The Co-Development of Science, Math, and Language Interest Among Spanish and Finnish Secondary School Students

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The present two studies with a 3-year longitudinal design examined the co-development of science, math, and language (e.g., Spanish/Finnish) interest among 1,317 Spanish and 804 Finnish secondary school students across their transition to post-compulsory secondary education, taking into account the role of gender, performance, and socioeconomic status (SES). The research questions were analyzed with parallel process latent growth curve (LGC) modeling. The results showed that Spanish students' interest in each domain slightly decreased over time, whereas Finnish students experienced an overall high and relatively stable level of interest in all domains. Further, boys showed greater interest in math and science in both countries, whereas girls reported having a greater interest in languages. Moreover, Spanish and Finnish students with high academic achievement typically experienced high interest in different domains, however, some declines in their interest occurred later on.

Keywords: achievement, interest development, gender differences, languages, science, transitions

INTRODUCTION

According to the expectancy-value theory of achievement motivation (EVT), interest and task values play a crucial role in shaping students' achievement and career choices, even more than ability self-concepts (Wigfield and Cambria, 2010; Wigfield and Eccles, 2002). Task values consist of interest value (liking or enjoyment), utility value (instrumental value of the task), attainment value (personal importance), and cost (the negative consequences of making a concrete choice). Task values are domain-specific; a student can be interested in math but not in languages and vice versa–(Frenzel et al., 2010). Together with other task values, interest value plays an important role in "shaping individuals' achievement-related decisions like activity choice, participation, and engagement" (Eccles, 2005, p. 109). Interest values in different domains are similar to intrinsic values (Eccles, 2005; Frenzel et al., 2010), and are often relatively stable over time (Frenzel et al., 2010; Wigfield and Eccles, 2002). However, in comparison to other expectancy-value constructs (i.e., utility value) interest value has been understudied (Chow and Salmela-Aro, 2011). When students intrinsically value an activity, they often become deeply engaged in it and can persist at it for a long time (Wigfield and Eccles, 2002;Cambria, 2010). However, little is known about the differences of interest values in different domains. Consequently, the present study examined the co-development of math, science, and language interest among Spanish and Finnish secondary school students. Moreover, the low representation of women in many STEM (Science, Technology, Engineering, and Mathematics)

studies and occupations is a worldwide phenomenon (OECD, 2015), which also varies across different STEM fields. Thus, the present study examined the possible gender differences in student's interest values further.

Development of Interest in Math, Science, and Languages

Adolescents tend to become more negative about themselves and school after the transition to higher educational levels (Eccles and Wigfield, 2002; Jacobset al., 2002). Students whose valuing of different academic activities declines sharply over the school years are at risk of becoming apathetic about learning (Wigfield and Cambria, 2010).

Numerous changes in school environments during the transition to higher educational levels influence students' interest in different domains (Jacobs et al., 2002). For instance, increasing evaluations may lead students to undervalue activities and domains in which they do not do particularly well (Wigfield and Eccles, 2002). This evaluative pressure can also decrease students' intrinsic value in learning (Wigfield and Cambria, 2010). Students become much better at understanding and interpreting the evaluative feedback they receive and engage in more social comparison with their peers over time (Sáinz and Eccles, 2012; Wigfield and Eccles, 2002). As a result, many students become more accurate or realistic or even negative in their self-assessments (Jacobs et al., 2002; Wigfield and Eccles, 2002; Wigfield and Cambria, 2010; Sáinz and Upadyaya, 2016).

Similarly, boys' and girls' patterns of interest evolve differently over time, and declines in task values vary across domains (Jacobs et al., 2002). Girls' interest in math decreases in adolescence to a greater extent than boys', and girls are more likely to express greater interest in languages than in math over time (Jacobs et al., 2002). In addition, parents, teachers, peers, and school context influence the development of interest values (Frenzel et al., 2010; Wigfield and Eccles, 2002). For example, parents socialize their children's interest and engagement in different domains through various means (e.g., showing confidence in children's abilities, by encouraging their children's participation and interests in different activities) (Eccles, 2014).

Achievement as an Antecedent of Interest

According to the internal/external (I/E) frame of reference model, self-concepts and interests in one domain are closely connected to achievement in the same domain (Marsh and Hau, 2004). For instance, whereas math and verbal achievement are highly correlated, math and verbal interest values and self-concepts tend to be weakly associated (Nagy et al., 2008). Likewise, "students compare their achievement in one domain (i.e., math) with that in another domain (i.e., languages) and consider themselves as either "math persons" or "language persons" but not both simultaneously" (Marsh and Hau, 2004, p. 57). Similarly, math interest is positively related to achievement and course choices in math, but negatively associated with achievement and course choices in languages (Nagy et al., 2008).

Recently, the I/E model of reference has been extended to near-domain science domains (biology, physics, and math) and positive cross-domain effects between achievement and self-concept have been found (Guo et al., 2015). Consistent with the EV theory, prior achievement in one domain (i.e., languages) predicts interest in that domain, which in turn influences students' course selection in that domain (Marsh et al., 2005; Nagy et al., 2008).

Gender and SES as Antecedents of Interest

Math and science are often considered to be domains in which boys have a high level of achievement, values, and self-concepts, while the same is applicable for girls in languages (Durik et al., 2006; Sáinz and Eccles, 2012). The association between academic achievement and intrinsic values has been observed across different domains (Durik et al., 2006; Jacobs et al., 2002). Gender and previous academic achievement often predict intrinsic values in STEM domains (Chow and Salmela-Aro, 2011) and reading (Durik et al., 2006). Moreover, the same student may highly value languages, but may value other subjects to the same extent, such as math or physical science (Chow and Salmela-Aro, 2011; Sáinz and Eccles, 2012)

Differential interest in math, science, and language may lead to the under-representation of women in some STEM fields, as well as to the over-representation of men in most STEM fields (Eccles, 2014). In addition, high family socioeconomic status (SES) often promotes students' educational outcomes, and further influence their academic and occupational decisions (Davis-Kean, 2005; Eccles & Wang, 2015; Sáinz and Müller, 2018). Interestingly, family SES is more strongly linked to educational aspirations among boys than among girls (Guo et al., 2015), and students whose parents have higher educational attainments develop higher interest in STEM courses (Eccles & Wang, 2015; Gorard and Beng, 2009; Sáinz and Müller, 2018). However, to the authors' knowledge there is a dearth of research tackling the influence of gender and family SES on the co-development of students' interest in different subject areas.

The Present Study

Two European contexts with different educational systems and cultures facing similar problems—i.e., the lack of female participation in STEM and students' interest decline in STEM subjects across secondary schooling—were selected for this study (OECD, 2015). Interestingly, both countries are among the top-ten most equal European countries. Whereas Finland ranks fourth in the Gender Equality Index, Spain ranks the position 8th in this Index (EIGE, 2021). As in many OECD countries, jobs in the STEM fields in Finland and Spain are mainly occupied by men. These jobs are currently in high demand in the labor market, and they are characterized by being well-paid and normally associated with leadership positions (OECD, 2015; European Parliament, 2020). The present study contributes to international research on the on the co-development of gendered interest in various domains across the transition to higher education.

The Educational Systems in Finland and Spain

Compulsory comprehensive education in Finland lasts for 9 years, until the students are 18 years old. After that,

TABLE 1 | Sample characteristics for the Spanish and Finnish samples.

Waves	Spanish sample (n = 1,317)			Finnish sample (n = 804)		
	Time 1	Time 2	Time 3	Time 1	Time 2	Time 3
	Early adolescence		Mid-adolescence	Mid-adolescence		
Grades	8	9	10	9	10	11
Age	13	14	15	15	16	17
Gender	52% females			47.71% females		
SES	26% high SES, 54% intermediate SES, and 19% low SES			34% high white collar SES, 49% low white collar SES, 17% blue collar SES		
Origin	74% born in Spain			99% Finnish native speakers		

The dark bars indicates the transition points to higher educational stages. Whereas in the Spanish sample, a pseudo-transition happens between time 2 and 3 (the last course of compulsory secondary education), in the Finnish sample the transition to post-compulsory secondary education happens between time 1 and 2.

approximately 50% of adolescents' transition to senior high schools and approximately 41% go to vocational schools (School Statistics, 2010). Average academic achievement in the ninth grade is the minimum requirement for admission to senior high school. Both senior high schools and vocational schools take 3–4 years to complete, after which time students may apply to higher education institutes. Meanwhile, compulsory comprehensive education in Spain lasts for ten, until students are 16 years old. After that, either senior high school or vocational education take 2 years to complete. Spanish senior high school students have to choose one out of the three available tracks: science and technology, humanities and social sciences, or the arts.

The present study examined the following research questions: 1) How does Spanish and Finnish secondary school students' interest in math, science, and languages (e.g., Spanish or Finnish) co-develop during their transition to high school? 2) To what extent students' academic achievement, gender, and family socioeconomic status (SES) predict the parallel development of math, science, and language interest in among Spanish and Finnish students?

STUDY 1

Methods

The data were drawn from the Spanish *Expectancies* study, in which secondary school students participated. Consent was obtained from students after getting prior permission from both parents and educational authorities. The first survey (Time 1, age = 13) was carried out at the end of grade 8. The second (Time 2, age = 14) and third (Time 3, age = 15) surveys were gathered at the end of the third and fourth years of compulsory secondary school (grades 9 and 10, respectively). A total of 1,317 students (703 males, 604 females) from 10 public secondary schools in Madrid and Barcelona participated in the study (see **Table 1**).

The majority of participants (74%) were born in Spain. Students most often lived with both parents (69%). The occupational distribution of parents was: 24% of the fathers and 14.4% of the mothers worked in higher-level white-collar occupations (e.g., doctors, lawyers), 63.5 and 57.3% worked in

intermediate-level white-collar occupations (e.g., clerks, teachers) or in blue-collar occupations (e.g., taxi drivers, police officers), and 4.1 and 25.2% were unemployed, homemakers, or retired. Approximately 36% of the fathers and 39% of the mothers had university degree, 56% of the fathers and 55% of the mothers had completed secondary education, while only 2% of the fathers and 3% of the mothers had completed only primary school.

Attrition analyses were conducted by comparing the students who participated in the study at each measurement time (N = 417) with those who had missing data at one or more measurement times (N = 592). Students who participated in the study at each measurement reported higher level of interest in math (M = 4.03, SD = 1.71) and science (M = 4.50, SD = 1.76) at Time 1 than those who did not (M = 3.34, SD = 1.574, t (5.07) = p < 0.001 for math; M = 4.12, SD = 1.87, t (2.47) = p < 0.001 for science). In addition, students who participated at each measurement reported higher math interest at Time 2 (M = 4.10, SD = 1.82) than students who did not (M = 3.53, SD = 1.81, t (2.66) = p <.01). Moreover, students who participated at each measurement reported higher final grades in math (M = 5.63, SD = 1.93), Spanish (M = 6.05, SD = 1.89) and science (M = 6.09, SD = 2.22) than students who did not participate at each measurement (M = 4.58, SD = 1.93, t (6.42) = p <.001 for math; M = 4.95, SD = 1.89, t (6.86) = p <.001 for Spanish); M = 4.61, SD = 2.14; $t(6.0)$ = p < 0.001 for science).

Measures

Intrinsic value (Times 1–3) was measured with the Task Value Scale translated into Spanish, which consisted of three items (Eccles and Harold, 1991). Participants were asked to rate separately the intrinsic value of math, Spanish and natural sciences (physics and chemistry in Time 2 and 3) using a 7-point scale (1 = not at all; 7 = very much). Sample items read as follows: "How much do you like...?", "In comparison to other subject areas, how much do you like...?", and "How much would you like to work with...". Cronbach's alpha reliability was 0.86 for math, 0.87 for Spanish and 0.93 for natural sciences.

Academic performance was measured with self-reported final grades (Time 1) ranging from 1 (lowest) to 5 (highest) for math, natural sciences, and Spanish.

Demographics. Gender was coded 1 = girl, 2 = boy. Family SES was coded as 3 = High, 2 = Intermediate, and 1 = Low.

TABLE 2 | Correlations, means, and variances for the Spanish sample.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. Math Interest[a]	—	—	—	—	—	—	—	—	—	—	—	—	—	—
2. Math Interest[b]	0.63***	—	—	—	—	—	—	—	—	—	—	—	—	—
3. Math Interest[c]	0.58***	0.65***	—	—	—	—	—	—	—	—	—	—	—	—
4. Science Interest[a]	0.24***	0.16***	0.22***	—	—	—	—	—	—	—	—	—	—	—
5. Science Interest[b]	0.37**	0.49***	0.47***	0.38***	—	—	—	—	—	—	—	—	—	—
6. Science Interest[c]	0.38***	0.42***	0.55***	0.25***	0.60***	—	—	—	—	—	—	—	—	—
7. Spanish Interest[a]	−0.11**	−0.10*	−0.06	0.16***	−0.01	0.00	—	—	—	—	—	—	—	—
8. Spanish Interest[b]	−0.17***	−0.12**	−0.10*	0.01	−0.05	−0.06	0.51***	—	—	—	—	—	—	—
9. Spanish Interest[c]	−0.12**	−0.07	−0.06	0.01	−0.05	−0.01	0.44***	0.46***	—	—	—	—	—	—
10. Math Performance	0.51***	0.40***	0.40***	0.46***	0.28***	0.33***	−0.01	−0.09*	−0.02	—	—	—	—	—
11. Science Performance	0.26***	0.20***	0.28***	0.12**	0.30***	0.29***	0.09*	−0.03	−0.01	0.52***	—	—	—	—
12. Spanish Performance	0.13***	0.11**	0.12**	0.12*	0.15**	0.15***	0.34***	0.15***	0.09	0.46***	0.51***	—	—	—
13. Gender	−0.12***	−0.11**	−0.09**	−0.12**	−0.10**	−0.11**	0.17***	0.15***	0.13***	−0.04	−0.01	0.12**	—	—
14. SES	0.07*	0.05	0.05	0.12*	0.04	0.08*	0.03	0.02	0.02	0.15***	0.14***	0.24***	0.04	—
M	3.71	3.69	3.49	4.33	3.84	3.53	4.17	3.99	3.92	2.43	2.68	2.66	1.46	2.02
Var	2.89	3.30	3.31	3.19	3.38	3.63	2.32	2.25	2.25	1.70	1.73	1.59	0.25	0.38

Note. ***p < 0.001; **p < 0.01; *p <.05

[a]Time 1

[b]Time 2

[c]Time 3.

Analysis Strategy

To capture the parallel development of students' interest in math, science, and Spanish, the results were analyzed with parallel process latent growth curve (LGC) modeling (Muthén and Muthén, 1998-2018). In these models, the mean levels of math, science, and Spanish interest (intercept), their linear growth (linear slope), and individual variation across these scores were estimated. The intercepts were specified by setting the loadings of the three observed values of math, science, and Spanish interest to 1; the linear slope was specified by setting the loadings of the three observed values to 0, 1, and 2. The residual variances of the observed variables were able to be freely estimated. The linear slopes of each growth curve were regressed to the intercepts of each growth curve. The statistical analyses were performed using Mplus (Version 8; Muthén and Muthén, 1998-2018) with the missing data method and MLR estimator. Goodness-of-fit was evaluated using four indicators: χ^2 test, Comparative Fit Index (CFI), Tucker-Lewis Index (TLI), Root Mean Square Error of Approximation (RMSEA), and the Standardized Root Mean Square Residual (SRMR). Next, students' gender, SES, and performance in math, science, and Spanish were included in the model as covariates to predict the interest intercepts and slopes. In the final model, all the statistically non-significant associations were fixed to zero.

RESULTS

Parallel Process LGC Model for Students' Interest in Math, Science, and Spanish

The means, variances, and correlations between all the variables are shown in **Table 2**. The fit of the final parallel LGC model was good: χ^2 (18, N = 1,317) = 168.6, p = 0.00, CFI = 0.95, TLI = 0.93, RMSEA = 0.04, SRMR = 0.04 (**Table 3**; **Figure 1**). The variances of both the initial levels and linear slopes of the interest variables (except Spanish) were statistically significant, indicating significant individual differences both in the initial status and in the developmental trends of the interest variables. Only the variance of Spanish interest slope was non-significant, indicating that the decreasing linear development was similar for all the students. Moreover, the initial level of science interest positively predicted the linear slope of math interest (s.e. = 0.32, p <.01), and the initial level of math interest positively predicted the linear slope of science interest (s.e. = 0.57, p <.001).
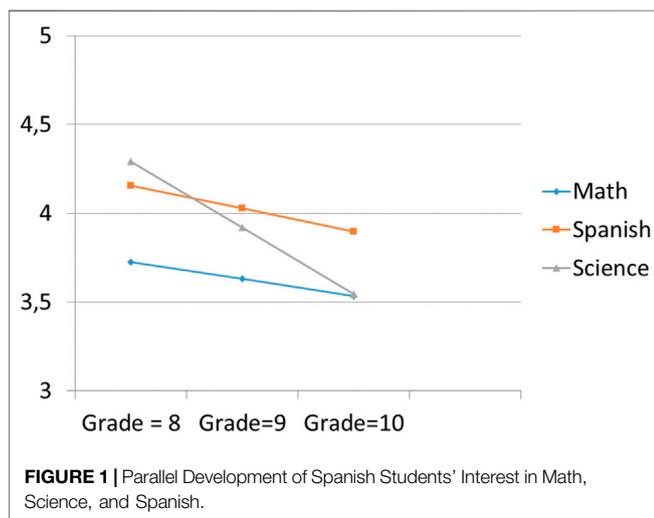
Next, students' gender, SES, and performance in math, science, and Spanish were included in the parallel process LGM as covariates. In this model students' math performance positively predicted the initial level of math interest, and negatively predicted the initial level of Spanish interest (**Table 4**). However, when students reported high math performance, their math interest decreased and Spanish interest increased more rapidly later on. Spanish performance, in turn, positively predicted the level of Spanish interest, and negatively predicted the initial level of math and science interest (**Table 4**). However, when students reported high Spanish performance, their subsequent interest in Spanish decreased, and subsequent interest in science increased more rapidly later on. Students with high science performance experienced a high initial level of science, which, however, decreased more rapidly later on. Moreover, male students reported higher initial interest in math, whereas female students reported higher initial level of Spanish interest. In addition, students from lower SES families were initially more interested in Spanish, whereas Spanish interest increased more among students from higher SES families[1].

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[1]However, further analyses indicated that these results were due to a suppression effect as no statistically significant correlation emerged between family SES and Spanish interest. When the analyses were run without the performance variables in the model, the effect of family SES on Spanish interest was non-significant (s.e. = 0.05, p ns for intercept; s.e. = −0.06, p ns for slope).

TABLE 3 | Latent growth components of the parallel process LGC model (standard errors in the parentheses).

	Spanish students			Finnish students	
	Math interest	**Spanish interest**	**Science interest**	**Math/Science interest**	**Finnish interest**
Growth components					
Means					
Intercept	3.73 (0.05)[a]	4.16 (0.05)[a]	4.29 (0.06)[a]	3.92 (0.06)[a]	4.05 (0.06)[a]
Linear slope	−0.10 (0.03)[b]	−0.13 (0.03)[a]	−0.37 (0.04)[a]	−0.03 (0.03)	−0.01 (0.02)
Variances					
Intercept	2.12 (0.19)[a]	1.09 (0.08)[a]	1.58 (0.25)[a]	2.08 (0.14)[a]	1.58 (0.11)[a]
Linear slope	0.24 (0.10)[c]	0*	0.70 (0.14)[a]	0.23 (0.03)[a]	0.21 (0.05)[a]
Residual variances					
Interest (Time 1)	0.78 (0.18)[a]	1.18 (0.09)[a]	1.67 (0.26)[a]	0.39 (0.03)[a]	0.45 (0.03)[a]
Interest (Time 2)	1.21 (0.09)[a]	1.12 (0.09)[a]	1.53 (0.11)[a]	0*	0.10 (0.10)[a]
Interest (Time 3)	0.86 (0.18)[a]	1.27 (0.09)[a]	0.18 (0.06)[b]	0.43 (0.)[a]	0.44 (0.03)[a]

Note. [a]p < 0.001; [b]p < 0.01; [c]p < 0.100 = fixed to zero.*

FIGURE 1 | Parallel Development of Spanish Students' Interest in Math, Science, and Spanish.

STUDY 2

Methods

The data were drawn from the Finnish Educational Transitions (FinEdu) study, in which all the ninth-grade students in a medium-sized town with a population of 88,000 in Central Finland were recruited (see **Table 1**). The first survey (Time 1, age = 15) was carried out at the end of the students' ninth grade and before the transition to high school (academic track) or vocational school (vocational track). Two measurements were carried out during post-comprehensive education: the first was half a year after the transition to post-comprehensive education (Time 2, age = 16) and the second was 1 year later (Time 3, age = 17). A total of 871 students (456 males, 415 females) from nine secondary schools and, later on, from 13 post-comprehensive schools participated.

Consistent with the general population in Central Finland, the majority of participants (99%) were Finnish-speaking (Kuopion Lukiokoulutus, 2009). Students most often lived with both parents (62%), or with their mother or father, either as a single parent (25%), or living with her/his new spouse (11%), or with somebody else (1%). Approximately 27% of the fathers and 20% of the mothers worked in higher-level white-collar occupations (e.g., doctors, teachers); 16 and 49%, respectively, worked in lower-level white-collar occupations (e.g., clerks, salespeople); 36 and 17%, respectively, had blue-collar occupations (e.g., cooks, bus drivers); 11 and 4%, respectively, were private entrepreneurs; 1 and 2%, respectively, were students; 3 and 2%, respectively, were retired; and 5 and 6%, respectively, had some other status (e.g., unemployed).

Attrition analyses were carried out to examine attrition between the measurements by comparing students who participated in the study at each measurement time ($N = 435$) with those who had missing data at a certain measurement time ($N = 443$). Students who participated in the study at each measurement time showed higher interest in Finnish at Time 1 ($M = 4.24$, $SD = 1.61$) and Time 2 ($M = 4.24$, $SD = 1.76$) than those who did not ($M = 3.82$, $SD = 1.93$, $t = −2.32$, $p <.05$; $M = 3.87$, $SD = 1.66$, $t = −2.12$, $p < 0.05$). Moreover, students who participated in the study at each measurement time showed higher interest in math and science at Time 1 ($M = 4.09$, $SD = 1.88$) than those who did not ($M = 3.56$, $SD = 1.95$, $t = −2.62$, $p < 0.01$).

Measures

Interest (Times 1–3) was measured with the Task Value Scale (Niemivirta, 2002), which was developed based on the EV theory (Eccles and Wigfield, 2002). Participants rated interest in math, sciences, and Finnish separately using a 7-point scale (1 = not at all; 7 = very much).

Academic performance was measured with the grade point average (GPA) of the final comprehensive school report (Time 1), on a scale ranging from 4 (lowest) to 10 (highest).

Demographics. Gender was coded 1 = girl, 2 = boy. Family SES was coded 1 = blue collar, 2 = lower-level white collar, 3 = higher-level white collar.

RESULTS

The results were analyzed similarly as in Study 1. **Table 5** shows the means, variances, and correlations between all the variables. The parallel process LGC model was constructed for students' interest in math and natural sciences and in Finnish. The fit of the final parallel LGC model was good $χ^2(10, N = 857) = 44.30$, $p = 0.00$, *CFI*

TABLE 4 | Antecedents of the latent growth components of the parallel process LGC model (standardized estimates, standard errors in the parentheses) among Spanish secondary school students.

	Math interest		Spanish interest		Science interest	
	Intercept	*Slope*	*Intercept*	*Slope*	*Intercept*	*Slope*
Math Performance	0.67 (0.04)[a]	−0.29 (0.08)[a]	−0.29 (0.05)[a]	0.31 (0.15)[c]	0*	0*
Spanish Performance	−0.13 (0.04)[b]	0*	0.58 (0.04)[a]	−0.98 (0.29)[b]	−0.21 (0.06)[a]	0.22 (0.7)[b]
Science Performance	0*	0*	0*	0*	0.82 (0.05)[a]	−0.48 (0.08)[a]
Gender	−0.09 (0.03)[b]	0*	0.16 (0.03)[a]	0*	0*	0*
SES	0*	0*	−0.14 (0.05)[b]	0.34 (0.14)[c]	0*	0*

Note; [a]p < 0.001; [b]p < 0.01; [c]p < 0.05.0 = fixed to zero; gender: 1 = male, 2 = female.*

TABLE 5 | Correlations, means, and variances for the Finnish sample.

	1	2	3	4	5	6	7	8	9
1. Math/science interest[a]	—	—	—	—	—	—	—	—	—
2. Math/science interest[b]	0.71***	—	—	—	—	—	—	—	—
3. Math/science interest[c]	0.54***	0.49***	—	—	—	—	—	—	—
4. Finnish interest[a]	0.07	−0.08*	0.03	—	—	—	—	—	—
5. Finnish interest[b]	0.07	0.01	0.05	0.63***	—	—	—	—	—
6. Finnish interest[c]	0.06	0.02	0.24***	0.55***	0.50***	—	—	—	—
7. GPA	0.28***	0.16***	0.33***	0.24***	0.17***	0.30***	—	—	—
8. Gender	0.19***	0.23***	0.16***	−0.34***	−0.29***	−0.37***	−0.19***	—	—
9. SES	−0.03	0.06	−0.04	−0.00	0.08	−0.05	0.34***	0.06	—
M	3.88	3.84	3.91	4.02	4.00	4.03	8.03	1.53	2.01
Var	3.61	3.68	3.61	3.03	2.88	2.88	0.72	0.25	0.46

*Note. ***p < 0.001; **p < 0.01; *p <.05;*
[a]Time 1
[b]Time 2
[c]Time three.

= 0.96, *TLI* = 0.94, *RMSEA* = 0.06, *SRMR* = 0.03). The results showed that Finnish students experienced a relatively high level of math/science and Finnish interest, and both remained stable over time (**Table 3**; **Figure 2**). The variances of both the initial levels and linear slopes of the interest variables were statistically significant, indicating significant individual differences both in the initial status and in the developmental trends of math/science and Finnish interest. In addition, a high initial level of math/science interest negatively predicted the linear trend of Finnish interest, whereas a high initial level of Finnish interest negatively predicted the linear trend of math/science interest (**Figure 3**).

Finally, students' gender, GPA, and SES were included in the parallel process LGC model as covariates. The final model fit the data well: $\chi^2(23, N = 876) = 85.65, p = 0.00, CFI = 0.95, TLI = 0.93, RMSEA = 0.06, SRMR = 0.04$ (**Table 6**). The results showed that boys had a higher initial level of math/science interest, whereas girls showed a higher initial level of interest in Finnish. Moreover, students who had a higher GPA showed a higher initial level of math/science and Finnish interest; which however, slightly decreased later on.

DISCUSSION

The present study contributes to STEM education in Spain and Finland since it is the first to investigate the co-development of math, science, and language interest among Spanish and Finnish

secondary school students across the transition to post-compulsory education, and taking into account the role of gender, academic achievement, and family SES. In both studies, students following an academic/vocational track were followed. The results showed that Spanish students' interest values in all three domains decreased across the school years, whereas Finnish students' interest values remained relatively stable. In addition, students with high achievement showed a higher initial level of math/science and language interest.

Development of Spanish and Finnish Students' Interest in Math, Science, and Language

The results showed first, that Spanish students' interest in math, science, and Spanish language slightly decreased over time. However, Finnish students' interest in math/science and Finnish language remained relatively stable over time. These differences may be related to the educational stages of the students from both samples. While Finnish students faced a transition to secondary education between Time 1 and Time 2, all students in Spain went through a pre-specialization stage during Time 3, regardless of whether they were or not going to pursue vocational training or high school the following year. While math and Spanish are compulsory subjects at this educational stage in Spain, science domains such as physics are optional, which may show as decreases in Spanish students' physics interest.

FIGURE 2 | Parallel Development of Finnish Students' Interest in Math and Science, and Finnish.
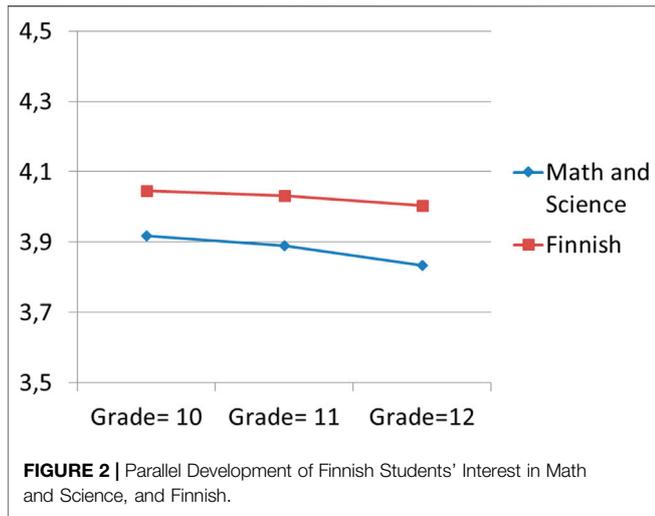
These findings may also be explained by the students' age and school experiences: at the beginning of the study, Spanish students were slightly (e.g., 2 years) younger than Finnish students. In line with other studies, younger students (e.g., here Spanish students) tend to report higher interest than older students in different domains, which may decrease more rapidly over time (Jacobs et al., 2002; Upadyaya and Eccles, 2015). Given their broader school experience, older students (*e.g.*, Finnish students) develop a more stable perceptions of their domain interests (Wigfield and Eccles, 2002; Wigfield and Cambria, 2010). Similarly, Finnish students' high level of performance in all PISA competence assessments across time could be another indicator of the stability in the Finnish students' interest in the target domains (OECD, 2015).

In addition, transition to high school may show in students' interest in the different subject areas (Jacobs et al., 2002; Wigfield and Cambria, 2010). In Finland the transition to post-compulsory secondary schooling took place between the first and second measurement, when students had already selected their academic/vocational track and might know their academic strengths/weaknesses relatively well. This may show as stability in students' domain interests. Importantly, these results suggest that more changes in students' domain interests occur during the earlier stages of their education (Jacobs et al., 2002; Wigfield and Eccles, 2002). The "pseudo-transition" that Spanish students undergo at the end of compulsory secondary schooling (Time 3) may also have an impact on their interest in different domains, when the choices of available subjects are limited and may diminish students' interest values.

Interestingly, when Spanish students reported high science interest, their math interest decreased less later on. Similarly, when Spanish students reported high initial math interest, their subsequent science interest decreased less. These findings may be due to the fact that whereas math and science are near-domain scientific subjects, math and language are not that close (Nagy et al., 2008). Therefore, students who show an interest in math tend to not show an interest in language, and vice versa.

Among the Finnish students, high math/science interest also predicted decreases in Finnish interest, whereas a high level of

FIGURE 3 | The Parallel Process LGC Model of Math/Science Interest and Finnish Interest Among Finnish Students. Note.**$p < 0.01$; ***$p < 0.001$. I = intersect, s = slope.
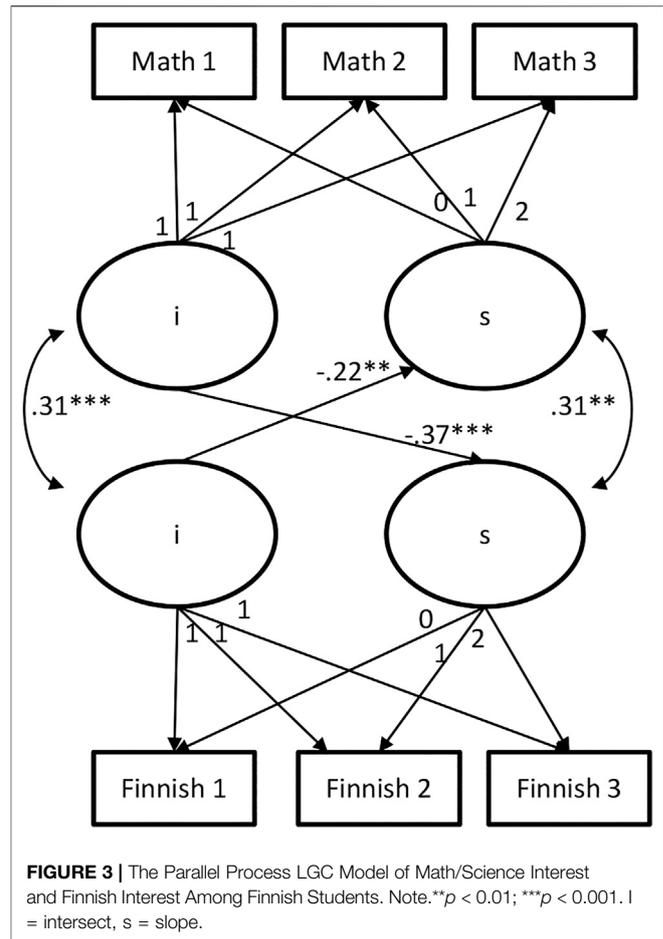
TABLE 6 | Antecedents of the latent growth components of the parallel process LGC model (standardized estimates, standard errors in the parentheses) among Finnish secondary school students.

	Math/Science interest		Finnish interest	
	Intercept	*Slope*	*Intercept*	*Slope*
Gender	0.33 (0.04)[a]	0*	–0.41 (0.04)[a]	0*
SES	0*	0*	0*	0*
GPA	0.52 (0.04)[a]	–0.22 (0.08)[b]	0.30 (0.05)[a]	–0.15 (0.05)[a]

Note: [a]$p < 0.001$, [b]$p < 0.01$; [c]$p < 0.05$.0 = fixed to zero; gender: 1 = girl, 2 = boy.*

Finnish interest predicted decreases in the level of interest in math/science (Nagy et al., 2008). The changes associated with school specialization may have greater effect on Finnish students and may have led students with high math interest to experience decreases in their language interest and vice versa. Following the I/E frame of reference (Marsh and Hau, 2004), students might consider themselves to be either "math/science persons" or "language persons," but not both. Similarly, Spanish students with university aspirations may have different pattern of interest from those with vocational aspirations. This parallel development of math, science, and language interest provides an opportunity for cross-domain comparisons. Over time, the parallel development of interest in different domains was very similar both among Finnish and Spanish students.

Factors Influencing Students' Math, Science, and Language Interest

In line with the EVT (Wigfield and Eccles, 2002), the results for Spanish students showed that girls reported higher interest in Spanish and lower interest in math than males. Similarly, Finnish boys reported higher math/science interest, whereas girls showed higher language interest. Male students often attach greater personal importance to math than female students (Sáinz and Eccles, 2012), while female students attach more value to languages than male students (Durik et al., 2006; Jacobs et al., 2002). These findings also show that even secondary students brought up in the most gender-equal societies (e.g., Finland) deploy gender differences in their interest in science and languages.

Further, some findings confirmed the assumptions of both the EVT (Wigfield and Eccles, 2000) and the I/E model of the reference (Marsh and Hau, 2004). In line with the reciprocal effects between achievement and task values in math and language (Marsh and Hau, 2004; Nagy et al., 2008), high GPA predicted high math/science and Finnish interest, which, however, slightly decreased later on among Finnish students. These findings also confirm assumptions of the EVT (Jacobs et al., 2002; Wigfield and Cambria, 2010). In addition, among Spanish students achievement in one domain predicted high interest in the same domain (Marsh and Hau, 2004; Nagy et al., 2008). Students with high Spanish achievement reported high initial interest in Spanish and low initial math and science interest. However, when Spanish students reported high performance in any of the three target domains, their subsequent interest in that same domain decreased (Jacobs et al., 2002), whereas their subsequent interest in the rest of domains increased more rapidly later on. These findings could be associated with students' need to increase the motivational value of those subject areas where they had lower achievement. Similarly, among Finnish students high GPA predicted high initial interest in math/science or Finnish, which decreased more rapidly later on. These results add to the previous findings by showing that students' performance shapes the co-development of students' interest in different academic domains (see also Eccles, 2005; Wigfield and Cambria, 2010).

Cultural reasons may explain the different patterns of SES influence on the development of students' interest in Spanish language. Spanish society is more heterogeneous in terms of a higher percentage of immigrant population than Finnish society. This results in a much higher heterogeneity in the classroom, which may enhance the importance of the role of Spanish language in the curriculum of secondary education and increase students' interest in Spanish over time (García-Ruiz, 2011).

Limitations

The present study has several limitations. First, the results can be generalized only for the same age group, educational stage, domains, and countries. More cross-cultural studies would be needed to further examine students' motivation and interest in math, science, languages, and other domains, and in countries with different socio-cultural contexts. Even though the interest value measures used in this study were based on the same background theory, the differences in the results may be due to the use of different items. In the future studies the use of parallel items measuring students' motivation would be crucial. In addition, it is possible that various homogeneous subgroups of students exist reflecting different developmental trajectories of math, science, and language interest. More person-oriented studies will be needed in the future to further examine these possible subgroups (Chow and Salmela-Aro, 2011).

In addition, among Finnish students math/science interest was measured with one combined item, which might explain some country differences in the results. In the future studies it would important to examine the interest in these two academic subject domains separately (Wigfield and Eccles, 2000). Moreover, the attrition analyses indicated that students who participated in the study at each measurement time reported slightly higher motivation in both data sets. Thus, it is possible that the results suffered from a selection effect which should be noted when generalizing the findings. Finally, while Finnish students were going through middle adolescence and transiting into high school and vocational training between the first and the second measurement time, the Spanish students were going through early adolescence and experiencing a pseudo-transition into high school or higher vocational training across the third time (the last course of compulsory secondary education), making the educational transition the students were facing at each country slightly different. Future studies should better address these differences.

DATA AVAILABILITY STATEMENT

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by IRB (Institutional Review Board) at the UOC and University of Helsinki. Written informed consent to participate in this study was provided by the participants' legal guardian/next of kin.

AUTHOR CONTRIBUTIONS

MSI and KU have conducted the analyses and written the article. KS has given feeddback to the last versions of the article.

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