). The factor scores for these three outcomes were saved as regression scores and used in the analyses (DiStefano et al., 2009). All other outcomes (parent and teacher-reported conduct problems and social skills, child attendance, and self-regulation) were checked for normality and then standardized. Self-regulation, parent-reported prosocial behavior and school attendance were positively skewed and were transformed by squaring prior to standardization. The use of factor scores and standardized scores resulted in regression coefficients expressed in standard deviations for all outcomes. In all analyses, child age and sex, dummy variables for data collector, dummy variables for the year of data collection, a variable for whether the child was evaluated in the original study or not, and group assignment were entered as fixed effects and school and classroom as random effects. Multilevel analyses were conducted with MLWin version (v3.05) (Charlton et al., 2020).

TABLE 1 | Child and family characteristics and child behavior in preschool by study group. Values are Mean (SD) unless otherwise stated.

Children evaluated in preschool	Intervention $n = 113$	Control $n = 112$	*P*-value*
Child and family characteristics			
Child age (in years)	4.2 (0.9)	4.2 (0.8)	0.86
Child sex: *n* (%) boys	67 (59.3)	71 (63.4)	0.53
Caregiver age	31.5 (10.6)	30.8 (8.7)	0.22
Caregiver finished high school *n* (%)	46 (40.7)	47 (42.0)	0.85
Father lives with child *n* (%)	47 (41.6)	45 (40.2)	0.87
Crowding[a]	2.2 (1.3)	2.0 (1.0)	0.35
Possessions[b]	8.9 (2.4)	8.9 (2.6)	0.98
Child behavior in preschool			
Structured observations of child behavior			
Aggressive/destructive behavior, *median (range)*[c]	12 (0–50)	13 (0–45)	0.53
Disruptive behavior, *median (range)*[d]	32 (3–89)	32 (6–98)	0.99
Rating scales of child behavior[e]			
Conduct problems	2.70 (0.85)	2.81 (0.85)	0.33
Activity level	3.32 (0.73)	3.19 (0.67)	0.08
On-task behavior	4.95 (0.87)	4.85 (0.84)	0.25
Follows rules and expectations	4.75 (0.72)	4.63 (0.67)	0.17
Teacher-reported child behavior			
Conduct problems (SESBI intensity scales)	154.29 (44.38)	152.45 (31.96)	0.86
Clinical range for conduct problems at school: *n*(%)[f]	60 (53.1)	63 (56.3)	0.64
Prosocial skills (SDQ)	5.30 (2.31)	5.49 (2.32)	0.50
Parent-reported child behavior			
Conduct problems (ECBI intensity scales)	120.05 (22.66)	119.83 (24.26)	0.90
Clinical range for conduct problems at home: *n*(%)[g]	42 (37.2)	35 (31.3)	0.35
Prosocial skills (SDQ)	7.33 (2.23)	7.82 (1.87)	0.07
Children evaluated in grade one	**Intervention *n = 181***	**Control *n = 183***	***P*-value***
Child and family characteristics			
Child age (in years)	6.91 (0.39)	6.90 (0.38)	0.73
Child sex: *n* (%) boys	110 (60.1)	102 (56.4)	0.47
Family on PATH (cash-transfer) programme *n* (%)	19 (10.5)	22 (12.0)	0.53
Caregiver age	34.04 (9.29)	33.98 (9.85)	0.95
Caregiver finished secondary school *n* (%)	83 (46.1)	88 (49.2)	0.60
Father lives with child *n* (%)	69 (38.3)	56 (33.0)	0.16
Crowding *median (range*[a]	1.6 (0.4–6.0)	1.7 (0.4–8.0)	0.71
Possessions[b]	8.68 (2.32)	8.35 (2.49)	0.19
Teacher/classroom characteristics			
Teacher sex: *n* (%) female	180 (99.4)	183 (100)	0.32
Number of years teaching	16.48 (11.38)	17.57 (11.76)	0.37
Number of years teaching at current school	11.13 (9.23)	11.51 (9.54)	0.70
Teacher qualified *n* (%)	175 (96.7)	175 (95.6)	0.26
Teacher has early childhood teaching qualification: *n* (%)	66 (36.5)	76 (41.5)	0.37
Number of children in class	31.00 (7.52)	31.45 (6.38)	0.55

t-tests were used for normally distributed continuous variables, Mann-Whitney tests were used for continuous variables that were not normally distributed, Chi-square analyses were used for categorical variables. SESBI, Sutter-Eyberg Student Behavior Inventory; SSBS, School Social Behavior Scales; ECBI, Eyberg Child Behavior Inventory; SDQ, Strengths and Difficulties Questionnaire. [a]Number of people per room. [b]Number of possessions from a list of 15 items; stove, fridge, washing machine, sofa or soft chair, mobile phone, landline, radio, CD player, TV, cable TV, DVD player, computer, bicycle, motorbike, motor car. [c]Counts over 12 5-min observation intervals conducted over 2 school days. [d]Instantaneous sampling at 15 s intervals over a total of 1 h of observation over 2 school days (max = 240). [e]Mean of 12 ratings conducted after each 5-min observation periods on a scale of 0–7, where 0, low; 7, high. [f]Above cut-off (>150) on SESBI intensity scale. [g]Above cut-off (>130) on ECBI intensity scale.

RESULTS

Sample Characteristics

We identified 214/225 (95.1%) of the children recruited in preschool (104/113 intervention, 110/112 control). Two children lost to follow-up had migrated (both intervention), and nine were not found. There were no significant differences between those lost and those found on family characteristics and child behavior at home and at school at baseline. However, children lost to follow up were younger ($p = 0.02$) and less likely to be male ($p = 0.08$) (**Supplementary Table 5**).

Over the 4 years of the study, study children were dispersed over fifty primary schools and 149 different classrooms. There was a mean of 6.25 children per school, with a range from 1 to 57. Over 54% (198/364) of the children attended the same five primary schools [54.1% (98/181) intervention, 54.6% (100/183) control]. In addition, 49 classrooms in 14 schools catered to nearly 50% (177/364) of the children [47.5% (86/181) intervention, 49.7% (91/183) control].

There were no significant differences between the groups on child, family, teacher and classroom characteristics in grade one, and for the children evaluated in preschool, no significant differences between the groups at baseline (**Table 1**).

Effect of Intervention

Raw scores for all outcomes are shown in **Table 2** with the significance of unadjusted intervention effects. **Table 3** shows the intervention effects using multi-level linear regression analyses. Benefits of the preschool teacher-training intervention were found for children's academic achievement (ES = 0.23), oral language (ES = 0.28), self-regulation (ES = 0.25), and school attendance (ES = 0.30) in grade one of primary school. No

TABLE 2 | Raw data for child outcomes in grade one of primary school by study group. Values are Mean (SD) unless otherwise stated.

	Intervention *n = 181*	Control *n = 183*	*P*-value*
Structured observations of child behavior			
Aggressive/destructive behavior, *median (range)*[a]	6 (0–40)	6 (0–31)	0.19
Disruptive behavior, *median (range)*[b]	23 (0–93)	25 (2–99)	0.07
Rating scales of child behavior, mean (SD)[c]			
Conduct problems	2.01 (0.68)	2.07 (0.65)	0.38
Activity level	2.83 (0.032)	2.87 (0.36)	0.24
On-task behavior	5.04 (0.93)	4.91 (0.87)	0.19
Follows rules and expectations	5.40 (0.67)	5.31 (0.69)	0.21
Teacher-reported child behavior			
Conduct problems (SESBI frequency scales)	117.96 (42.38	126.07 (47.80)	0.09
Social skills (SSBS)	108.65 (22.76)	103.45 (23.08)	0.03
Parent-reported child behavior[d]			
Conduct problems (ECBI frequency scales)	116.28 (25.78)	115.03 (23.74)	0.63
Prosocial skills (SDQ)	9 (1–10)	9 (3–10)	0.81
Academic achievement, language, and self-regulation			
Letter-word identification	24.37 (8.97)	22.18 (7.96)	0.01
Reading comprehension	10.59 (5.04)	9.52 (4.50)	0.03
Spelling	19.15 (4.82)	17.79 (4.47	0.006
Maths calculation, *median (range)*	5 (0–12)	5 (0–11)	0.002
Maths reasoning, *median (range)*	25 (2–31)	25 (0–31)	0.005
Receptive language (following directions)	21.01 (8.24)	18.78 (8.55)	0.01
Expressive language (story recall)	23.53 (14.75)	20.14 (13.21)	0.02
Self-regulation, *median (range)*[e]	26 (5–30)	26 (8–30)	0.02
School attendance			
School attendance, *median (range)*[f]	94.44 (35.85–100)	89.47 (25.33–100)	<0.0001

**t-tests were used for normally distributed continuous variables, Mann-Whitney tests were for continuous variables that were not normally distributed. SESBI, Sutter-Eyberg Student Behavior Inventory; SSBS, School Social Behavior Scales; ECBI, Eyberg Child Behavior Inventory; SDQ, Strengths and Difficulties Questionnaire. [a]Counts over 1 h. [b]Instantaneous sampling at 15 s intervals over a total of 1 h of observation (max=240). [c]Mean of 12 ratings conducted after 5-min observation periods on a scale of 0–7, where 0, low; 7, high. [d]For parent-reported outcomes: n = 180 intervention, 179 control. [e]Sum of 10 ratings of child behavior during the test on a scale of 0–4 (min=0, max=40). [f]Expressed as a percentage.*

significant benefits were found for observed conduct problems (ES = −0.13), or parent-reported conduct problems (ES = 0.10) and prosocial skills (ES = 0.06). However, teacher-reported conduct problems (ES = −0.16) and social skills (ES = 0.19) were significant at $p < 0.1$.

DISCUSSION

To our knowledge, this is the first trial of a preschool teacher-training, violence-prevention program from LMIC with follow-up measures of child outcomes when children have transitioned to primary school. The intervention involved training teachers in classroom behavior management and in how to promote child social-emotional competence through everyday teaching and learning activities. In this study, although we implemented a universal preventative intervention, we recruited children with the highest levels of conduct problems in preschool in the evaluation sample. We found significant benefits to: (1) direct tests of child academic achievement and oral language, (2) tester ratings of self-regulation (including child attention and impulse control), and (3) child school attendance from school records. No significant benefits were found for child conduct problems and social skills at home and at school.

We report effect sizes between 0.13 and 0.25 on child behavior at school, between 0.23 and 0.28 on child outcomes on an academic achievement test, and 0.30 on school attendance. These effect sizes are of a similar level of magnitude to those reported by meta-analyses of longer-term effects from universal, school-based, social, emotional, and behavioral programs that have largely been implemented in primary schools in high-income countries. These meta-analyses report effect sizes between 0.07 and 0.33 for children's social-emotional skills, conduct problems, prosocial behaviors, and academic achievement, with strongest effects for academic achievement (Sklad et al., 2012; Taylor et al., 2017). We are aware of only two previous studies, both conducted in the US, that investigated the longer-term effects of such programs implemented in preschool settings. These studies reported sustained benefits to child behavior, academic achievement and/or executive function (Zhai et al., 2012; Bierman et al., 2014; Sasser et al., 2017; Welsh et al., 2020), especially for children with poorer baseline functioning (Sasser et al., 2017) and for children who subsequently attended higher-quality schools (Zhai et al., 2012). However, these US programs were resource intensive (e.g., incorporating teacher mental health, extensive in-class support, services for high-risk children, use of a structured social-emotional curriculum, and/or an additional intervention component targeting child preacademic skills) (Bierman et al., 2008a; Raver et al., 2008), and hence would be unlikely to be affordable in LMIC contexts. Our intervention was teacher-focussed (Baker-Henningham et al., 2012; Baker-Henningham and Walker, 2018), and benefits to parent-reported child behavior were small at post-intervention (ES = 0.22), and there were no longer-term benefits to child behavior at home. For sustained gains to child behavior at home, a parent-training component is likely to be necessary (Bierman et al., 2015).

There are two main potential pathways for the effect of the intervention on child achievement, language, self-regulation, and attendance. Firstly, benefits post-intervention may have led to sustained benefits in primary school. For example, benefits to child attendance were found in preschool and these benefits were sustained in primary school, possibly due to increased parent interest and involvement in their child's schooling and/or children's increased bonding to school (Hawkins et al., 1992; O'Donnell et al., 1995). Although we did not measure child pre-academic, language, and self-regulation skills in preschool, it is possible that these skills were also improved at post-intervention (Raver et al., 2011), with benefits sustained in grade one. Secondly, gains to specific skills and behaviors at post-intervention may mediate the effect of intervention on other

TABLE 3 | Multilevel regression analyses of the effect of the preschool teacher-training intervention on child outcomes in grade one of primary school.

	Standardized Scores[a]		Effect size B (95% CI)[b]	ICC[c]	*P*-value
	Intervention ($n = 181$)	Control ($n = 183$)			
Child behavior					
Observed conduct problems[1]	−0.08 (0.99)	0.08 (1.01)	−0.13 (−0.32, 0.05)	0.12	0.16
Teacher-reported conduct problems[2]	−0.08 (0.93)	0.09 (1.05)	−0.16 (−0.35, 0.02)	0.03	0.09
Teacher-reported social skills[2]	0.12 (0.99)	−0.11 (1.00)	0.19 (−0.01, 0.38)	0.00	0.06
Parent-reported conduct problems[2]	0.03 (1.04)	−0.03 (0.96)	0.10 (−0.08, 0.30)	0.01	0.31
Parent-reported prosocial skills[2,3]	−0.01 (1.07)	0.01 (0.93)	−0.07 (−0.27, 0.14)	0.02	0.52
Child academic achievement, language, and self-regulation					
Academic achievement[4]	0.16 (1.02)	−0.15 (0.95)	0.23 (0.04, 0.42)	0.28	0.02
Oral language[5]	0.16 (1.00)	−0.15 (0.95)	0.28 (0.08, 0.48)	0.13	0.006
Self–regulation[2,3]	0.14 (0.94)	−0.13 (1.04)	0.25 (0.07, 0.43)	0.03	0.007
Child attendance					
Child attendance[2,3]	0.17 (1.02)	−0.16 (0.97)	0.30 (0.10, 0.49)	0.09	0.003

[a]Mean (SD). [b]Regression coefficient (95% confidence interval), expressed as standardized scores. [c]Intracluster correlation coefficient. [1]Factor score of structured observations of aggressive/destructive behavior and disruptive behavior, and ratings of child conduct problems, activity level, on-task behavior, and follows rules/expectations over 12 5-min observation intervals over 2 days of observation. [2]Standardized by subtracting the mean and dividing by the SD. [3]Normalized by squaring prior to standardizing. [4]Factor score of Letter-Word Identification, Passage Comprehension, Spelling, Maths Calculation, and Maths Reasoning. [5]Factor score of Following Directions (receptive language) and Story Recall (expressive language).

All regressions controlled for child age and sex, dummy variables for data collectors, dummy variables for year of data collection, and a dummy variable for in original study sample or not as fixed effects, and school and classroom as random effects.

aspects of child functioning in primary school. That is, children's later attainments may build on earlier skill development (Heckman, 2006). For example, the benefits to child academic achievement and language skills may have been mediated by the gains to child behavior post-intervention (Nix et al., 2013). In addition, through the teacher-training program, preschool teachers were trained to provide a positive, structured classroom environment, with clear rules and expectations, and with behavioral supports to help children meet these expectations. These teacher behaviors promote the development of children's self-regulation skills, and in two recent Jamaican studies, we have found benefits to child self-regulatory competencies from training teachers in classroom behavior management (Baker-Henningham et al., 2019, 2021). Self-regulation has been shown to predict longer-term gains to child outcomes in other studies (Bierman et al., 2008b; Raver et al., 2011). Benefits to school attendance may have also mediated the effect of the intervention on child academic skills (Gottfried, 2010).

Grade one classrooms in inner-city primary schools in Kingston are characterized by low levels of emotional support, frequent use of harsh punishment by teachers, low levels of class-wide child prosocial behavior, and relatively high levels of class-wide child aggression (Baker-Henningham et al., 2019). The lack of a nurturing classroom environment and exposure to peers displaying aggressive behaviors and poor social skills may make it difficult for children to sustain gains to their behavior in this new context (Zhai et al., 2012; Wolf, 2019). It is perhaps surprising, that despite these non-sustaining environments, benefits to child functioning across multiple domains were found. It is possible that larger benefits to child outcomes, including child conduct problems and social skills would be found if training was also provided for teachers in the early primary grades to ensure a consistent approach as children transition from preschool to formal schooling.

The strengths of the study include: (1) use of multiple informants to measure child behavior, including independent observations, teacher, and parent report (Scott, 2001), (2) use of direct tests of child school achievement and language skills, and tester ratings of child self-regulation, (3) all measurements administered by masked assessors, (3) good psychometric properties of the outcome measures, and (4) low attrition of the original study sample with over 95% of children followed up in primary school. The study also has limitations. We had limited power to detect small effects and it is possible that a larger sample size may have shown significant effects on child behavior at school, especially for teacher-reported outcomes which were significant at $p < 0.1$. Some factors may limit the generalisability of the results. Children with high levels of conduct problems who had poor preschool attendance were ineligible to participate in the evaluation. However, only 25 children were excluded for poor attendance, <7% of the sample. Preschools in the original trial were selected based on the number of classrooms and number of children per class due to logistical reasons relating to training, measurement, and identification of high-risk children. However, as the intervention involves training all teaching staff, we anticipate benefits for children attending schools with different numbers of classrooms and/or smaller class sizes. We were unable to conduct longitudinal analyses to examine mediators of intervention effectiveness as over 40% of the children included in this study were not evaluated in preschool. As we only recruited children with heightened levels of conduct problems at baseline, we do not know whether the

intervention benefited all children, or whether benefits were concentrated in children at high-risk.

In conclusion, we found that a low-cost, scalable teacher-training, violence-prevention program led to benefits across multiple outcomes in grade one primary school for children with high initial levels of conduct problems. Future research is required to examine whether the intervention benefits children with low-to-moderate levels of conduct problems, in addition to those at heightened risk and whether benefits are sustained over the longer-term. It is also important to investigate the potential for cumulative effects to child functioning from training preschool and primary school teachers and from combining the teacher-training with a complementary parent-training program to promote an integrated approach across contexts.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by University of the West Indies Ethics Committee, Mona, Kingston, Jamaica. Written informed consent to participate in this study was provided by the participants' legal guardian/next of kin.

AUTHOR CONTRIBUTIONS

HB-H and SW contributed to the conceptualization of the study and funding acquisition. HB-H and YS contributed to project administration. YS, TF, and HB-H contributed to investigation. TF and YS were responsible for data curation. HB-H and TF were responsible for data analysis. HB-H was responsible for writing the original draft. All authors reviewed and edited the manuscript.

FUNDING

The work was supported by The Wellcome Trust, [grant number 094307/Z/10/Z].

ACKNOWLEDGMENTS

We thank the principals, teachers, parents, and children who participated in this study and the research assistants for data collection.

SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpsyg.2021.652050/full#supplementary-material

REFERENCES

Baker-Henningham, H., Bowers, M., Francis, T., Vera-Hernandez, M., and Walker, S. P. (2021). The Irie Classroom Toolbox, a universal violence-prevention teacher-training programme, in Jamaican preschools: a single-blind, cluster-randomised controlled trial. *Lancet Glob. Health*. 9, e456–468. doi: 10.1016/S2214-109X(21)00002-4

Baker-Henningham, H., Scott, S., Jones, K., and Walker, S. (2012). Reducing child conduct problems and promoting social skills in a middle-income country: cluster randomised controlled trial. *Br. J. Psychiatry* 201, 101–108. doi: 10.1192/bjp.bp.111.096834

Baker-Henningham, H., Scott, Y., Bowers, M., and Francis, T. (2019). Evaluation of a violence-prevention programme with Jamaican primary school teachers: a cluster randomised trial. *Int. J. Environ. Res. Public. Health* 16:2797. doi: 10.3390/ijerph16152797

Baker-Henningham, H., and Walker, S. (2018). Transporting an evidence-based, violence prevention intervention to Jamaican preschools: a cluster randomized trial. *Glob. Mental Health* 5:e7. doi: 10.1017/gmh.2017.29

Baker-Henningham, H., Walker, S., and Chang-Lopez, S. (2007). *Special Education Needs Study: End of Study Report*. Kingston: Primary Education Support Project Office, Ministry of Education and Youth.

Bierman, K. L., Domitrovich, C. E., Nix, R. L., Gest, S. D., Welsh, J. A., Greenberg, M. T., et al. (2008a). Promoting academic and social-emotional school readiness: the Head Start REDI program. *Child Dev.* 79, 1802–1817. doi: 10.1111/j.1467-8624.2008.01227.x

Bierman, K. L., Nix, R. L., Greenberg, M. T., Blair, C., and Domitrovich, C. E. (2008b). Executive functions and school readiness intervention: Impact, moderation, and mediation in the Head Start REDI program. *Dev. Psychopathol.* 20, 821–843. doi: 10.1017/S0954579408000394

Bierman, K. L., Nix, R. L., Heinrichs, B. S., Domitrovich, C. E., Gest, S. D., Welsh, J. A., et al. (2014). Effects of Head Start REDI on children's outcomes one year later in different kindergarten contexts. *Child Dev.* 85, 140–159. doi: 10.1111/cdev.12117

Bierman, K. L., Welsh, J. A., Heinrichs, B. S., Nix, R. L., and Mathis, E. T. (2015). Helping Head Start parents promote their children's kindergarten adjustment: the research-based developmentally informed parent program. *Child Dev.* 86, 1877–1891. doi: 10.1111/cdev.12448

Burkey, M. D., Hosein, M., Morton, I., Purgato, M., Adi, A., Kurzrok, M., et al. (2018). Psychosocial interventions for disruptive behaviour problems in children in low- and middle-income countries: a systematic review and meta-analysis. *J. Child Psychol. Psychiatry* 59, 982–993. doi: 10.1111/jcpp.12894

Charlton, C., Rasbash, J., Browne, W. J., Healy, M., and Cameron, B. (2020). *MLwiN Version 3.05*. University of Bristol: Centre for Multilevel Modelling.

DiStefano, C., Zh, M., and Mîndrilă D. (2009). Understanding and using factor scores: considerations for the applied researcher. *Pract. Assess. Res. Eval.* 14, 1–11. doi: 10.7275/da8t-4g52

Eyberg, S., and Ross, A. (1978). Assessment of child behavior problems: the validation of a new inventory. *J. Clin. Child Psychol.* 7, 113–116. doi: 10.1080/15374417809532835

Gershoff, E. T. (2017). School corporal punishment in global perspective: prevalence, outcomes and efforts at intervention. *Psychol. Health Med.* 22, 224–239. doi: 10.1080/13548506.2016.1271955

Goodman, R. (1999). The extended version of the strengths and difficulties questionnaire as a guide to child psychiatric caseness and consequent burden. *J. Child Psychol. Psychiatry* 40, 791–799. doi: 10.1111/1469-7610.00494

Gottfried, M. A. (2010). Evaluating the relationship between student attendance and achievement in urban elementary and middle schools: an instrumental variables approach. *Am. Educ. Res. J.* 47, 434–465. doi: 10.3102/0002831209350494

Greenberg, M. T., and Abenavoli, R. (2017). Universal interventions: Fully exploring their impacts and potential to produce population-level impacts. *J. Res. Educ. Eff.* 10, 40–67. doi: 10.1080/19345747.2016.1246632

Hahn, R., Fuqua-Whitley, D., Wethington, H., Lowy, J., Crosby, A., Fullilove, M., et al. (2007). Effectiveness of universal school-based programs to prevent violent and aggressive behaviour. a systematic review. *Am. J. Prev. Med*. 33, S114–S129. doi: 10.1016/j.amepre.2007.04.012

Hawkins, D., Kosterman, R., Catalano, R., Hill, K., and Abbott, R. (2008). Effects of social development intervention in childhood 15 years later. *Arch. Pediatr. Adolesc. Med*. 162, 1133–1141. doi: 10.1001/archpedi.162.12.1133

Hawkins, J. D., Catalano, R. F., Morrison, D. M., O'Donnell, J., Abbott, R. D., and Day, L. E. (1992). "The Seattle Social Development Project: effects of the first four years on protective factors and problem behaviors," in *Preventing Antisocial Behavior: Interventions From Birth Through Adolescence*, eds J. McCord, and R. E. Tremblay (New York, NY: Guilford Publications), 139–161.

Heckman, J. J. (2006). Skill formation and the economics of investing in disadvantaged children. *Science* 321, 1900–1902 doi: 10.1126/science.1128898

Hillis, S., Mercy, J., Amobi, A., and Kess, H. (2016). Global prevalence of past-year violence against children: a systematic review and minimum estimates. *Pediatrics* 137:e20154079. doi: 10.1542/peds.2015-4079

Keiling, C., Baker-Henningham, H., Belfer, M., Conti, G., Ertem, I., Omigbodun, O., et al. (2011). Child and adolescent mental health worldwide: evidence for action. *Lancet* 378, 1515–1525. doi: 10.1016/S0140-6736(11)60827-1

Korpershoek, H., Harms, T., de Boer, H., van Kuijk, M., and Doolaard, S. (2016). A meta-analysis of the effects of classroom management strategies and classroom management programs on students' academic, behavioural, emotional and motivational outcomes. *Rev. Educ. Res*. 86, 643–680. doi: 10.3102/0034654315626799

Mahoney, J. L., Durlak, J. A., and Weissberg, R. P. (2018). An update on social and emotional learning outcome research. *Phi. Delta Kappan*. 100, 18–23. doi: 10.1177/0031721718815668

Merrell, K. W. (2002). *School Social Behavior Scales, 2nd Edition (SSBS-2)*. Eugene, OR: Assessment Intervention Resources.

Nix, R. L., Bierman, K. L., Domitrovich, C. E., and Gill, S. (2013). Promoting children's social-emotional skills in preschool can enhance academic and behavioral functioning in kindergarten: findings from Head Start REDI. *Early Educ. Dev*. 24, 1000–1019. doi: 10.1080/10409289.2013.825565

O'Donnell, J., Hawkins, J. D., Catalano, R. F., Abbott, R. D., and Day, L. E. (1995). Preventing school failure, drug use, and delinquency among low-income children: long-term intervention in elementary schools. *Am. J. Orthopsychiatry* 65, 87–100. doi: 10.1037/h0079598

Polanczyk, G. V., Salum, G. A., Sugaya, L. S., Caye, A., and Rohde, L. A. (2015). Annual research review: a meta-analysis of the worldwide prevalence of mental disorders in children and adolescents. *J. Child Psychol. Psychiatry* 56, 345–365. doi: 10.1111/jcpp.12381

Raver, C. C., Jones, S. M., Li-Grining, C., Zhai, F., Bub, K., and Pressler, E. (2011). CSRP's impact on low-income preschoolers' preacademic skills: self-regulation as a mediating mechanism. *Child Dev*. 82, 362–378. doi: 10.1111/j.1467-8624.2010.01561.x

Raver, C. C., Jones, S. M., Li-Grining, C. P., Metzger, M., Champion, K. M., and Sardin, L. (2008). Improving preschool classroom processes: preliminary findings from a randomized trial implemented in Head Start settings. *Early Child Res. Q*. 23, 10–26. doi: 10.1016/j.ecresq.2007.09.001

Rayfield, A., Eyberg, S., and Foote, R. (1998). Revision of the sutter-eyberg student behavior inventory: teacher ratings of conduct problem behavior. *Educ. Psychol. Meas*. 58, 88–98. doi: 10.1177/0013164498058001008

Sasser, T. R., Bierman, K. L., Heinrichs, B., and Nix, R. L. (2017). Preschool intervention can promote sustained growth in the executive function skills of children exhibiting early deficits. *Psychol. Sci*. 28, 1–12. doi: 10.1177/0956797617711640

Schindler, H., Kholoptseva, J., Oh, S., Yoshikawa, H., Duncan, G., Magnuson, K., et al. (2015). Maximising the potential of early childhood education to prevent externalizing behaviour problems: a meta-analysis. *J. School Psychol*. 53, 243–263. doi: 10.1016/j.jsp.2015.04.001

Scott, S. (2001). Deciding whether interventions for antisocial behaviour work: Principles of outcome assessment, and practice in a multicentre trial. *Eur. Child Adolesc. Psychiatry* 10, 59–70. doi: 10.1007/s007870170007

Scott, S. (2015). "Oppositional and conduct disorders," in *Rutter's Child and Adolescent Psychiatry 6th edition*, eds A. Thapar, D. Pine, J. Leckman, S. Scott, M. Snowling, and E. Taylor E (Oxford: Wiley-Blackwell), 913–930.

Sklad, M., Diekstra, R., De Ritter, M., and Ben, J. (2012). Effectiveness of school-based universal social, emotional, and behavioral programs: do they enhance students' development in the area of skill, behavior, and adjustment. *Psychol. Sch*. 49, 892–909. doi: 10.1002/pits.21641

Smith-Donald, R., Raver, C., Hayes, T., and Richardson, B. (2007). Preliminary construct and concurrent validity of the Preschool Self-Regulation Assessment (PSRA) for field-based research. *Early Child Res. Q*. 22, 173–187. doi: 10.1016/j.ecresq.2007.01.002

Taylor, R. D., Oberle, E., Durlak, J. A., and Weissberg, R. P. (2017). Promoting positive youth development through school-based social and emotional learning interventions: a meta-analysis of follow-up effects. *Child Dev*. 88, 1156–1171. doi: 10.1111/cdev.12864

Webster-Stratton, C. (2000). *The Incredible Years Training Series*. Washington DC: Office of Juvenile Justice and Delinquency Prevention, Juvenile Justice Bulletin. doi: 10.1037/e300152004-001

Webster-Stratton, C., and Hammond, M. (1998). Conduct problems and level of social competence in Head Start children: prevalence, pervasiveness and associated risk factors. *Clin. Child Fam. Psychol. Rev*. 1, 101–124.

Webster-Stratton, C., and Taylor, T. (2001). Nipping early risk factors in the bud: preventing substance abuse, delinquency and violence in adolescence through interventions targeted at young children (0-8 years). *Prev. Sci*. 2, 165–192. doi: 10.1023/a:1011510923900

Welsh, J. A., Bierman, K. L., Nix, R. L., and Heinrichs, B. N. (2020). Sustained effects of a school readiness intervention: 5th grade outcomes of the Head Start REDI program. *Early Child Res. Q*. 53, 151–160. doi: 10.1016/j.ecresq.2020.03.009

Werner, C. D., Linting, M., Vermeer, H. J., and Van Ijzendoorn, M. H. (2016). Do intervention programs in child care promote the quality of caregiver-child interactions? A meta-analysis of randomized controlled trials. *Prev. Sci*. 17, 259–273. doi: 10.1007/s11121-015-0602-7

Wilson, S. J., and Lipsey, M. W. (2007). School-based interventions for aggressive and disruptive behaviour – update of a meta-analysis. *Am. J. Prev. Med*. 33, S130–S143. doi: 10.1016/j.amepre.2007.04.011

Wolf, S. (2019). Year 3 follow-up of the 'Quality Preschool for Ghana' interventions on child development. *Dev. Psychol*. 55, 2587–2602. doi: 10.1037/dev0000843

Woodcock, R., McGrew, K., and Mather, N. (2001). *Woodcock-Johnson III Tests of Achievement*. Itasca, IL: Riverside Publishing.

Woodcock, R., McGrew, K., and Werder, J. (1994). *Woodcock-McGrew-Werder Mini-Battery of Achievement*. Itasca, IL: Riverside Publishing.

World Health Organization (1993). *The ICD-10 Classification of Mental and Behavioural Disorders Diagnostic Criteria for Research*. Geneva: World Health Organisation.

Zhai, F., Raver, C. C., and Jones, S. M. (2012). Academic performance of subsequent schools and impacts of early intervention: evidence from a randomized controlled trial in Head Start settings. *Child Youth Serv. Rev*. 34, 946–954. doi: 10.1016/j.childyouth.2012.01.026

Conflict of Interest: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Advantages of publishing in Frontiers

OPEN ACCESS
Articles are free to read for greatest visibility and readership

FAST PUBLICATION
Around 90 days from submission to decision

HIGH QUALITY PEER-REVIEW
Rigorous, collaborative, and constructive peer-review

TRANSPARENT PEER-REVIEW
Editors and reviewers acknowledged by name on published articles

Frontiers
Avenue du Tribunal-Fédéral 34
1005 Lausanne | Switzerland

Visit us: www.frontiersin.org
Contact us: frontiersin.org/about/contact

REPRODUCIBILITY OF RESEARCH
Support open data and methods to enhance research reproducibility

DIGITAL PUBLISHING
Articles designed for optimal readership across devices

FOLLOW US
@frontiersin

IMPACT METRICS
Advanced article metrics track visibility across digital media

EXTENSIVE PROMOTION
Marketing and promotion of impactful research

LOOP RESEARCH NETWORK
Our network increases your article's readership