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Harnessing virtues for educational success: introducing the Positive Development and Assessment Competencies Theory (PDAC)

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This study investigates the role of positive psychology virtues in predicting educational competencies 5th and 6th-grade students. The evidence-based benefits of fostering virtues in educational settings, including academic success, emotional resilience, ethical behavior and social integration, are well documented. This research further emphasizes the contribution of virtues to the formation of well-rounded individuals, prepared for lifelong learning and personal growth. Using a quantitative, correlational, cross-sectional design, data were collected from 993 students through validated questionnaires. Random forest logistic regression analysis identified six as significant predictors of perceived competencies, with Transcendence standing out as a particularly strong and consistent predictor across multiple competencies. These findings emphasize the profound impact of virtues on student development. The study also introduces the Positive Development and Assessment Competencies Theory (PDAC), which advocates for the integration of virtue-based interventions and character strengths into educational programs. PDAC aims to enhance the assessment of subjective competencies, improve educational interventions, and promote student wellbeing.

KEYWORDS

positive psychology, virtues, educational competencies, Positive Development and Assessment Competencies Theory (PDAC), student wellbeing

Introduction

The educational landscape today is increasingly focused on preparing students with a broad range of competencies that go beyond traditional academic skills (Southworth et al., 2023), emphasizing non-cognitive skills such as collaboration, communication, critical thinking, and adaptability to meet the demands of the 21st century (Guo et al., 2023). Emerging research further highlights the role of non-cognitive skills in fostering resilience, motivation, and lifelong learning (Dykhuis et al., 2024). These competencies are crucial for adapting to and thriving in a rapidly evolving world. As technological advancements and globalization continue to reshape our societies, students must be equipped not only with academic knowledge but also with the skills to innovate, apply knowledge practically, and solve complex problems (Olorunfemi, 2023).

Developing such competencies is essential for fostering a generation capable of navigating the uncertainties and challenges of the 21st century. Traditional educational models, which predominantly focus on rote learning and standardized testing, are no longer sufficient to meet the demands of modern society. There is a growing consensus among educators and policymakers that a holistic approach to education—one that integrates cognitive, social, and emotional learning—is necessary to prepare students for future success (Akintayo et al., 2024). The Learning Policy Institute, a US-based national education think tank, emphasizes that education should support essential capacities to help children navigate the world successfully (Greenberg, 2023).

The Organization for Economic Co-operation and Development (OECD) has emphasized the importance of a holistic educational approach that combines cognitive, social, and emotional learning to prepare students for future success. In its report Skills for Social Progress: The Power of Social and Emotional Skills, the OECD highlights that socio-emotional skills are essential for individual wellbeing and social progress and should be a priority in education systems (OECD, 2015). Additionally, the OECD has developed the Study on Social and Emotional Skills (SSES), an international assessment aimed at better understanding students' socio-emotional competencies and their influence on academic performance and overall wellbeing (OECD, 2020).

Over the past two decades, a substantial body of research, particularly that conducted by the OECD, has advocated for the implementation of innovative educational strategies with the objective of enhancing competencies beyond the mere pursuit of academic excellence (OECD, 2018). Similarly, positive psychology has been widely integrated into the field of education, with a particular focus on wellbeing (Seligman et al., 2009). Nevertheless, a notable gap remains in the analysis of how virtues, as key constructs of positive psychology, predict specific educational competencies. While a substantial body of literature emphasizes the role of social-emotional learning and character strengths in promoting wellbeing, there has been limited attention devoted to the influence of virtues on self-perceived competencies in younger students (Park and Peterson, 2009).

This study addresses these gaps by exploring and implementing innovative educational strategies that encompass these diverse competencies. One promising avenue is the integration of positive psychology into educational practices. Positive psychology, introduced by Seligman (1999), emphasizes the cultivation of character strengths that contribute to personal growth and wellbeing. Character strengths such as resilience, empathy, and creativity are critical for students' overall development and their ability to contribute meaningfully to society. Research in positive psychology has demonstrated that these character strengths can significantly enhance students' academic performance, social relationships, and emotional wellbeing (Wagner and Ruch, 2023). However, there is a gap in understanding how these strengths specifically predict educational competencies. This research seeks to investigate how these character strengths can predict self-perceived educational competencies among elementary students. By examining this relationship, the study aims to provide empirical evidence that can inform educational policies and practices.

The present study delineates the distinct and related character strengths and competencies. Character strengths, as defined by Peterson and Seligman (2004), are positive traits that are reflected in thoughts, feelings, and behaviors which contribute to individual flourishing. These strengths are central to the framework of positive psychology and include virtues such as kindness, resilience, and gratitude.

By introducing the Positive Development and Assessment Competencies Theory (PDAC), this study aims to integrate virtue-based interventions into educational practices. PDAC provides a framework for assessing and enhancing students' subjective competencies, which are crucial for their academic and personal development. The integration of PDAC into educational programs is expected to improve students' self-efficacy, motivation, and overall wellbeing, thereby supporting their ability to thrive in an ever-changing world.

The importance of this study lies in its potential to transform educational practices by highlighting the role of character strengths in fostering competencies that are essential for the 21st century. By providing a comprehensive understanding of the interplay between virtues and educational competencies, this research aims to contribute to the development of more effective educational strategies that not only improve academic outcomes but also promote the holistic development of students.

Literature review

Virtues and competencies in education

Competencies are vital for basic education, equipping students with the skills to navigate a constantly changing world (Meriläinen and Piispanen, 2019). The 1995 report "Teaching and Learning: Toward the Learning Society" by the European Commission provided a framework for lifelong learning and skills development. Subsequently, the European Union's Memorandum on Lifelong Learning of 2000 declared that this competence-based learning is essential for active citizenship and employability in modern society (Rieckmann, 2012).

This competence-based learning paradigm was developed almost simultaneously by the Council of Europe, UNESCO, and the OECD, although they approached it from different perspectives as a result of the connection between education, vocational training, and sustainable development (Sabán Vera, 2009). The OECD's DeSeCo project (2003) prompted most OECD countries to reformulate their school curricula based on the concept of competencies (OECD, 2010). This shift encourages students to take responsibility for their own learning and transition from passive consumers of knowledge to active creators (Delors and Mufti, 1996).

According to UNESCO (2023), education does not directly generate employment but helps develop the capacity to innovate, apply knowledge, solve problems, and handle complex tasks. The terminology around competencies—such as 21st-century skills, key competencies, or transversal competencies—varies, with differing definitions (Bray et al., 2023). This study focuses on the Key Competencies of the European Union implemented in the Spanish educational system, including linguistic, mathematical, scientific, digital, social, cultural, learning to learn, and personal initiative competencies (Comisión de las Comunidades Europeas, 2007).

The field of positive psychology, as proposed by Seligman (1999), is a branch of psychology that investigates the virtues and strengths that are held in high regard across diverse cultural and traditional contexts. Empirical evidence substantiates the universal applicability of these character strengths model in both Western and Eastern regions. In Western contexts, studies have demonstrated the model's efficacy in enhancing wellbeing, academic performance, and social relationships (Park et al., 2004). Similarly, research conducted in Eastern contexts has corroborated the model's relevance. For example, Sink et al. (2022) investigated the role of character strengths in fostering positive outcomes among South Korea and Japan, thereby substantiating the model's cultural adaptability. Additional cross-cultural studies have further supported this universality. For example, McGrath (2015) conducted a large-scale analysis of VIA character strengths across 75 nations, revealing substantial consistency in the endorsement and importance of virtues worldwide.

This study uses the 24-character strengths model developed by Peterson and Seligman (2004) for its universal applicability, strong theoretical and empirical support, and potential for educational development through positive education.

The virtues of positive psychology, as outlined by Peterson and Seligman (2004), encompass a range of character strengths that are integral to human flourishing. Virtues, as overarching qualities valued across cultures, are operationalised through specific character strengths that represent measurable and actionable traits contributing to human flourishing (Peterson and Seligman, 2004). For instance, the virtue of humanity is expressed through strengths like kindness, love, and social intelligence, demonstrating how abstract virtues translate into observable behaviors (McGrath, 2015). These virtues include Transcendence (appreciation of beauty, gratitude, spirituality, hope, humor), Justice (fairness, leadership, civic responsibility), Courage (perseverance, bravery, integrity), Wisdom and Knowledge (creativity, open-mindedness, curiosity, love of learning), Humanity (love, social intelligence, kindness), and Temperance (self-control, forgiveness, humility). For youth aged 10–17, the VIA-Youth instrument has been shown to reliably assess these strengths, demonstrating positive correlations with wellbeing and negative associations with psychopathology (Gillham et al., 2011; Park and Peterson, 2006).

Schools play a pivotal role in fostering student wellbeing through the implementation of positive psychological interventions. The incorporation of character strengths into educational programmes has been shown to yield considerable benefits across a range of domains. The research conducted by Seligman et al. (2009) within the framework of positive education indicates that the integration of character strengths, including perseverance, gratitude, and hope, within the curriculum has the potential to enhance both academic performance and student wellbeing. In particular, interventions that focus on identifying and nurturing students' character strengths have been linked to enhanced resilience and engagement in learning activities.

As evidenced by studies conducted by Shoshani and Slone (2017), character strengths programs have been shown to reduce stress and foster positive relationships among students. For example, the implementation of school-wide positive psychology programmes in primary and secondary educational establishments has been demonstrated to foster social connectedness and academic motivation by encouraging students to recognize and apply their distinctive strengths in their daily activities.

Furthermore, the findings of Wagner and Ruch (2015) indicate that strengths-based interventions have a substantial impact on students' life satisfaction and emotional distress. This highlights the necessity of integrating both cognitive and non-cognitive abilities in order to prepare students for comprehensive success.

Moreover, cross-cultural research conducted by Shimai et al. (2006) revealed that character strengths programmes are adaptable to diverse cultural contexts, thereby enhancing their universality. By aligning educational objectives with individual strengths, educational institutions can establish environments that facilitate both personal growth and academic achievement (Bakker and van Woerkom, 2018; Seligman et al., 2009; Shoshani and Aviv, 2012; Shoshani and Slone, 2013; Wagner et al., 2021; Weber et al., 2016). The integration of character strengths into educational programs can significantly enhance students' overall development and academic performance.

Shubert et al. (2022) underscore the importance of empowering young people to utilize their skills and competencies in developing specific character strengths. Arguís Rey et al. (2012) propose a virtues and strengths model that offers a holistic approach to the three Core Competencies: personal autonomy and initiative, social and citizenship, and learning to learn. This model breaks down these competencies into manageable parts, aiding in the organization of Tutorial Action and Values Education programs. Such an approach is essential for comprehensive education that addresses both academic and personal growth.

Despite the established benefits of integrating character strengths into education, further research is needed to explore the relationship between positive psychology's character strengths and the subjective dimension of competencies in education. Additionally, understanding the role of educational environments in fostering these strengths is crucial for developing effective interventions. This study aims to fill these gaps by investigating how virtues from positive psychology predict self-perceived educational competencies, thereby providing a stronger foundation for future educational practices and policies.

Convergences between virtues and competencies

The integration of virtues and competencies in education, as proposed by López González et al. (2023a,b), focuses on the cardinal virtues—prudence, justice, fortitude, and temperance—and their essential role in character education and holistic development. These cardinal virtues serve as the foundation for other virtues and are integral to the development of human faculties such as intelligence and will. Measuring these virtues through personal competencies is crucial for promoting wellbeing and human flourishing.

Personal competencies involve the ability to know how to act and how to be, akin to making moral and ethical decisions (Sotés, 2003; Tardif, 2003). This dynamic set of knowledge, skills, attitudes, and values, when internalized and expressed in actions, leads to maturity and excellence (Crespí and García-Ramos, 2020). This

interconnection between competencies and virtues highlights their role in achieving personal and academic excellence.

Research has examined the similarities and differences between competencies and virtues, although not all virtues from the VIA classification are universally considered (López González et al., 2023b). Some scholars interpret competence broadly as a form of virtue (Morales-Sánchez and Cabello-Medina, 2015), while Niemiec (2018) mentions various studies and programs (e.g., in the USA, Australia, China) that have implemented character strengths in education. The document refers to the paradigm shift in education toward competency-based learning, which encourages students to take responsibility for their learning and transition from being passive consumers of knowledge to active creators. These positive outcomes such as increased life satisfaction and academic engagement suggests that character strengths are central mechanisms through which skills and competencies operate. This perspective underscores the importance of integrating character strengths into educational frameworks to enhance overall student development.

Personal competence and virtue are closely related concepts in the literature. According to Crespí and García-Ramos (2020), personal competencies involve a dynamic set of knowledge, skills, attitudes, and values that, when internalized, lead to maturity, excellence, fulfillment, and happiness. This alignment between competence and virtue suggests that virtues can be effectively explored through the components of personal competencies. Therefore, understanding this relationship is key to developing educational practices that promote holistic student growth.

The European Higher Education Area (EHEA) (Curaj et al., 2020) and the Tuning Project (González and Wanegaar, 2008) emphasize the importance of developing competencies, particularly generic competencies, through an educational process that fosters excellent performance. These initiatives highlight the critical role of competencies in achieving educational and professional success, reinforcing the need to integrate virtues into educational programs to support comprehensive student development.

Both virtue and competence involve behaviors aligned with good values (Pieper, 2017). A virtuous individual acts according to good principles, guided by their deepest inclinations. This intrinsic motivation links virtue and competence through behavior, emphasizing the role of education in nurturing these traits (Crespí and García-Ramos, 2020). However, good behavior alone does not equate to virtue; it must involve motivation, deliberation, and reflection. This distinction is crucial for understanding how to effectively cultivate virtues and competencies in educational settings.

Crespí and García-Ramos (2020) highlight the close relationship between virtue and competence in education. This relationship is based on the premise that both virtues and competencies guide behavior toward the good, contributing to the overall development of the individual. Attitude plays a crucial role in shaping both virtues and competencies, acting as a bridge that connects them and facilitating their integration into education (López González et al., 2023a). This study aims to explore this relationship further, providing a stronger theoretical foundation for educational strategies that promote holistic development and enhance student wellbeing.

Research aim

The objective of this study is to examine the capacity of the six virtues derived from positive psychology, as outlined in the 24-character strengths framework, to predict self-perceived competence among a sample of 993 students in 5th and 6th grades. A robust quantitative, non-experimental, correlational, regression, and cross-sectional design is employed to explore the influence of these virtues on students' perceptions of their educational competencies.

In order to achieve these objectives, the research employs a random forest approach, a machine learning technique that is renowned for its ability to handle complex, non-linear relationships and interactions between variables. In contrast to traditional regression techniques, which assume linearity and independence of predictors, the random forest approach generates an ensemble of decision trees to evaluate the relative importance of each virtue in predicting self-perceived competencies. This method not only enhances predictive precision but also elucidates the interactions between variables, rendering it especially well-suited for elucidating complex constructs such as virtues and competencies. By capturing the nuances in the data, random forest analysis offers a more nuanced understanding of the relationships, thereby reinforcing the study's contribution to the field.

Research questions

How do the six virtues from positive psychology predict and influence self-perceived educational competencies among 5th and 6th-grade students?

By addressing this question, the study provides empirical evidence to support the integration of virtue-based interventions in schools, thereby enhancing students' overall development and wellbeing within educational settings.

Methodology

Participants

The study comprised a sample of 993 students from 5th and 6th grades, including 502 in Year 5 and 491 in Year 6. A simple random sampling procedure was employed to select the 993 cases from a population of 3,492 students from Seville (Spain) and its metropolitan area. Each participant was assigned a unique identification number (ID). The sample comprised 453 males and 539 females, with one student failing to specify their gender. The participants' ages ranged from 10 to 13 years, with the majority falling within the 10- and 11-year-old age groups, comprising 373 and 470 students, respectively. Furthermore, eight participants were 13 years of age, while the remaining students were 12 years of age.

Furthermore, the sample demonstrated a heterogeneous composition with regard to the type of educational institution attended. A total of 88 students were enrolled in private schools, 434 in public schools, and 471 in "concertado" schools. In Spain, a concertado school is a semi-private educational institution that

operates under a public-private partnership. These schools are privately owned but receive government funding to cover the costs of providing a basic education, which allows them to offer tuition free or at a low cost to students. In return for the financial support, concertado schools are obliged to comply with the regulations set out by the government, including those relating to curriculum standards and admissions policies. The objective of this system is to enhance accessibility to education and offer families a broader range of options, integrating aspects of both public and private educational models.

To guarantee the representativeness of the sample, the characteristics of the sample population were contrasted with data from the educational records of Seville as a whole. A comparison of the distributions indicated that there were similar proportions of males and females, as well as of students in different age groups and at different educational levels. In particular, the population is comprised of approximately 51% males and 49% females, with an age distribution that closely aligns with that observed in the sample. In accordance with the available population data, 8% of students are enrolled in private schools, 51% in public schools, and 41% in semi-private schools, which aligns with the sample proportions. This distribution reflects the population proportions, thereby ensuring a representative analysis (La educación en Andalucía, (n.d.)).

Furthermore, the sampling error was calculated, and confidence intervals were established for the key demographic variables. The margin of error was determined to be 3.5%, and the confidence intervals demonstrated that the sample parameters were in close alignment with the population parameters within a 95% confidence level. The comprehensive sampling and validation process guarantee that the study's findings are generalizable to the wider population of fifth and sixth-grade students in Seville, Spain.

Procedure

Students completed the questionnaires with pencil and paper during regular school hours, specifically during music or art classes, after exam and evaluation periods. The presence of the classroom teacher and, in some cases, the group tutor, ensured a comfortable environment that minimized any external influence on the students' self-assessments of their strengths and competencies.

For data analysis, Python was employed, utilizing several specialized libraries. Pandas was used for data handling (McKinney, 2010), and NumPy facilitated numerical calculations (Harris et al., 2020). Matplotlib and seaborn were employed to create graphs and visualizations (Hunter, 2007; Waskom, 2021). For machine learning tasks, including logistic regression and cross-validation, scikit-learn was utilized (Pedregosa et al., 2012). Additionally, SciPy was used for further statistical analyses, including *p*-value estimation (Virtanen et al., 2020). The tqdm library provided progress tracking during lengthy processes (da Costa-Luis, 2019).

This comprehensive and methodical approach to data collection and analysis ensured the reliability and validity of the study's findings, providing robust support for the investigation of the relationships between students' self-perceived competencies and virtues.

Research design

This study employed a quantitative, non-experimental, correlational, regression, and cross-sectional design to examine the relationships and predictive capabilities between students' self-perceptions of key competencies and virtues. Data were collected through validated questionnaires to identify patterns and associations between these variables (Creswell and Creswell, 2017).

Supervised classification models, specifically random forests, were utilized to analyze and predict key educational competencies based on virtues derived from positive psychology. Random forests, known for their robustness and versatility, are used for both classification and regression tasks. They operate by constructing multiple decision trees during training and outputting the mode of the classes for classification or the mean prediction for regression (Breiman, 2001).

To enhance the predictive power of the model, a random forest approach was employed. This method involves creating an ensemble of decision trees, each built from a subset of the data and features and combining their outputs to make more accurate and stable predictions (James et al., 2013). Random forests are particularly effective in handling high-dimensional data and complex interactions among variables, making them well-suited for the analysis of educational competencies and virtues.

A segmentation analysis was conducted to identify the most significant variables explaining the variability in the data. By using random forest analysis, which involves averaging multiple decision trees, it was determined that virtues from positive psychology significantly impact all the competencies assessed. Subsequently, a logistic regression analysis was conducted to ascertain whether perceptions of virtues can predict self-perceptions of educational competencies among 5th and 6th-grade students (Hosmer et al., 2013).

The analytical strategy involved supervised classification to estimate the probability that an individual belongs to a specific group based on their self-perceived competencies. Logistic regression was particularly appropriate for modelling dichotomous variables, such as the perceived competencies examined. This method allowed for the classification of observations and measurement of the model's performance in terms of true positives, false positives, true negatives, and false negatives, ensuring a comprehensive evaluation of the predictive power of virtues on educational competencies (Agresti, 2018).

Measure

Self-perceived competencies

Self-perceived competencies were measured using the "Competency-based Perceived Learning Questionnaire for Elementary School Students" (#ICOMpri1) developed by Meroño et al. (2017). This questionnaire assesses students' self-perceived proficiency in the eight EU key competencies through 27 questions. The instrument has demonstrated high validity and reliability, with internal consistency and a good statistical fit, achieving Cronbach's alpha reliability coefficients above 0.70.

Virtues from positive psychology

Students' self-perceptions of the six virtues of positive psychology were measured using the IVyF Children Questionnaire (Inventory of Virtues and Strengths for Children), adapted and validated by Grinhauz and Castro Solano (2014). This tool is reliable and valid for assessing the virtues and strengths defined by Peterson and Seligman (2004), specifically for children aged 10–12. Responses were collected using a five-point Likert scale ranging from "Not true for me at all" to "Absolutely true for me."

Coding scheme

To facilitate understanding of the analyses and results, the following coding was used for the variables: **C1** (Competence in Linguistic Communication), **C2** (Mathematical Competence), **C3** (Knowledge and Interaction with the Physical World), **C4** (Information Processing and Digital Competence), **C5** (Social and Citizenship Competence), **C6** (Cultural and Artistic Competence), **C7** (Learning to Learn Competence), **C8** (Autonomy and Personal Initiative), **V1** (Transcendence), **V2** (Justice), **V3** (Courage), **V4** (Wisdom and Knowledge), **V5** (Humanity), **V6** (Temperance).

This structured approach to data collection ensures that the study accurately captures the relationships between students' self-perceived competencies and their perceptions of virtues, providing a robust foundation for subsequent analyses.

Reliability

The internal reliability of the tools was tested using Cronbach's Alpha, both globally and by individual dimensions, to assess the stability and validity of the model. The reliability scores were high across all measures, with an overall Cronbach's Alpha of 0.928. Removing any item did not significantly affect this score, which ranged from 0.926 to 0.927, indicating strong internal consistency. The reliability of the different variables is presented in the Appendix.

For dimensional analysis, Principal Component Analysis (PCA) was employed due to its suitability for the data distribution. The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy was 0.941, indicating excellent appropriateness for factor analysis. Bartlett's Test of Sphericity was significant ($p < 0.001$), further supporting the feasibility of the analysis. The scree plot suggested that retaining two factors was appropriate, as they captured most of the data's variance.

The anti-image correlation matrix showed that all variables had values above 0.9, indicating that each positively contributed to the model and that none needed to be excluded. Orthogonal rotation (Varimax rotation with Kaiser normalization) was applied to the component matrix to enhance clarity and interpretation. The rotated component matrix, presented in Table 1, highlights the variables most strongly associated with each factor.

This rigorous approach to assessing reliability ensures that the findings of the study are both valid and reliable, providing a strong foundation for interpreting the relationships between students' self-perceived competencies and virtues.

TABLE 1 Rotated components matrix.

	Components	
	1	2
C2	0.742	0.037
C7	0.699	0.270
C3	0.694	0.235
C4	0.677	0.304
C1	0.656	0.285
V6	0.646	0.270
V4	0.572	0.475
C8	0.571	0.390
V3	0.562	0.460
V5	0.102	0.801
V1	0.262	0.733
C6	0.207	0.642
V2	0.445	0.562
C5	0.435	0.550

Table 2 shows the percentages of the variance of the two factors; it can be seen that the model explains 53.428% of the variance.

Analytical strategies

Given the study's focus on supervised classification, logistic regression was utilized to estimate the probability of an individual's group membership, specifically whether they belong to group 1 or group 0. Logistic regression is particularly suited for modelling dichotomous variables, such as the perceived competencies under examination, which serve as the dependent variable (Hosmer et al., 2013). These competencies were classified in relation to the Standard Deviation, following the approach recommended by Westfall and Henning (2013).

Defining the cut-off point for classifying observations is a common challenge in tasks involving dichotomous or binary variables. Classification models for these variables provide a probability of group membership ($\Omega 1$). A critical issue is determining the probability threshold at which an observation is classified into a specific group, significantly impacting the model's overall precision, sensitivity, and specificity (Westfall and Henning, 2013).

To evaluate the performance of the classification models, contingency tables, also known as confusion matrices, were employed (Agresti, 2007). These tables compare the predicted values with the actual values, allowing measurement of the model's performance in terms of true positives, false positives, true negatives, and false negatives. The analysis specifically focused on two types of classification errors as highlighted by Guerrero-San Vicente (2021):

TABLE 2 Total variance explained from principal components analysis (PCA).

Component	I total	I % of variance	I % cumulative	L total	L % of variance	L % cumulative	R total	R % of variance	R % cumulative
1	6,395	45,681	45,681	6,395	45,681	45,681	4,306	30,759	30,759
2	1,084	7,746	53,428	1,084	7,746	53,428	3,174	22,669	53,428
3	0,908	6,487	59,915						
4	0,743	5,306	65,221						
5	0,676	4,828	70,048						
6	0,597	4,264	74,313						
7	0,562	4,013	78,326						
8	0,495	3,535	81,861						
9	0,476	3,401	85,262						
10	0,451	3,223	88,485						
11	0,430	3,069	91,554						
12	0,408	2,914	94,469						
13	0,396	2,830	97,299						
14	0,378	2,701	100,000						

I, Initial eigenvalues; L, Sums of squared loadings of extraction; R, Sums of squared rotation loadings.

- **False negatives:** Occur when an observation belonging to $\Omega 1$ is incorrectly classified as belonging to $\Omega 0$.
- **False positives:** Occur when an observation belonging to $\Omega 0$ is incorrectly classified as belonging to $\Omega 1$.

While one approach to model evaluation is to maximize the total accuracy rate, alternative strategies, such as the mini-max criterion, aim to minimize both the proportion of false negatives and false positives. This involves balancing the model's sensitivity (true positive rate) and specificity (true negative rate), as advocated by Westfall and Henning (2013). The goal is to identify a cut-off point that equalizes the true positive and true negative rates, thus creating a balanced model that does not favor one group over the other, ensuring fair and robust performance assessment.

Given the balanced sample, with an equal number of cases in both group 1 and group 0, the cut-off point was arbitrarily set at 0.5. This means that all observations with a probability >0.5 are classified as group 1, and those with a probability <0.5 are classified as group 0. This threshold allows for the study of the significance of each variable, identifying those that significantly contribute to the prediction of group membership.

It is important to note that the logistic regression model cannot be evaluated using the r-squared coefficient of determination, which is typical for linear regression models. Instead, reliance was placed on the confusion matrix to assess model accuracy, which in this study ranges between 75% and 80% (Hosmer et al., 2013; Agresti, 2018).

Results

A segmentation analysis was conducted to identify the most significant variables explaining the variability in the data and to determine which variables facilitate effective segmentation. To enhance the predictive capacity of the model, a Random Forest analysis was employed, involving the averaging of multiple decision trees.

The random forest approach represents a powerful machine learning method, widely employed due to its flexibility and predictive accuracy. In contrast to traditional regression techniques, which assume linear relationships and frequently necessitate meticulously defined model parameters, random forest demonstrates superior capabilities in addressing intricate, non-linear interactions among variables without the necessity for rigid assumptions (Breiman, 2001). The construction of an ensemble of decision trees allows for the aggregation of predictions, thereby reducing the likelihood of overfitting and enhancing the accuracy of the results. This approach has been shown to outperform traditional techniques in a number of scenarios (Hastie et al., 2009).

Furthermore, the random forest method provides insights into the relative importance of variables, which is not a feature inherent to standard regression techniques. This allows researchers to identify the most influential predictors in their models (Cutler et al., 2007). This is particularly advantageous in studies involving multifaceted constructs like virtues and competencies, where interactions among variables may obscure linear relationships that are detectable by traditional regression methods. Although standard regression remains an effective method for estimating linear relationships and providing interpretable coefficients, random forest offers a superior alternative for uncovering complex patterns in high-dimensional data (Goldstein et al., 2011).

As illustrated in Figure 1, the findings indicate that virtues from positive psychology (V1–V6) have a significant impact on all the competencies assessed. While socio-demographic and contextual variables—such as type of school, gender, and exposure to artistic environments—also play a role, their impact is less pronounced

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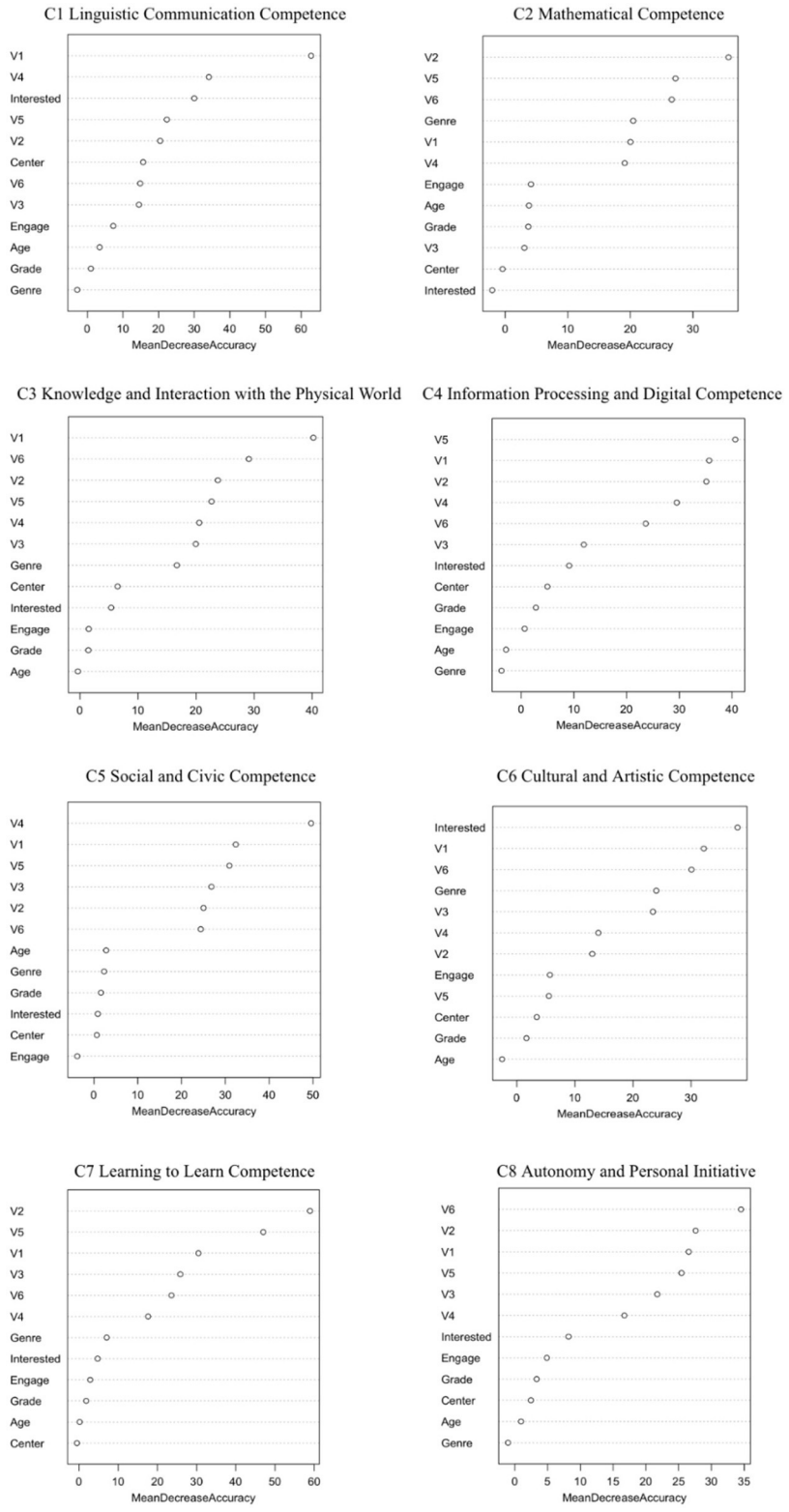

FIGURE 1
Random forest trees of 1,000 trees.

compared to the virtues. This suggests that the personal strengths associated with the virtues of positive psychology are particularly crucial for the development of competencies in students.

The Random Forest analysis highlights that virtues are key predictors of students' self-perceived competencies. This insight underscores the importance of integrating virtue-based education into school curricula to enhance students' overall development.

The significant influence of virtues over socio-demographic factors points to the universal applicability of positive psychology principles in fostering essential competencies among elementary school students.

Logistic regression analysis

As illustrated in Figure 1, the findings indicate that the virtues from positive psychology (V1–V6) exert a significant influence on all the competencies assessed. While socio-demographic and contextual variables (i.e., type of school, gender, grade, age, and exposure to artistic environments—Interested and Engage) were included in the analyses, their discussion is omitted in this paper due to space constraints. The analysis considered all measured variables; however, the focus of this paper is to determine which factors most significantly predict students' self-perceived competencies. While it is acknowledged that socio-demographic variables could interact with the virtues to influence students' self-perceived competencies, this remains an empirical question and is one of the areas proposed for further research.

The logistic regression analysis for each competence yields the coefficients displayed in Table 3, indicating the extent to which each virtue influences the competencies under investigation. These coefficients provide valuable insights into the predictive power of individual virtues on students' self-perceived competencies.

The analysis highlights the significant impact of specific virtues on various competencies, demonstrating the importance of integrating these virtues into educational practices. The detailed coefficients allow for a nuanced understanding of how virtues such as Transcendence, Justice, Courage, Wisdom and Knowledge, Humanity, and Temperance contribute to the development of key competencies among elementary school students.

This comprehensive approach ensures that the findings are robust and actionable, offering clear directions for educators and policymakers to enhance student development through virtue-based interventions.

Based on the results presented in Table 3, we conducted an in-depth analysis of the influence of the virtues of positive psychology on the key competencies perceived by students. The virtue of **Transcendence (V1)**, which includes strengths such as enjoyment of beauty and excellence, spirituality, purpose, gratitude, humor, and hope, emerged as one of the strongest and most consistent predictors across several competencies. It showed highly significant coefficients in Linguistic Communication (C1) (6.502, $p < 0.001$), Science and Technology (C3) (3.544, $p < 0.001$), Digital Competence and Information Processing (C4) (3.594, $p < 0.001$), Cultural and Artistic Competence (C6) (4.188, $p < 0.001$), Social and Citizen Competence (C5), and Autonomy and Personal Initiative (C8). These findings suggest that Transcendence, or a connection to something larger than oneself, is crucial across a wide range of educational competencies. This indicates that fostering this virtue can have a broadly positive impact on students' perceived competencies.

The virtue of **Justice (V2)**, encompassing strengths such as civility, teamwork, social responsibility, impartiality, equity, and leadership, also proved to be a strong predictor. It particularly stood out in Mathematical Competence (C2) with a coefficient of 3.744 ($p < 0.001$). It also showed significant influence in Science and Technology (C3) (2.275, $p < 0.05$), Digital Competence (C4) (2.990, $p < 0.01$), Learning to Learn (C7) (5.130, $p < 0.001$), and Autonomy and Personal Initiative (C8) (2.395, $p < 0.05$). These results suggest that a sense of equity and justice is not only important for mathematical performance but also crucial for self-directed learning and personal initiative, highlighting the importance of fostering a fair and equitable educational environment.

Courage (V3), including strengths like bravery, persistence, industriousness, perseverance, integrity, honesty, vitality, and enthusiasm, also emerged as a significant predictor for several competencies. It notably impacted Social and Citizen Competence (C5) (3.019, $p < 0.01$), Cultural and Artistic Competence (C6) (2.860, $p < 0.01$), and Learning to Learn (C7) (2.952, $p < 0.01$). Additionally, it showed significance in Science and Technology (C3). This indicates that courage and determination are fundamental for developing social, civic, and cultural competencies, as well as for enhancing self-learning skills.

The virtue of **Wisdom and Knowledge (V4)**, comprising strengths such as curiosity, a love of learning, open-mindedness, critical thinking, creativity, insight, and perspective, proved to be a significant predictor for Linguistic Communication Competence (C1) (3.670, $p < 0.001$), Mathematical Competence (C2) (2.207, $p < 0.05$), Digital Competence (C4) (2.703, $p < 0.01$), and Social and Citizen Competence (C5) (3.691, $p < 0.001$). This suggests that wisdom and knowledge are essential not only for effective communication and mathematical performance but also for digital skills and civic engagement.

Humanity (V5), which includes strengths like kindness, generosity, compassion, empathy, love, social intelligence, and emotional intelligence, was particularly relevant in Learning to Learn (C7) (4.089, $p < 0.001$) and Mathematical Competence (C2) (2.440, $p < 0.05$), indicating that interpersonal relationships and empathy play significant roles in self-learning and mathematical performance. It also showed significance in Cultural and Artistic Competence (C6).

Finally, the virtue of **Temperance (V6)**, which includes strengths such as forgiveness, prudence, humility, modesty, and self-control, was significant in Cultural and Artistic Competence (C6) (2.143, $p < 0.05$) and Autonomy and Personal Initiative (C8) (3.512, $p < 0.001$). This indicates that self-control and moderation are essential for personal development and cultural appreciation.

Figure 2 presents a visual summary, showing which virtues are associated with and predict different competencies.

As seen in Figure 2 and the results in Table 3, we can conduct a detailed analysis to identify which virtues have the greatest predictive capacity on the key competencies perceived by students. Table 4 presents the evaluation of the logistic models.

Discussion

The objective of this study was to examine the predictive power of six virtues from positive psychology on self-perceived competencies among students in the fifth and sixth grades. The findings indicate that virtues, particularly Transcendence (V1), exert a considerable influence on students' competencies,

TABLE 3 Logistic Regression coefficients.

Estimate	C1	C2	C3	C4	C5	C6	C7	C8
(Intercept)	3.421***	−0.770	−1.155	−0.989	3.913***	−0.005	−0.068	3.701***
V1	6.502***	0.820	3.544***	3.594***	2.304*	4.188***	1.041	2.461*
V2	1.282	3.744***	2.275*	2.990**	1.105	0.738	5.130***	2.395*
V3	0.851	0.063	2.046*	0.128	3.019**	2.860**	2.952**	2.804**
V4	3.670***	2.207*	0.906	2.703**	3.691***	1.010	−0.447	1.513
V5	0.424	2.440*	1.268	2.058*	2.486*	−0.326	4.089***	2.216*
V6	0.299	1.941·	2.609**	1.460	1.854	2.143*	0.542	3.512***

Signif. codes: $p < 0$ "***" $p < 0.001$ "**" $p < 0.01$ "*" $p < 0.05$ "·" $p < 0.1$.
C1 (Competence in Linguistic Communication), C2 (Mathematical Competence), C3 (Knowledge and Interaction with the Physical World), C4 (Information Processing and Digital Competence), C5 (Social and Citizenship Competence), C6 (Cultural and Artistic Competence), C7 (Learning to Learn Competence), C8 (Autonomy and Personal Initiative), V1 (Transcendence), V2 (Justice), V3 (Courage), V4 (Wisdom and Knowledge), V5 (Humanity), V6 (Temperance).

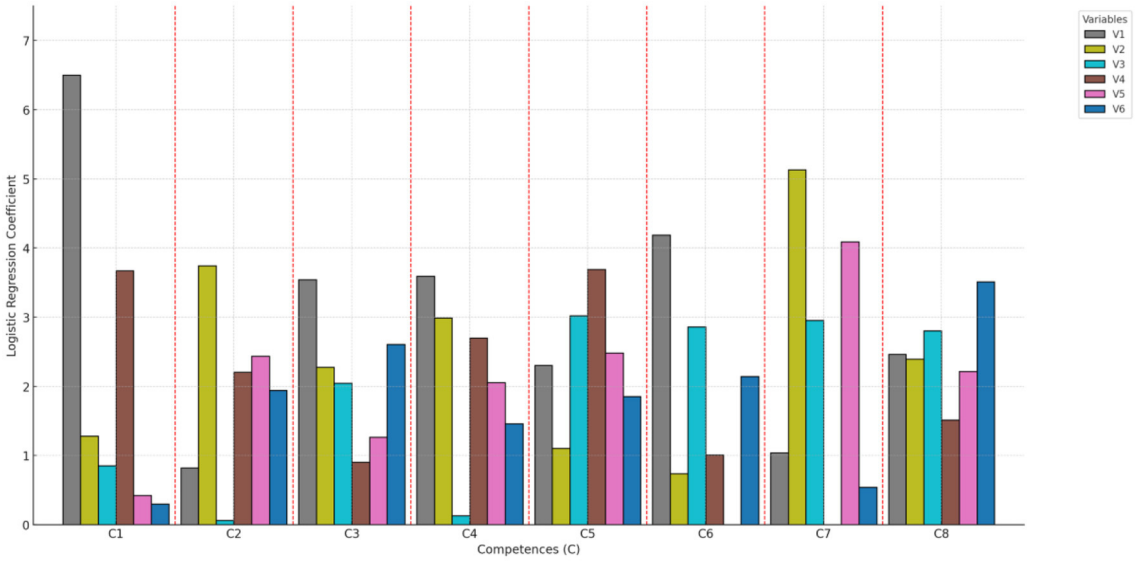

FIGURE 2
Logistic regression coefficient by competence and virtue.

TABLE 4 Evaluation of logistic models.

	C1	C2	C3	C4	C5	C6	C7	C8
Precision	0.8426667	0.7668919	0.7883008	0.8436482	0.8888889	0.7981366	0.8808777	0.8141809
Sensitivity (recall)	0.9017094	0.7352941	0.7439024	0.8322148	0.9036145	0.7922078	0.8853503	0.8630705
Specificity	0.7446809	0.79375	0.825641	0.8544304	0.8688525	0.8035714	0.8765432	0.7440476

thereby corroborating the growing body of evidence that personal strengths are pivotal for holistic educational development. These findings are in accordance with the conclusions of Lavy (2020), who conducted a comprehensive review and emphasized the importance of integrating character strengths into school curricula with a view to enhancing students' wellbeing, resilience and academic performance.

Lavy's (2020) findings illustrate that interventions designed to enhance character strengths, such as fostering gratitude, kindness, and optimism, not only lead to improved individual outcomes but also contribute to the creation of a positive classroom environment. In accordance with the aforementioned findings, our study demonstrates that virtues such as Transcendence (V1), which encompass strengths such as hope and gratitude, exert a particularly pronounced influence. This indicates that educational programmes which target these strengths may enhance students' capacity to navigate challenges, find meaning in their learning, and build stronger social connections.

The unexpected prominence of Transcendence (V1) as the strongest predictor in our study highlights the potential of

higher-order virtues to influence competencies beyond traditional measures. Lavy's (2020) emphasis on the necessity of tailoring character strengths interventions to specific educational contexts is in accordance with this finding, which suggests that the implementation of reflective practices and gratitude exercises could have a considerable impact on student engagement and motivation.

In practical terms, the fostering of Transcendence (V1) entails the assistance of students in developing a sense of purpose and connection to something greater, whether through mindfulness activities, community projects, or artistic endeavors. Such programmes align with Lavy's observation that character strengths not only benefit individual students but also contribute to the collective wellbeing of school communities, thereby promoting a culture of mutual support and resilience.

Our findings, in conjunction with those of Lavy (2020), serve to reinforce the necessity for virtue-based education that integrates cognitive, emotional, and existential learning. By prioritizing the development of virtues such as transcendence (V1), educators can empower students to excel both academically and personally, thereby equipping them to meet the demands of an ever-changing world.

López González et al. (2023a) stress the importance of cardinal virtues, including those analogous to Temperance (V6), Justice (V2), Courage (V3), and Wisdom (V4). This aligns with the current findings, yet also underscores Transcendence (V1) as a significant predictor for a range of competencies, including digital and cultural competencies. This suggests that Transcendence could be an additional critical virtue to consider in skill development.

Supporting the findings of Crespí and García-Ramos (2020), who developed a scale to measure competencies related to virtues and found high internal consistency and strong correlations between virtues and competencies, this study further identifies Justice (V2) as a predictor of Mathematics (C2) and Learning to Learn (C7). The identification of Transcendence (V1) as a significant predictor indicates that the existing theoretical framework may benefit from incorporating this virtue more prominently.

The results indicate that the six virtues of positive psychology—Transcendence, Justice, Courage, Wisdom and Knowledge, Humanity, and Temperance—impact various educational competencies. Promoting these virtues appears to be an effective strategy for enhancing performance across multiple educational areas. This underscores the importance of integrating virtue development into educational programs to support comprehensive student growth.

Transcendence (V1) emerges as the strongest and most consistent predictor across most competencies, followed by Justice (V2) and Courage (V3). Wisdom and Knowledge (V4), Humanity (V5), and Temperance (V6) are also significant predictors, though their impact varies by competence. These findings highlight the need to foster a range of virtues to improve various educational competencies, providing a solid foundation for holistic educational interventions. This study contributes new insights by highlighting the importance of Transcendence (V1) across various key competencies, a perspective not widely recognized in prior research. This suggests that fostering a connection to the transcendent could have significant benefits for the development of educational competencies and may influence the future design of educational curricula.

This study offers valuable insights into the relationship between perceived virtues and competencies, using robust methods to validate and generalize the findings. The model enables the assessment of how virtues influence students' perceptions of their skills, treating virtues as predictors with significant and differentiated effects on competencies. Through this model, clear and quantifiable interpretations via odds ratios are provided, facilitating an understanding of each virtue's impact on educational competencies. This is crucial for developing a solid foundation in Positive Development and Assessment Competencies Theory (PDAC).

In contemporary education, evaluating students' competencies from both objective and subjective perspectives is essential. PDAC, which integrates concepts from positive psychology and contemporary competence education theory, proposes that competencies can be effectively assessed and developed through character virtues and strengths. By addressing the subjective aspects of educational competencies, including emotional and social dimensions such as attitudes, motivation, and values, PDAC offers a comprehensive approach to student development. These subjective dimensions, crucial for students' holistic development, have been challenging to evaluate quantitatively. PDAC proposes character virtues and strengths as key indicators for measuring and enhancing perceived competencies.

This study underscores the significant role of virtues from positive psychology, particularly Transcendence, in predicting and enhancing educational competencies among elementary students. The findings highlight the need for integrating virtue-based interventions into educational programs to foster comprehensive student growth and development. By offering robust empirical evidence, this research provides a valuable contribution to the Positive Development and Assessment Competencies Theory (PDAC) and underscores the transformative potential of cultivating virtues in educational settings, paving the way for more holistic and effective educational strategies.

Conclusion

This study highlights the significant role of positive psychology virtues in predicting and enhancing educational competencies among elementary students. By focusing on virtues such as Transcendence, Justice, and Courage, the research provides valuable insights into the holistic development of students. The findings underscore the importance of integrating virtue-based interventions into educational programs to foster comprehensive student growth and wellbeing.

Limitations

Sample size and diversity

The study was limited to 993 students from a specific region in Spain, which may not be representative of the broader population. The lack of diversity in geographical

locations and school types (public vs. private) could limit the generalizability of the findings to other contexts. Additionally, the focus exclusively on 5th and 6th-grade students excludes other age groups that might show different patterns in the relationship between virtues and competencies. The developmental stages of students outside this age range were not explored, potentially limiting the applicability of the results to younger or older students.

Cross-sectional design and self-reported data

The use of a cross-sectional design precludes any conclusions about causality. This approach captures a snapshot in time, which does not allow for observations of changes over time or the effects of interventions aimed at enhancing virtues. Furthermore, reliance on self-reported questionnaires introduces the possibility of response biases, such as social desirability bias. Students might have reported their competencies and virtues in a manner they perceived to be more favorable rather than accurately reflecting their true abilities and traits. Although the study examined six virtues from positive psychology, other potentially relevant virtues and character strengths were not included, which might restrict the comprehensiveness of the findings.

Measurement issues

The reliability indices obtained in this study, while not exemplary in all cases, are deemed acceptable and robust, particularly given the relatively limited number of items included in the scales. In the virtues scale, the overall Cronbach's alpha of 0.825 is classified as "good" according to the criteria established by George and Mallery (2003), who indicate that values between 0.8 and 0.9 reflect adequate reliability for educational and psychological instruments. Similarly, the competence scale yielded an alpha of 0.849, which is also deemed to be "good," thereby reinforcing the internal consistency of the instrument.

With regard to the corrected item-total correlations, values such as 0.610 for Transcendence or 0.500 for Humanity are deemed acceptable, particularly in instruments comprising fewer than 10 items per dimension (Field, 2013). These results indicate that the items contribute significantly to the overall scale, although they could benefit from minor revisions or expansion to enhance their accuracy and robustness.

It is noteworthy that the reported levels of reliability are consistent with those reported in previous studies in the area of character strengths and educational competencies (Nunnally and Bernstein, 1994). Furthermore, the high overall reliability of 0.928 for all measured variables indicates a robust internal consistency in the overall instrument. While no significant issues were identified in the reliability of the instruments, future research could consider increasing the number of items in specific dimensions, such as Humanity or Cultural and Artistic Competence, to reduce dispersion and enhance reliability levels. This approach would facilitate the capture of the complexities inherent in these dimensions in greater detail.

Future research directions

Expanding sample size and age range

Future studies should aim to include a larger and more diverse sample, covering various regions and balancing representation between public and private schools. This would enhance the generalizability of the findings and provide a more comprehensive understanding of the relationship between virtues and competencies across different contexts. Expanding the age range of participants to include students from different developmental stages, such as primary, secondary, and high school, would provide insights into how virtues influence competencies across a wider spectrum of ages.

Exploring sociodemographic moderators

The current study establishes a robust relationship between positive psychology virtues and students' self-perceived competencies. However, understanding the potential moderating roles of sociodemographic variables, such as gender, age, grade level, and exposure to artistic environments, remains an open question for future research. These variables may introduce interaction effects, offering opportunities to deepen our understanding of how individual and contextual factors shape these relationships. Future investigations should systematically examine how the intersectionality of sociodemographic factors might influence the strength or nature of the associations described here. Exploring these interactions could provide a more nuanced understanding of how positive psychology virtues operate across diverse socio-demographic contexts. Such research would extend the current findings and contribute to the development of a more refined theoretical framework, advancing knowledge of the complex dynamics between individual virtues and self-perceived competence.

Exploring experiences and longitudinal designs

Future research should explore the experiences of students who have repeated a grade to gain deeper insights into their self-perception of competencies in relation to academic performance. Employing longitudinal and experimental designs would allow researchers to investigate causal relationships and observe the long-term effects of interventions aimed at enhancing virtues. Such designs could provide stronger evidence for the impact of positive psychology virtues on educational outcomes. Additionally, incorporating objective measures of competencies and virtues, such as teacher assessments, academic records, and observational data, would help mitigate response biases and provide a more accurate assessment of students' competencies and virtues. Including a broader range of virtues and character strengths in future studies would offer a more comprehensive understanding of how different virtues contribute to educational competencies.

Measurement issues

In order to overcome the limitations related to the reliability of some items, it is recommended that a thorough review of the measurement instruments used be carried out, with the aim

of improving their accuracy and appropriateness for students in Grades 5 and 6. This would entail the redesign of less consistent items, such as those pertaining to the dimensions of Humanity and Cultural and Artistic Competence, with the objective of ensuring that they are clearly formulated and relevant to the everyday context of students. It would also be advisable to increase the number of items for each dimension in the questionnaires, which would serve to reduce the dispersion of responses and enhance the reliability of the scales. This increase in the number of items would facilitate a more accurate capture of the characteristics assessed, thereby strengthening the internal consistency of the measures.

Developing evaluative rubrics

Future research should focus on developing evaluative rubrics for the attitudinal component of competencies in educational settings based on character strengths. This approach would significantly contribute to educational psychology by improving intervention and assessment programs, providing robust evidence on the impact of positive psychology virtues on skill development. This comprehensive strategy would support the holistic development of students, ensuring that educational interventions are effective and inclusive of various dimensions of student growth.

Pedagogical implications

The Positive Development and Assessment Competencies Theory (PDAC) offers significant practical implications for the design and implementation of educational programs. Integrating virtues and character strengths into educational curricula can enhance both students' competencies and overall wellbeing, supporting holistic development and providing a more comprehensive assessment of students' growth beyond academic performance.

In the business sector, soft skills such as teamwork, empathy, resilience, and ethics are essential. PDAC can be used to develop training programs that incorporate these virtues, thereby improving workplace performance and cohesion. Companies can utilize PDAC-based assessment tools to identify and nurture employees' virtues and strengths, aiding in performance evaluations, leadership identification, and career planning. Integrating PDAC into business practices can foster a positive organizational culture, enhancing job satisfaction and reducing turnover.

PDAC can also complement traditional Human Development Index (HDI) indicators by incorporating subjective dimensions such as emotional wellbeing and resilience. This approach offers a more complete view of sustainable human development. PDAC evaluation methods can measure the impact of educational and social programs on virtues and character strengths, providing valuable data for sustainable development policies. UNESCO can utilize PDAC to design educational interventions aligned with the Sustainable Development Goals (SDGs), promoting comprehensive wellbeing and sustainability competencies.

Furthermore, PDAC can be integrated into the OECD Program for International Student Assessment (PISA) to include non-cognitive competencies like collaboration skills and creativity. Implementing PDAC in PISA assessments can provide a holistic view of educational performance, informing policies that foster comprehensive student development.

To conclude, this study highlights the transformative potential of integrating virtues from positive psychology into educational practices. By emphasizing the development of character strengths, PDAC offers a robust framework for enhancing educational outcomes and fostering sustainable human development. This research makes a significant contribution to knowledge, advocating for a more holistic approach to education that aligns with contemporary developmental goals.

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 humans were approved by Maria Julia Morales Castillo and Alejandro Jose Tapia Frade, Universidad Loyola Andalucia. The studies were conducted in accordance with the local legislation and institutional requirements. Written informed consent for participation in this study was provided by the participants' legal guardians/next of kin. Written informed consent was obtained from the minor(s)' legal guardian/next of kin for the publication of any potentially identifiable images or data included in this article.

Author contributions

PV-M: Conceptualization, Data curation, Investigation, Methodology, Project administration, Writing – original draft. SC: Writing – review & editing. MG: Writing – review & editing. AS-H: Writing – review & editing. LM-G: Formal analysis, Writing – review & editing.

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Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/feduc.2025.1501130/full#supplementary-material

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