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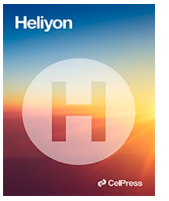

Research article

Determinants of academic achievement: How parents and teachers influence high school students' performance

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ABSTRACT

This study explores the contribution of various drivers of attainment in secondary education in Portugal. We propose a model explaining the influence of students, teachers, and parents' traits on high school achievement, measured by the self-reported Math and Portuguese final grades of 220 students. Using PLS-SEM, we show that previous achievement predicts current achievement in both subjects; however, noteworthy differences were found. Portuguese grades are significantly better for students whose parents have post-secondary education and communicate higher expectations about their offspring's school careers. At the same time, Math achievement is influenced by students' perception of teachers' involvement but not by parents' expectations or education. Previous retention and receiving educational allowance impair Math achievement, but not Portuguese. Results and implications are discussed.

1. Introduction

Education is the base of countries' economic prosperity and development [1]. High-ranking countries in the OECD's Program for International Student Assessment (PISA), a triennial evaluation of student skills in Math, reading, and science, are also the countries with a higher Gross domestic product (GDP). Economic prediction models have shown that an increase in PISA scores can yield significant economic gains [2]. Work and education play a central role in establishing social status, security, and income [3]. The profuse technology advances in the past decades have made the skills required for career success evolve quickly and require an ever-higher degree of specialization. Highly educated people are better equipped to deal with these challenges, as they are more skilled and able to adapt, thus accomplishing individual growth, better jobs, higher socioeconomic status (SES), and cultural capital, and at the same time contributing to social and economic development [4].

Research has focused on understanding the determinants of academic achievement (AA), i.e., why some students succeed while others struggle to achieve [5]. This research string is of particular interest to policymakers as it informs on how to promote AA and develop educational strategic plans, which are essential to granting equity in access and opportunities for every student to complete their education, reducing the impact of any prior factors that may lead to inequality [6]. Students are understandably the leading agents in their learning and achievement, yet teachers and parents also greatly influence school progress [7]. During high school, student-teacher and parent-children relationships are pertinently relevant, as this school period overlaps with adolescence, in which identity, autonomy development, and concerns about the future can be emotionally challenging for teenagers, increasing the chance to

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exhibit externalizing behavior [8,9]. Research shows that the quality of relationships students maintain with teachers, and parents can help them stay engaged in high school to a greater extent than the quality of relationships with peers [10].

In this study, we intend to explore the determinants of AA considering this student, parent, and teacher interaction in Portuguese high schools. Portugal has been seen as a particular case concerning PISA scores. Starting from an unfavorable position compared to the OECD average, the country has shown consistent growth in ranking since 2000, unlike any other OECD country, primarily due to significant changes in educational policies [11]. However, 2018 results show there are still striking discrepancies that account for inequality in education. For example, the score difference in Math between the top 10% of students with the highest scores and the bottom 10% of students with the lowest scores is one of the largest among PISA-participating countries and economies. The average difference in the reading scores of advantaged and disadvantaged students is also above average, with disadvantaged students showing higher retention rates [12]. The fact that such progress in PISA results has been made highlights the importance of changing policies; however, the results also show a gap not only within this generation but between these students and high schoolers from previous generations.

In Portugal, all high school students must attend Math and Portuguese (native language) classes, regardless of the vocational course in which they are enrolled. These are considered crucial subjects in compulsory learning that are important to establish competencies and gain access to post-secondary education. Portuguese language skills in high school are oriented to further developing literacy development, interpretation, and linguistic reflection [13]. High school Math goals aim to assimilate reasoning and abstract thinking further. Math has the reputation of being one of the most challenging subjects in school, and many students suffer from Math anxiety [14]. This issue is not so common in reading-related subjects (native or foreign language, for example). We propose a conceptual model exploring how determinants related to students, teachers, and parents influence secondary school level Portuguese and Math scores. Student determinants are previous retention (i.e., having failed at least a year in school), previous achievement, ICT use, and age; as for teachers, we assess the influence of their (pedagogical and social) involvement on AA; parents' expectations, parental education, and educational allowance (SES measure) are the determinants concerning parents. We aim to shed light on the importance of each determinant to student performance in two subjects essential for a successful career. Career choice and preparedness for adult life is a significant matter in high school as it is associated with both positive and harmful psychological, physical, and socioeconomic inequalities that persist beyond youth [3]; thus, the importance of understanding AA in secondary school.

The main contributions of this study are twofold. First, we intend to develop and test a comprehensive model of AA in high school, comparing students', teachers', and parents' contributions to achieving better grades, informing opportunities for AA improvement, and producing reliable insights for decision-makers in education. Second, because this investigation also compares the determinants for AA in Portuguese and Math in the same model, it allows for a critical overview of the similarities and differences between AA in these two core subjects, which are mandatory for graduation, as they are common to all high schoolers' curricula, regardless of the area of studies in which they are enrolled. The paper is organized as follows: Section 2 consists of a relevant literature review and hypotheses development, Section 3 details the applied method, Section 4 focuses on the results, and finally, Section 5 discusses the results and implications of the research.

2. Literature review and hypotheses

AA is measured through performance outcomes such as individual students' grades, school achievement exam grades, standardized test scores, or grade point averages [15]. These outcomes are an expression of the extent of accomplishment of students' learning goals and represent the results of the learning developed during all school years. Understanding what determines AA is essential, particularly for the benefit of low achievers with enduring academic difficulties, who tend to be at risk of dropping out and suffering problems in adulthood [16]. School dropout is linked to poverty, social exclusion, and obstacles to pursuing a prosperous professional career [17]. High school completion is fundamental to achieving a successful professional career or university education, as it is mandatory in most developed countries, including Portugal. Nevertheless, despite having decreased in the past decades, high school dropout rates are still a concern.

AA determinants have been extensively described in the literature, namely determinants pertaining to students [18] but also teachers [19] and parents [20,21] who play a pivotal role in student life, education, and ability to make good career decisions.

2.1. Students

Students' cognitive ability, measured by psychometric tests, has been considered a major determinant of AA [22]· General intelligence and other cognitive abilities correlate with Math scores [23]; however, research has shown that a much wider number of factors interact to explain AA [24]. In fact, individual psychological attributes such as personality traits, motivation, academic engagement, self-efficacy beliefs, and grit are positive determinants of AA, as they influence students' pursuit of learning goals, work efforts, and performance [18]. Abstractedness and perfectionism also predict better educational results [25], while anxiety due to self-esteem issues impairs AA [26,27]. Recent research found that motivational and personal predictors at the high school level are more critical to explaining AA than cognitive abilities. In fact, the importance of cognitive abilities decreases significantly as students advance to graduation [28]. The motivational and personal predictors are linked to students' academic track records, i.e., the progress students have made during their school years and their achieved academic results. Previous achievement is a positive predictor of AA [29,30] due to the cumulative nature of learning and knowledge acquisition throughout all school years. Past achievement encompasses students' history of successes and failures that impact AA and motivation [31]. For students with persistent academic difficulties, failing a year can impair AA significantly. Research shows that not only does grade retention not provide significant benefits

[32], there is evidence that there is a higher probability for a previously retained student to fail a year again [29]. A recent study in Portugal on elementary school retention shows meager retention benefits before 4th-grade completion on 6th-grade exam scores [33]. These benefits tend to fade at later stages, as failing 8th grade affects the likelihood of high school completion [34]. Grade retention negatively impacts self-esteem, academic self-concept, and homework completion and contributes to higher maladaptive motivation and absenteeism [35]. Retention has been linked to stigmatization by peers, particularly during early adolescence, aggravating behavioral and socioemotional adjustment problems [36]. Considering the impact of student track records, we propose the following hypotheses:

H1a. Previous retention negatively impacts Portuguese AA.

H1b. Previous retention negatively impacts Math AA.

Academic track records are part of the information teachers have about their students at the beginning of every school year. Research shows teacher behavior toward students who have failed is contingent upon their perception of student capabilities and effort. In some cases, teachers show a tendency to give up on the efforts to help the student improve [37]. However, according to Anderson et al. (2001), one of the principal explanations for the negative impacts of retention is the absence of specific remedial strategies, which we believe can be implemented by teachers directly, fostering a positive cycle of interaction where higher involvement from teachers will produce better results. Thus, we propose the following:

H1c. Previous retention moderates the relationship between teacher involvement and Portuguese AA in such a way that the effect is more positively significant than for non-retained students.

H1d. Previous retention moderates the relationship between teacher involvement and Math AA in such a way that the effect is more positively significant than for non-retained students.

H2a. Previous achievement positively impacts Portuguese AA.

H2b. Previous achievement positively impacts Math AA.

AA also depends on students' demographic factors, such as age, nationality, and gender. Older students typically perform worse [38]. The AA of non-national students or those whose parents are immigrants is contingent on how well they have adapted to school [39]. Girls typically achieve higher than boys [40], yet boys score better in specific Math skills [41].

Over the past few years, high schoolers have increasingly become avid internet users, mainly due to the massification of ICT access. There are striking benefits of ICT use in many areas, yet the impact on AA is still controversial, as both gains and losses for learning have been identified. Although ICT is an essential tool for education, ICT use for leisure has escalated, especially among teenagers. Excessive internet use for hedonic purposes (for instance, spending too much time on social media, online games, etc.) elicits lower academic results due to sleep disturbances and neglect of study time [42], lower general health, and a higher chance to develop internet addiction, and engaging in risky behaviors [43]. However, moderate computer use and video gaming have positively influenced high school AA [44,45]. Research has also demonstrated that students who have a higher internet usage frequency tend to perform better [46] and students with computer access, i.e., who do not only rely on a cell phone for internet access, and students with better digital skills typically outperform their peers [47]. We therefore propose:

H3a. ICT Use positively impacts Portuguese AA.

H3b. ICT Use positively impacts Math AA.

A framework of ICT usage's impact on adolescents has considered demographic factors such as gender, socioeconomic attributes, perceived academic achievement, and relevant use type [48]. According to UTAUT [49], age is a moderator of technology usage behavior. We propose that age is another demographic factor that may be important in assessing the impact of ICT use. Older teenagers are not only more expert users of ICT, as they tend to have more autonomy and less parental guidance compared to younger peers. Therefore, older teens are probably more likely to engage in excessive ICT use, thus suffering from the negative consequences that, according to the literature, impact AA, suggesting the following hypotheses:

H4a. Age moderates the relationship between ICT use and Portuguese AA in such a way that for older students, ICT use impairs Portuguese AA.

H4b. Age moderates the relationship between ICT use and Math AA in such a way that ICT use impairs Math AA for older students.

2.2. Teachers

Teachers' influence is also a significant determinant in explaining students' AA [50]. Previous research in Portuguese high schools assessed the impact of teacher gender, employment situation, education level, and experience on student AA. The results revealed that classes with female teachers and those with more experienced teaching staff typically achieve higher AA. In contrast, negative impacts were found for teachers who work away from home. Younger teachers who are less experienced have less stable contracts and are more likely to work away from home, which can account for these differences. The education level effect (BSc vs. MSc or Ph.D.) was insignificant [51]. Teachers who communicate higher expectations about student performance help improve students' academic self-concept and AA [52].

Besides pedagogical involvement, student perception of teacher social involvement and emotional support increase engagement and academic resilience [53], leading to better results. Teenagers' urge for independence from their parents may strengthen

student-teacher relationships in high school: students rely on teachers for help in planning their careers and even for support in their decision-making process [54]. Student perceived support of their teachers is a strong positive predictor of AA [55], leading us to propose:

H5a. Teacher involvement positively impacts Portuguese AA.

H5b. Teacher involvement positively impacts Math AA.

2.3. Parents

AA is determined by the specificities of the student's family, such as parental expectations, education level, SES, and cultural capital. Family background is critical for student development and adjusting to school life and demands. In fact, parents from lower educational backgrounds struggle to value education, give the necessary support in school matters, and provide the resources needed to improve AA [56]. Most research found that parental involvement in their children's academic path positively influences AA [20,57]. Parents' participation in school matters builds students' coping mechanisms and develops appropriate behavioral attitudes that lead to success [58]. Parents who are more involved tend to have higher expectations regarding their children's academic path and professional future, and these high expectations improve motivation for school work and yield better results [59]. The benefits of parental involvement are more noticeable for disadvantaged families [60,61], who participate less actively. Schools and teachers play an

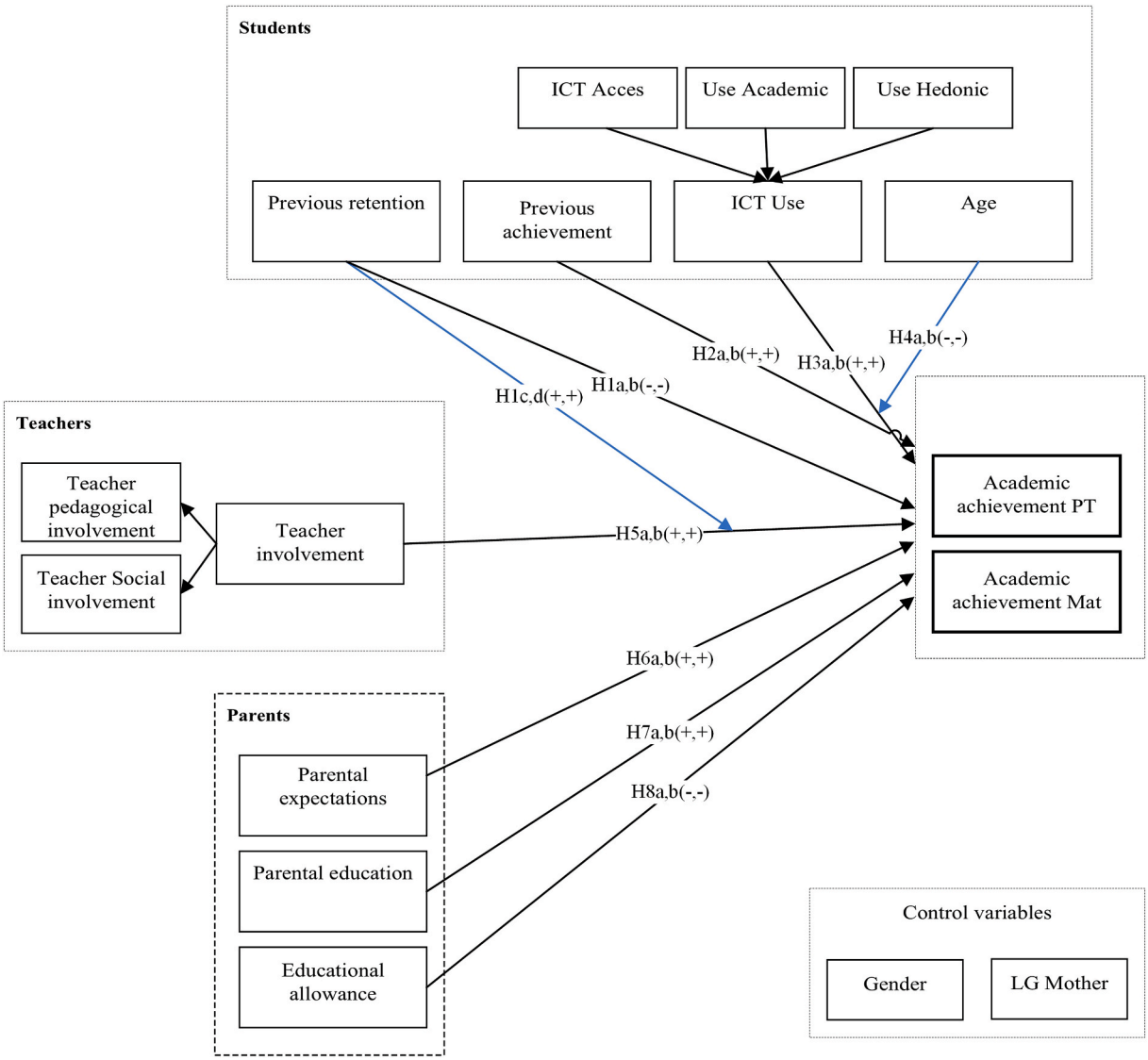

Fig. 1. Conceptual model and hypotheses.

essential role in promoting expectations and developing parental involvement skills [62]. In Portugal, there is a public discussion about future living conditions and employment of young adults, emphasizing the importance of education to achieve more steady jobs. This aspect leads us to believe parental expectations about their children's academic path and professional future are a critical dimension of parental involvement, so we developed the following hypotheses:

H6a. Parental expectations positively impact Portuguese AA.

H6b. Parental expectations positively impact Math AA.

AA is positively linked to higher parental income, higher education levels, and the parents' occupation type [63,64]. In fact, middle school students with university-educated parents achieve much higher levels than their peers whose parents did not pursue post-secondary education [65]. Students with highly educated parents usually have better results, as parents are typically more involved and supportive of school matters. They can help students in a way that parents with less cultural capital cannot, for instance, by engaging in academic discussions with their children [66]. Regarding parental education, we propose the following:

H7a. Parental university education positively impacts Portuguese AA.

H7b. Parental university education positively impacts Math AA.

Students from socio-economically challenged families typically attain lower levels of development in communication, language, literacy, and mathematical skills. Children who receive financial support for educational purposes (i.e., state-granted educational allowances) tend to perform worse than their peers [67,68]. Likewise, early motherhood, low maternal qualifications, low family income, and unemployment predict lower scores at school [40]. In Portugal, lower-income families can apply for state-granted educational allowances to help bear education costs. Lower-level SES predicts low scores, so considering educational allowances as a proxy for lower-income, we propose:

H8a. Receiving educational allowances (due to lower SES) negatively impacts Portuguese AA.

H8b. Receiving educational allowances (due to lower SES) negatively impacts Math AA.

2.4. Conceptual model

Fig. 1 illustrates our proposed model based on previous AA literature. We defined which constructs to include in our model according to the student-teacher-parent interaction in high school life. Constructs related to the student were *previous retention, previous achievement, ICT use,* and *age*. As for teachers, we measured student perception of *teacher involvement.* Constructs pertaining to parents are student-perceived *parental expectations, parental education,* and *educational allowance. Gender* and *legal guardian mother* were control variables, and *age* was only present as a moderator between *ICT Use* and AA. For each construct, at least two research hypotheses were developed, one relating to Portuguese AA and the other to Math AA, thus allowing to compare the impact of each determinant in these two subjects, mandatory for all students to conclude high school in Portugal.

3. Method

3.1. Participants and procedure

We surveyed public high school students in the 10th, 11th, and 12th grades. The public sector was chosen because around 80% of all students in Portugal attend the public education system. Therefore it is more representative than the private education sector, which is typically an option only accessible to more privileged families. The survey had an estimated completion time of 10 min. It was designed online (Qualtrics XM) and was e-mailed to 44 schools across the country, along with an invitation and presentation of the study. Data were collected online due to the government's restrictive measures and school directions imposed during the COVID-19 pandemic. As compensation for schools' participation, a short report with the main findings was sent to school directors.

The questionnaire was answered online and was comprised of closed questions about the constructs included in the conceptual model (please see Appendix A): previous student retention, previous achievement (Day et al., 2010), ICT use, including academic and hedonic use [69], student perception of teacher (social and pedagogical) involvement (Johnson & Johnson, 1983), student perception of parental expectations towards their academic path [70], and sociodemographic information (parental education [65], educational allowance, gender, age, legal guardian). AA measures were the self-reported students' grades in the core subjects Portuguese and Math in the current school year. It is worth mentioning that both these subjects are compulsory in all three years of high school, regardless of the course students are enrolled in, and their completion is necessary for secondary education graduation.

Participants were informed of the voluntary condition of their participation and the use of their data (anonymous, confidential, and strictly for the purposes of this research). The survey was approved by the NOVA IMS Ethics Committee, the MagIC Research Centre, and the Directorate-General for Education of the Portuguese Ministry of Education. This approval meant students could consent to their participation in the study, dismissing the need for their legal guardians' consent.

3.2. Data

A pilot study with 37 students was conducted to help assess the instrument, allowing us to ensure the viability of the measurement scales and the appropriateness of the instrument to fulfill our research goals.

Data collection took place between April and November 2021. The final survey data, which only considered the fully completed responses, amounted to 220 valid responses from 404 answers. AA was measured through self-reported grades on a scale of 0–20 for Portuguese (M = 14.67, SD = 2.39) and Math (M = 13.97, SD = 3.49) of the current school year. Participant ages varied from 16 to 23 years old; students aged 18 or over can become their own legal guardians, meaning they make all decisions regarding their schooling. Sample demographics are detailed in Table 1.

4. Results

Structural equation modeling (SEM) was used to test the relations estimated in our theoretical model and its effects. We opted for partial least squares (PLS-SEM), a variance-based SEM technique due to this research's exploratory nature, to identify key driver constructs of AA. It is a method that works better than covariance-based SEM on complex models, allowing for smaller sample sizes and less restrictive assumptions on data while incorporating reflective and formative constructs [71].

We used the PLS-SEM method as the recommended two-step approach that first tests the reliability and validity of the measurement model and then assessed the structural model [72] with the SmartPLS 3 software [73].

4.1. Measurement model

Measurement models measure the relation between the latent variables and their indicators for both reflective and formative constructs. In this study, all constructs are reflective except ICT use, which is formative.

Table 2 shows that the composite reliability (CR) is higher than 0.7 in all constructs, reflecting internal consistency [74]. Analyzing the items' loadings, all above 0.6, we can verify indicator reliability (Appendix B). To demonstrate convergent validity, we verified the average variance extracted (AVE) values of constructs, and they are all higher than 0.5 (see Table 2), confirming convergent validity [75].

Three methods were used to analyze discriminant validity - the Fornell-Larcker criterion, the loadings, and cross-loadings analysis, and the heterotrait-monotrait ratio (HTMT) methodology. The Fornell-Larcker criterion states that the AVE square root of each construct should be higher than the correlation between constructs [76], as shown in Table 2. However, assessing the higher-order construct of teacher involvement's discriminant validity requires additional scrutiny. The lower-order components (TSInv and TPInv) must exhibit discriminant validity among each other and to all other constructs in the model—except for their own higher-order component of which they are a part [75]. The second criterion states that the loadings should be higher than the respective cross-loadings [77], which is observed in Appendix B. As for the HTMT criteria, HTMT values (please see Appendix C) should be lower than 0.9 [75]. Thus, all the constructs have discriminant validity.

We checked the model for multicollinearity by analyzing the variance inflation factor (VIF) to assess the validity of the formative construct ICT use. Table 3 shows the VIF values are all under five (Hair et al., 2017), as the threshold indicates, thus indicating no multicollinearity issues. In terms of significance, the three items are statistically significant ($p < 0.01$). We, therefore, verify the reliability of the formative construct. We can conclude that both reflective and formative constructs present a good measurement model and confirm the structural model results.

Table 1
Sample characteristics.

Measure	Value	%	Frequency
Gender	F	62.7	138
	M	35.0	77
	Other	2.3	5
School year	10	13.2	29
	11	38.2	84
	12	48.6	107
Age	16	44.5	98
	17	43.2	95
	18	10.9	24
	>18	1.4	3
Legal guardian	Mother	77.3	170
	Father	20.9	46
	Self	0.9	2
	Other	0.9	2
Parent education level	Less than 12 years (high school not complete)	14.5	32
	12 years (high school graduate)	35.5	78
	More than 12 years (tertiary education)	45.9	101
	Don't know/Don't want to answer	4.1	9
School allowance	Yes	13.6	30
	No	71.8	158
	Don't know/Don't want to answer	14.5	32
Parents nationality	Portuguese	85.9	189
	Other	14.1	31

Table 2
Descriptive statistics, composite reliability (CR), and average variance extracted (AVE).

	Mean	SD	CR	PRet	PAch	ICTA	ICTAc	ICTHe	Age	TSInv	TPInv	PExp	PEdu	EAlo	AAPT	AAMat
PRet	0.132	0.339	1.000	**1.000**												
PAch	14.702	2.541	0.866	−0.060	**0.829**											
ICTA	5.936	1.538	0.783	0.177	−0.104	**0.802**										
ICTAc	4.825	1.726	0.826	0.015	0.023	0.307	**0.839**									
ICTHe	6.036	1.422	0.803	0.047	−0.099	0.569	0.245	**0.820**								
Age	16.673	0.872	1.000	0.317	−0.021	0.009	0.015	−0.044	**1.000**							
TSInv	3.784	1.865	0.921	0.099	0.099	−0.037	0.224	−0.049	−0.134	**0.864**						
TPInv	5.181	1.685	0.918	0.058	0.137	−0.069	0.265	−0.090	−0.188	0.638	**0.858**					
PExp	6.368	1.274	0.926	−0.222	0.165	−0.002	0.229	0.045	−0.264	0.132	0.275	**0.846**				
PEdu	3.536	1.088	1.000	−0.196	0.128	0.006	−0.015	0.071	−0.158	0.039	0.043	0.241	**1.000**			
EAlo	0.160	0.367	1.000	−0.220	0.227	−0.129	−0.045	−0.085	0.037	−0.039	0.023	0.228	0.306	**1.000**		
AAPT	14.671	2.393	1.000	−0.268	0.418	−0.084	−0.039	−0.055	−0.132	0.082	0.064	0.396	0.349	0.230	**1.000**	
AAMat	13.967	3.490	1.000	−0.197	0.333	−0.109	−0.019	−0.086	−0.129	0.200	0.238	0.136	0.114	0.039	0.422	**1.000**

Notes: Values in bold are the AVE square root. PRet = previous retention; PAch = previous achievement; ICTA=ICT access; ICTAc = ICT academic use; ICTHe = ICT hedonic use; TSInv = teacher social involvement; TPInv = teacher pedagogical involvement; PExp = parental expectations; PEdu = parental education; EAlo = educational allowance; AAPT = academic achievement Portuguese; AAMat = academic achievement Math.

4.2. Structural model

First, we assessed the VIF to check the model for multicollinearity issues to estimate the structural model. The VIF values are below the threshold of five (Sarstedt et al., 2017), so the model does not have multicollinearity problems. We performed bootstrapping with 5000 resamples to evaluate the statistical significance of the path coefficients. The results are presented in Fig. 2.

Previous achievement is the only determinant that has a significant impact on both Portuguese AA ($\beta = 0.271$, $p < 0.10$) and Math AA ($\beta = 0.274$, $p < 0.10$), meaning that previous grades predict current grades. Previous retention only significantly negatively affects Math AA ($\beta = -0.275$, $p < 0.05$). Likewise, ICT use only significantly affects Math AA, revealing a negative value ($\beta = -0.079$, $p < 0.05$). When considering age as a moderator, ICT use impairs both Portuguese and Math grades ($\beta = -0.207$, $p < 0.05$; $\beta = -0.122$, $p < 0.10$).

Teacher involvement only affects Math AA ($\beta = 0.208$, $p < 0.05$), the effect on Portuguese AA is not statistically significant. With previous retention as a moderator of teacher involvement and AA, the pattern is the same: for previously retained students, teacher involvement is only significant in Math grades ($\beta = 0.250$, $p < 0.10$), as for all students.

Parental expectations and education are significant positive predictors of Portuguese AA ($\beta = -0.308$, $p < 0.01$; $\beta = 0.209$, $p < 0.05$) and non-significant for Math. While educational allowance only affects Math AA by impairing it ($\beta = -0.121$, $p < 0.05$), i.e., students from lower SES who receive educational allowances tend to score worse in Math.

5. Discussion

In this study, we proposed to compare the contribution of students-, teachers-, and parents-related determinants for high school AA in Math and Portuguese, two core subjects that all students must complete to graduate secondary education in Portugal. Although there are differences in the individual traits and skills necessary to succeed in language and Math at the high school level, considering most findings in previous literature, we did not anticipate differences in the relevance of each determinant for each of the subjects' AA. The results, however, show otherwise, as there are determinants that are only significant for one of them. Table 4 details our proposed hypotheses and the results of this research.

Looking into the constructs pertaining to students, we found that previous retention is only a significant determinant of Math AA, with a negative effect. This means that having failed a year previously impairs Math AA but not Portuguese AA. We hypothesized that both grades would be impaired by previous retention. However, we only confirmed the hypothesis regarding Math AA, hinting that the deleterious effects of retention affect Math performance specifically. Possible explanations may be that students perceive Math as a more difficult subject, eliciting higher performance anxiety levels. Math AA requires high levels of self-efficacy and perceived Math competence [78], and students who have previously failed are likelier to have lower perceived competence levels. Students' past learning and composite achievement contribute to current learning and performance. Our results show that previous achievement is a significant positive predictor of current achievement in both Portuguese and Math. These results are consistent with previous literature [79] and confirm both our hypotheses regarding previous achievements.

As for student ICT use, we found a significant negative effect for Math AA and a negligible effect for Portuguese AA. This disputes our initial assumption that ICT use would promote AA in both subjects. Contradictory effects have been found in previous research regarding ICT use and AA [44,80], so we analyzed the impact of both academic and hedonic usages of ICT on AA, aiming to clarify these results. Descriptive statistics show the mean value of self-reported frequency of use, indicating heavy usage for hedonic purposes ($M = 6.04$, $SD = 1.42$, on a scale from 1 – never to 7 – multiple times a day), which can explain the negative effect on AA. Such an adverse effect may likely be due to the disruption of work and poorer study habits that have been shown to particularly affect Math performance [81]. With age as a moderator, ICT use is a significant prejudicial driver of both Portuguese and Math AA.

Along with these student determinants, we also analyzed teacher-related determinants. We predicted higher levels of teacher involvement indicate higher AA, based on previous research assumptions [55,82], according to which teachers' involvement strengthens academic engagement and student performance. However, this effect was only significant for Math. A moderation effect of previous retention on teacher involvement and AA is significant for Math but not Portuguese, thus strengthening the assumption that Portuguese AA is somewhat independent of perceptions of teacher involvement. At the same time, Math AA improves with higher levels of teacher-social and pedagogical collaboration, an effect proven even for struggling students who have failed in the past.

Finally, regarding parental traits as determinants of AA, contributions are in the direction we had predicted: parents' expectations and education increase AA, while educational allowance (a proxy for lower SES) impair AA, and these findings are consistent with the literature [61,83]. However, the results also show differences in Portuguese and Math AA: Portuguese grades are significantly better for students whose parents communicate higher expectations about children's school path and who have post-secondary education. In

Table 3
Formative measurement model evaluation.

Items	VIF	Weights
ICTA	1.548	0.461***
ICTAc	1.113	0.372***
ICTHe	1.492	0.465***

Note: ***p < 0.001 ICTA=ICT access; ICTAC=ICT academic use; ICTHe = ICT hedonic use.

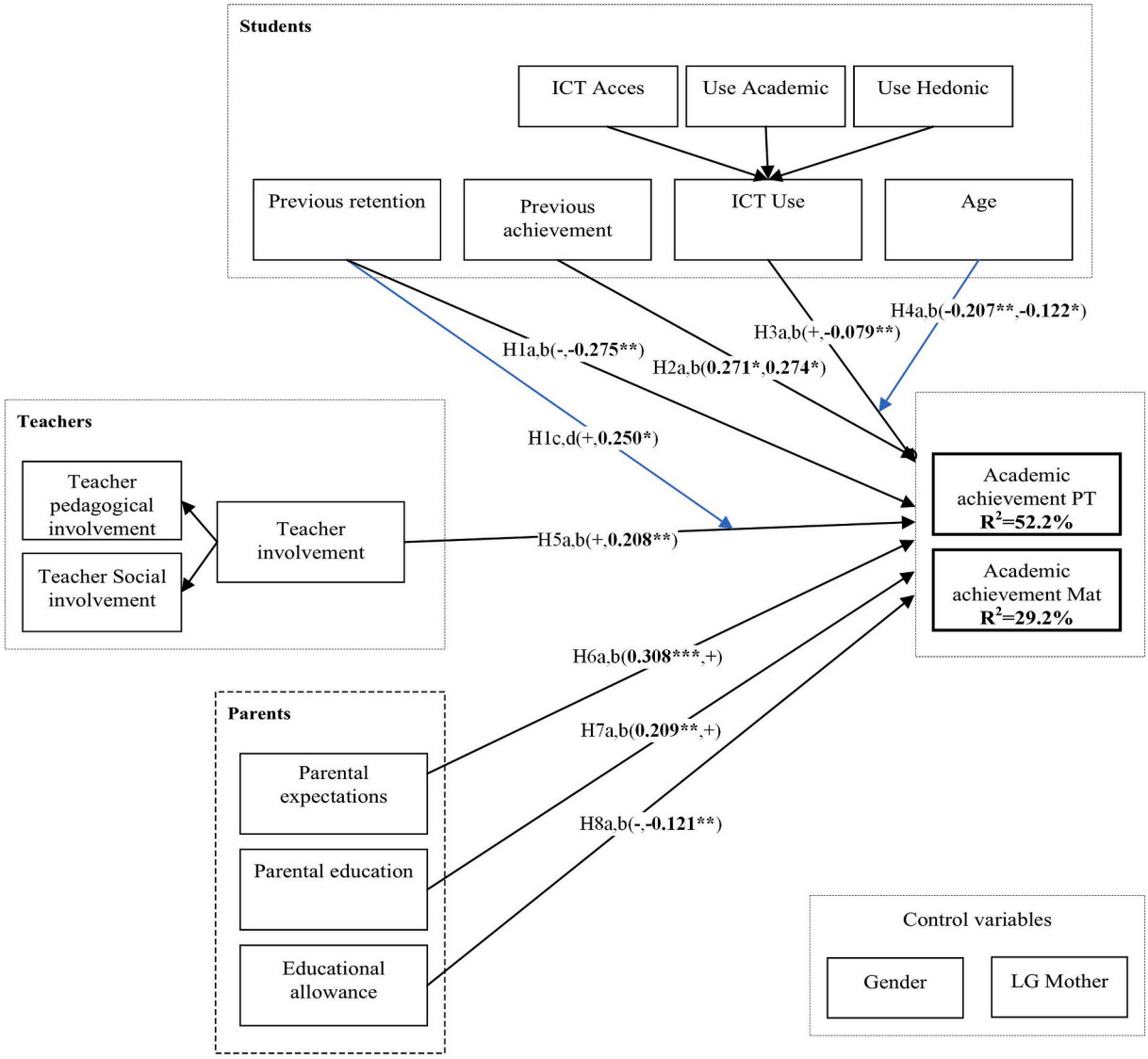

Fig. 2. Results – structural model.

contrast, educational allowances impair Math AA but not Portuguese.

From these results, we conclude that the only predictors of academic achievement in both language and Math are previous achievement and ICT use, with age as a moderator. All other determinants only explain one of the current grades. Considering Math, previous retention, ICT use, and educational allowance contribute to lower AA, while teacher involvement promotes it. Portuguese grades are positively determined by parental involvement and parental higher education level. This finding seems to show that the path to AA in Math and language is different and highlights the different roles that teachers and parents have in promoting success. Notwithstanding, previous literature has found that higher parent and Math teacher expectations combined in the 10th grade are associated with better 12th-grade Math AA and higher educational attainment two years after high school completion [84].

Looking into why such differences in parents' and teachers' roles in AA have emerged, we propose some possible explanations considering specifics of the Portuguese context that can account for the results. Cultural capital, i.e., familiarity with the dominant cultural codes in a society, can determine educational success because it can be misinterpreted by teachers as academic excellence and rewarded as such. Because children from high socioeconomic status (SES) backgrounds, on average, possess more cultural capital than those from low-SES backgrounds, they have a comparative advantage in the educational system, which helps them reproduce their privileged social position [85].

Parents with higher education levels and a higher cultural capital are better equipped to help their children thrive intellectually by promoting academic discussions and reading habits [66], as well as granting the development of skills necessary for language AA, such as interpretation and critical thinking. Nearly half of the students in our sample reported that their legal guardian (which in most cases

Table 4
Research hypotheses results.

	Independent variable		Dependent variable	Moderator	β	Findings	Conclusion
H1a	Previous retention	→	Academic achievement Portuguese	n.a.	−0.140	non-significant	not supported
H1b	Previous retention	→	Academic achievement Math	n.a.	−0.275	**	supported
H1c	Teacher involvement * Previous retention	→	Academic achievement Portuguese	Previous retention	0.101	non-significant	not supported
H1d	Teacher involvement * Previous retention	→	Academic achievement Math	Previous retention	0.250	*	supported
H2a	Previous achievement	→	Academic achievement Portuguese	n.a.	0.271	*	supported
H2b	Previous achievement	→	Academic achievement Math	n.a.	0.274	*	supported
H3a	ICT Use	→	Academic achievement Portuguese	n.a.	−0.044	non-significant	not supported
H3b	ICT Use	→	Academic achievement Math	n.a.	−0.079	**	supported
H4a	ICT Use * Age	→	Academic achievement Portuguese	Age	−0.207	**	supported
H4b	ICT Use * Age	→	Academic achievement Math	Age	−0.122	*	supported
H5a	Teacher involvement	→	Academic achievement Portuguese	n.a.	−0.021	non-significant	not supported
H5b	Teacher involvement	→	Academic achievement Math	n.a.	0.208	**	supported
H6a	Parental expectations	→	Academic achievement Portuguese	n.a.	0.308	***	supported
H6b	Parental expectations	→	Academic achievement Math	n.a.	0.052	non-significant	not supported
H7a	Parental education	→	Academic achievement Portuguese	n.a.	0.209	**	supported
H7b	Parental education	→	Academic achievement Math	n.a.	0.020	non-significant	not supported
H8a	Educational allowance	→	Academic achievement Portuguese	n.a.	−0.044	non-significant	not supported
H8b	Educational allowance	→	Academic achievement Math	n.a.	−0.121	**	supported

Notes: *p < 0.10, **p < 0.05, ***p < 0.01.

is the mother) had completed tertiary education. In recent decades, graduation rates have increased significantly in Portugal: according to national statistics data, in 2021, the percentage of women between 35 and 64 years who completed university was 31.7%, twice the value of 2011 (15.7%). Although tertiary education rates are increasing, most of the generation who are now high school student parents, despite having completed an upper secondary degree or higher, seem not to be particularly savvy in Math, as suggested by a previous study that demonstrated the low Math literacy skills of the adult population in Portugal in general [86]. Therefore, it seems the extent of parent contribution is more evident in language achievement than in Math. Likewise, parental expectations are only significant for Portuguese AA. This result contradicts the Benner et al. (2021) findings that show Math AA of American students is significantly driven by parents' expectations. According to Chen (2005), perceived parental support and expectations impaired global AA (combined scores of Math, English, and native language Chinese), suggesting that the stronger students perceive the support from parents, the worse they tend to perform, which is explained by a reactive strategy toward parents and difficulties in emotional regulation that is typical in teenagers. Other authors highlight that in Chinese culture, societal expectations are associated with "high-achieving" stereotypes, meaning students feel more stressed when facing school problems (Qu et al., 2020) and pressure to achieve. Seemingly, the effect of parents' expectations can differ according to cultural aspects or more or less disruption in parent-teenager relationship quality. Wang et al. (2013) found that positive relationships between students and teachers moderated the effect of effortful control and parent-adolescent conflict on emotional and behavioral adjustment at age 18.

As for Math AA, our results show the relevance of perceived teacher involvement as a positive predictor and receiving an educational allowance as a negative one. Gregory and Weinstein (2004) found that U.S. adolescents' perceptions regarding connection with and regulation from parents and teachers were the strongest predictors of growth in their Math AA from 8th to 12th grades, with teacher connection being the strongest predictor, particularly for adolescents from low SES families [87]. High school students in Portugal commonly attend private tutoring, as a complement to their high school classes, particularly for STEM subjects. However, this tutoring is contingent on family income, and one of the reasons why lower SES predicts lower Math AA.

These results highlight relevant aspects of theory and practice, comparing achievement in two fundamental subjects in pursuing tertiary education or a career.

5.1. Theoretical implications

From a theoretical perspective, these results have consolidated previous findings, such as the relevance of previous AA for current AA [30,60,88], a consequence of the cumulative nature of education and learning. We have also contributed to the debate on ICT use and its effect on AA, as self-reported high levels of ICT use predicted lower AA in Math, particularly for older students, for whom the negative effect was significant for both subjects. Research has shown that students consider ICT is an essential tool for their daily life

and that usage improves their academic and cognitive skills, as well as IT skills that they consider essential for career growth [89]. Our sample reported using ICT on average daily, for both academic and hedonic purposes, although more often (several times a day) for hedonic purposes such as browsing social networks, gaming, videos, etc. Previous studies have found seemingly different effects of using ICT: recreational use at moderate levels (one to 2 h a day) predicted positive scores in language and Math [44], while students who reported higher levels of ICT usage, both at home and at school tended to have, on average, lower Math AA [81], hinting that the time spent online plays an important role in AA.

The burden of previous retention for AA also corroborates earlier findings from the literature [34,90]. This observation was only proven for Math, suggesting that, at least in Portugal, the negative outcomes of being retained have worse consequences on subsequent performance in this subject. This result is in line with most studies on retention and AA and high school completion. Most evidence supports the negative impact that retention has on current performance [32]. It is justified mainly by the psychological impacts that being retained has on students [38]. However, few studies did find there may be benefits in repeating a year for some students, able to catch up to younger peers [91]. Our results did not find benefits in retention other than the non-significant effect on Portuguese AA in contrast to Math. Seemingly, the impacts of failing a year, such as a decrease in self-efficacy and motivation, for example, only impair Math performance. It may be the case that Math AA is more reliant on previous learnings compared to language subjects or that Portuguese high school students have an anxious approach to Math in particular. Academic self-efficacy may be more relevant to success if the latter is the case. Further research could help clarify these hypotheses.

Parents with university education significantly impact AA, a finding that is consistent with previous literature [65], although the effect was only significant for high school Portuguese AA and not Math. University education has been demonstrated as a significant driver of AA for kindergarteners, middle school students, and university students [92]. The low average mathematical literacy in Portugal can account for the fact that highly educated parents' contribution was negligible to Math AA. Parental expectations also only promoted Portuguese AA, which is an unexpected result according to the literature. Previous research states that parental expectations about AA help shape students' own expectations for success [93] and positively predict achievement [70]. The fact that parental expectations do not explain Math AA may be due to higher expectations regarding Math AA, thereby placing some degree of pressure on students [94], or that Math AA has particular features boosted by teachers and not Portuguese parents.

Among all the parental determinants we assessed, only low SES (receiving an educational allowance) predicted Math AA, which is also consistent with former findings [83]. Higher teacher involvement also predicted Math AA, but not Portuguese, and the effects of teacher expectations and involvement are variable, as previous results demonstrate [52].

5.2. Practical implications

In the late decades of the 20th century, the level of adult education in Portugal was significantly lower than in other developed nations. This scenario has changed as Portuguese PISA scores have increased drastically in recent years, accounting for the higher skills and knowledge inherent to younger generations. This improvement is a consequence of strategic efforts to grant universal access to education and learning, thus increasing competencies as well as graduation rates. Policies such as establishing universal access to preschool, increasing compulsory education years, a significant quality improvement of teaching programs, and introducing assessment exams at the end of each educational cycle have all contributed to higher AA [95]. Even though the current scenario is much more favorable, high school dropout rates in Portugal still surpass the European average. The present study's findings shed light on some practical implications that can still improve secondary school AA.

One of the drivers that impair AA is ICT use – high use, particularly for hedonic purposes, means students perform worse in Math. This factor highlights the need for more adult supervision to monitor the time spent on computers or smartphones or provide students with tools to self-regulate screen time by promoting other leisure activities. School curricula could also be updated to include more engaging pedagogical ICT activities.

Given the current high demand for STEM jobs, there is a more pressing need for students to develop and master Math skills. Our results suggest that Math achievement may be incremented by promoting teacher social and pedagogical involvement. Teacher training could focus on pedagogical and social competencies, as teachers' roles are more relevant than parents' for Math AA and particularly for disadvantaged students. Teachers play a crucial role in capacitating students and may be very influential in potentiating hope for a better future (particularly when parents fail to do so) and the possibility of breaking the disadvantage cycle. Recent research shows that when adolescents believe their SES conditions can be changed, they achieve more, highlighting the importance of focusing on a growth mindset, hopefulness, and school engagement to enhance AA [96].

Since previous retention is detrimental to Math grades, our results support the need to revise the criteria for failing a student. Retention policies have been under debate in Portugal in recent years. In fact, retention rates have been decreasing, but further work at the student level (such as individual tutoring at school for students at risk of failing), as previously suggested by Choi et al. (2018)[97], and also at the institutional level, by for example updating retention criteria seems beneficial. Research has found a prevalent culture of retention in some European countries. The dominant belief shared by teachers is that year repetition benefits learning [98], even though it has been repeatedly disputed in previous research. It may be useful to question such assumptions before implementing legislative changes. Our results show that higher teacher involvement promotes Math AA, particularly for students with at least retention. This factor is an important result that highlights the importance of teachers for AA. It should be focused on to increase society's perceptions of the relevance of high school teachers.

5.3. Limitations

Some limitations must be considered when interpreting the findings of this study. One of them is regarding sampling, as our sample is a relatively small portion of high school students considering the total of students enrolled in Portuguese public high schools. Due to constraints in data collection provoked by the Covid-19 pandemic and public health measures in schools, data collection was done online. Contacts with schools were done solely by e-mail or phone, which we believe has had an impact and explains our low response rates, thus suffering from self-selection bias. Further research with a larger sample that is more representative of public secondary schools could be useful to improve the generalization of findings. It would also allow for performing more comprehensive analyses according to school region/district, including statistics such as population density, average monthly income, and unemployment rate, among others.

6. Conclusions

This paper highlights the interaction between students, teachers, and parents as contributors to high school Portuguese and Math AA in Portugal. We showed that in high school, apart from the academic track record, student perceptions about significant adults in their school life – parents and teachers – are important to achieve better grades in two core subjects. Student previous achievement predicted current Portuguese and Math AA, yet significant differences in determinants according to the subject were found. Parents' influence was more significant in Portuguese than in Math, namely through expectations and higher education levels. Teacher influence on Portuguese grades was not significant. In fact, only Math grades were positively affected by higher perceptions of teacher involvement, particularly for students who have failed a year. Math grades are impaired by previous retention, higher self-reported ICT use, and receiving an educational allowance, a proxy for lower socioeconomic status. We discussed these findings and proposed possible explanations for these differences in light of the current Portuguese high school context. Further research may help clarify if sociocultural attributes are indeed at stake or if there are consistent differences in parent and teacher roles in language and Math AA.

Author contribution statement

Catarina Nunes: Conceived and designed the experiments; Performed the experiments; Analyzed and interpreted the data; Wrote the paper.

Tiago Oliveira: Conceived and designed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

Mauro Castelli: Analyzed and interpreted the data.

Frederico Cruz-Jesus: Conceived and designed the experiments; Analyzed and interpreted the data.

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Data availability statement

Data will be made available on request.

Declaration of interest's statement

The authors declare no conflict of interest.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.heliyon.2023.e13335.

Appendix A. Questionnaire

Constructs	Code	Item	Reference
Previous retention (PRet)	PRet	Have you been previously retained? (*Y/N*)	
Previous achievement (PAch)		*Please indicate, on a scale of 0-20, what was your:*	Day et al. (2010)
	PAch1	Portuguese previous achievement (final grade of the previous school year)	
	PAch2	Math previous achievement (final grade of the previous school year)	

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Constructs		Code	Item	Reference
Previous retention (PRet)		PRet	Have you been previously retained? (*Y/N*)	
		PAch3	Grade point average of the previous school year	
ICT Use (second-order reflective-formative type)			*Frequency of use (1=never; 7=many times a day)*	Tang & Patrick (2018)
	ICT access (ICTA)	ICTA1	Internet access via a computer or tablet	
		ICTA2	Internet access via smartphone	
	ICT Use Academic (ICTAc)	ICTAc1	Online search for information related to schoolwork	
		ICTAc1	Use of ICT to communicate with teachers	
	ICT Use Hedonic (ICTHe)	ICTHe1	Use of social networks (including WhatsApp, Facebook Messenger, etc.)	
		ICTHe2	Use of ICT for fun (i.e., playing online, watching multimedia content such as movies or music, etc.)	
Age (Age)		Age	How old are you?	Chowa et al. (2015)
Teacher involvement (TInv) (second order reflective-reflective type)			*Scale from 1 (Strongly Disagree) to 7 (Strongly Agree)*	Johnson & Johnson (1983)
	Teacher pedagogical involvement (TPInv)	TPInv1	My teachers care much about how I learn	
		TPInv2	My teachers like to see me work	
		TPInv3	My teachers like to help me learn	
		TPInv4	My teachers want me to do my best in my schoolwork	
	Teacher social involvement (TSInv)	TSInv1	My teachers think it is important to be my friend	
		TSInv2	My teachers like me as much as he/she likes other students	
		TSInv3	My teachers care about my feelings	
		TSInv4	My teachers really care about me	
			Scale from 1 (Strongly Disagree) to 7 (Strongly Agree)	Veas et al. (2015)
Parental expectations (PExp)		Expe1	My parents think that I will complete compulsory education successfully.	
		Expe2	My parents believe I can continue to pursue post-compulsory education	
		Expe3	My parents think that I can perform work successfully.	
		Expe4	My parents think that I will pursue higher education (university).	
		Expe5	My parents discuss my post-compulsory education plans with me.	
Parental education (PEdu)		PEdu	What is the highest education level your legal guardian has completed?	Chesters & Daly (2016)
Educational allowance (EAlo)		EAlo	Do you benefit from an educational allowance? (Y/N)	
			Please indicate, on a scale of 0-20, what was your:	(Gonzalez-pienda et al., 2002)
AA Portuguese (AAPT)		AAchi1	Portuguese achievement in the current year (grade on a scale of 0–20)	
AA Math (AAMat)		AAchi2	Math achievement in the current year (grade on a scale of 0–20)	

Appendix B. Loadings and cross-loadings

	PRet	PAchi	ICTA	ICTAc	ICTHe	Age	TSInv	TPInv	PExp	PEdu	EAlo
PRet	**1.000**	−0.060	0.177	0.015	0.047	0.317	0.099	0.058	−0.222	−0.196	−0.220
PAch1	0.007	**0.788**	−0.068	0.021	−0.077	0.047	0.035	0.090	0.043	−0.022	0.209
PAch2	−0.063	**0.999**	−0.106	0.019	−0.100	−0.024	0.099	0.136	0.167	0.135	0.228
PAch3	0.000	**0.668**	−0.035	0.072	−0.045	0.023	0.061	0.096	0.078	−0.002	0.130
ICTA1	0.203	−0.124	**0.777**	0.332	0.328	0.065	−0.002	−0.062	−0.034	0.014	−0.150
ICTA2	0.087	−0.046	**0.826**	0.170	0.573	−0.044	−0.055	−0.049	0.028	−0.004	−0.062
ICTAc1	−0.058	0.021	0.277	**0.831**	0.167	0.024	0.128	0.197	0.263	−0.056	−0.039
ICTAc2	0.080	0.017	0.238	**0.846**	0.243	0.000	0.245	0.246	0.124	0.028	−0.036
ICTHe1	0.057	−0.058	0.556	0.252	**0.872**	−0.069	−0.033	−0.056	0.054	0.008	−0.106
ICTHe2	0.016	−0.113	0.356	0.137	**0.764**	0.007	−0.049	−0.098	0.016	0.124	−0.022
Age	0.317	−0.021	0.009	0.015	−0.044	**1.000**	−0.134	−0.188	−0.264	−0.158	0.037
TsIn1	0.091	0.089	−0.025	0.243	−0.015	−0.156	**0.870**	0.596	0.073	−0.016	−0.084
TsIn2	0.104	0.012	−0.027	0.193	−0.041	−0.074	**0.723**	0.371	0.171	0.056	−0.020
TsIn3	0.117	0.104	−0.044	0.141	−0.030	−0.117	**0.922**	0.551	0.085	0.040	−0.051
TsIn4	0.042	0.119	−0.032	0.201	−0.080	−0.109	**0.925**	0.648	0.144	0.058	0.021
TPIn1	0.022	0.085	−0.052	0.290	−0.146	−0.087	0.618	**0.813**	0.173	−0.009	0.053
TPIn2	0.059	0.181	−0.070	0.158	−0.060	−0.203	0.442	**0.847**	0.276	0.071	0.026
TPIn3	0.100	0.101	−0.025	0.248	−0.077	−0.153	0.630	**0.921**	0.257	0.000	0.024
TPIn4	0.011	0.109	−0.095	0.202	−0.019	−0.209	0.478	**0.847**	0.240	0.096	−0.025
Expe1	−0.233	0.164	0.025	0.105	0.076	−0.314	0.074	0.155	**0.875**	0.273	0.173
Expe2	−0.171	0.141	−0.029	0.217	0.051	−0.241	0.120	0.278	**0.929**	0.204	0.206

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	PRet	PAchi	ICTA	ICTAc	ICTHe	Age	TSInv	TPInv	PExp	PEdu	EAlo
Expe3	−0.130	0.128	−0.051	0.225	−0.036	−0.198	0.190	0.330	**0.870**	0.164	0.205
Expe4	−0.247	0.180	−0.001	0.269	0.044	−0.202	0.094	0.234	**0.889**	0.211	0.249
Expe5	−0.088	−0.019	0.110	0.222	0.093	−0.044	0.106	0.223	**0.637**	0.102	0.076
PEdu	−0.196	0.128	0.006	−0.015	0.071	−0.158	0.039	0.043	0.241	**1.000**	0.306
EAlo	−0.220	0.227	−0.129	−0.045	−0.085	0.037	−0.039	0.023	0.228	0.306	**1.000**

Note: The correlations of the formative items (ICT use) and control variables (Gender and LG Mother) have been omitted. PRet = previous retention; PAch = previous achievement; ICTA=ICT access; ICTAc = ICT academic use; ICTHe = ICT hedonic use; TSInv = teacher social involvement; TPInv = teacher pedagogical involvement; PExp = parental expectations; PEdu = parental education; EAlo = educational allowance; AAPT = academic achievement Portuguese; AAMat = academic achievement Math.

Appendix C. Heterotrait-Monotrait Ratio (HTMT)

	PRet	PAch	ICTA	ICTAc	ICTHe	Age	TSInv	TPInv	PExp	PEdu	EAlo	AA PT	AA MAT
PRet													
PAch	0.027												
ICTA	0.270	0.125											
ICTAc	0.109	0.058	0.616										
ICTHe	0.061	0.125	1.137	0.430									
Age	0.317	0.036	0.102	0.020	0.064								
TSInv	0.109	0.079	0.075	0.314	0.073	0.141							
TPInv	0.060	0.137	0.123	0.366	0.142	0.203	0.707						
PExp	0.216	0.118	0.123	0.341	0.111	0.248	0.160	0.325					
PEdu	0.196	0.062	0.017	0.066	0.112	0.158	0.053	0.055	0.237				
EAlo	0.220	0.221	0.197	0.059	0.108	0.037	0.054	0.040	0.226	0.306			
AA PT	0.268	0.187	0.129	0.051	0.078	0.132	0.085	0.069	0.368	0.349	0.230		
AA MAT	0.197	0.142	0.164	0.035	0.130	0.129	0.209	0.254	0.131	0.114	0.039	0.422	

Note: PRet = previous retention; PAch = previous achievement; ICTA=ICT access; ICTAc = ICT academic use; ICTHe = ICT hedonic use; TSInv = teacher social involvement; TPInv = teacher pedagogical involvement; PExp = parental expectations; PEdu = parental education; EAlo = educational allowance; AAPT = academic achievement Portuguese; AAMat = academic achievement Math.

References

[1] E.A. Hanushek, L. Woessmann, A quantitative look at the economic impact of the European Union's educational goals, Educ. Econ. 28 (3) (2020) 225–244, https://doi.org/10.1080/09645292.2020.1719980.

[2] E.A. Hanushek, L. Woessmann, The High Cost of Low Educational Performance, 2010.

[3] P.J. Robertson, Health inequality and careers, Br. J. Guid. Counsell. 42 (3) (2014) 338–351, https://doi.org/10.1080/03069885.2014.900660.

[4] C. Power, Power Edu. 27 (2015).

[5] A. Koch, J. Nafziger, H.S. Nielsen, Behavioral economics of education, J. Econ. Behav. Organ. (2015), https://doi.org/10.1016/j.jebo.2014.09.005.

[6] European Commission, EACEA, Eurydice, Structural Indicators on Early Leaving from Education and Training in Europe – 2016, Eur. Comm., 2016, pp. 5–25.

[7] J. Hughes, O.M. Kwok, Influence of student-teacher and parent-teacher relationships on lower achieving readers' engagement and achievement in the primary grades, J. Educ. Psychol. 99 (1) (2007) 39–51, https://doi.org/10.1037/0022-0663.99.1.39.

[8] N.S. Ansary, S.S. Luthar, Distress and academic achievement among adolescents of affluence: a study of externalizing and internalizing problem behaviors and school performance, Dev. Psychopathol. 21 (1) (2009) 319–341, https://doi.org/10.1017/S0954579409000182.

[9] S.A. Bishop, H.I. Okagbue, J.A. Odukoya, Statistical analysis of childhood and early adolescent externalizing behaviors in a middle low income country, Heliyon 6 (2020) 2, https://doi.org/10.1016/j.heliyon.2020.e03377.

[10] M. Te Wang, J.S. Eccles, Social support matters: longitudinal effects of social support on three dimensions of school engagement from middle to high school, Child Dev. 83 (3) (2012) 877–895, https://doi.org/10.1111/j.1467-8624.2012.01745.x.

[11] J. Marôco, Portugal: the PISA effects on education, in: N. Crato (Ed.), Improving a Country's Education: PISA 2018 Results in 10 Countries, Springer International Publishing, Cham, 2021, pp. 159–174.

[12] OECD, Country profile Portugal Education GPS, Educ. (2022). *GPS. Retrieved from*, http://gpseducation.oecd.org.

[13] H.C. Buescu, J. Morais, M.R. Rocha, V.F. Magalhães, Programa e Metas Curriculares de Português do Ensino Básico, Ministério da Educ. e da Ciência 101 (2014), 2015.

[14] S. Leshem, Z. Markovitz, Mathematics and English, two languages: teachers' views, J. Educ. Learn. 2 (1) (2013) 211–221, https://doi.org/10.5539/jel.v2n1p211.

[15] G.A.N. Chowa, R.D. Masa, Y. Ramos, D. Ansong, How do student and school characteristics influence youth academic achievement in Ghana? A hierarchical linear modeling of Ghana YouthSave baseline data, Int. J. Educ. Dev. (2015), https://doi.org/10.1016/j.ijedudev.2015.09.009.

[16] M.A. Gottfried, J.S. Plasman, Linking the timing of career and technical education coursetaking with high school dropout and college-going behavior, Am. Educ. Res. J. 55 (2) (2018) 325–361, https://doi.org/10.3102/0002831217734805.

[17] M. Koc, O. Zorbaz, S. Demirtas-Zorbaz, Has the ship sailed? The causes and consequences of school dropout from an ecological viewpoint, Soc. Psychol. Educ. 23 (5) (2020) 1149–1171, https://doi.org/10.1007/s11218-020-09568-w.

[18] R. Steinmayr, A.F. Weidinger, A. Wigfield, Does students' grit predict their school achievement above and beyond their personality, motivation, and engagement? Contemp. Educ. Psychol. 53 (2018) 106–122, https://doi.org/10.1016/j.cedpsych.2018.02.004.

[19] T.M. Ober, M.R. Coggins, D. Rebouças-Ju, H. Suzuki, Y. Cheng, Effect of teacher support on students' math attitudes: measurement invariance and moderation of students' background characteristics, Contemp. Educ. Psychol. 66 (2021), 101988, https://doi.org/10.1016/j.cedpsych.2021.101988.

[20] M. Castro, E. Expósito-casas, E. López-martín, L. Lizasoain, Parental involvement on student academic achievement, A meta-analysis 14 (2015) 33–46, https://doi.org/10.1016/j.edurev.2015.01.002.

[21] D.D.B. Situmorang, R.M.A. Salim, Perceived parenting styles, thinking styles, and gender on the career decision self-efficacy of adolescents: how & why? Heliyon 7 (3) (2021), e06430 https://doi.org/10.1016/j.heliyon.2021.e06430.

[22] I.J. Deary, S. Strand, P. Smith, C. Fernandes, Intelligence and educational achievement, Intelligence 35 (1) (2007) 13–21, https://doi.org/10.1016/j.intell.2006.02.001.

[23] G.E. Taub, R.G. Floyd, T.Z. Keith, K.S. McGrew, Effects of general and broad cognitive abilities on mathematics achievement, Sch. Psychol. Q. 23 (2) (2008) 187–198, https://doi.org/10.1037/1045-3830.23.2.187.

[24] F. Galindo-Rueda, A. Vignoles, The declining relative importance of ability in predicting educational attainment, J. Hum. Resour. 40 (2) (2005) 335–353, https://doi.org/10.3368/jhr.xl.2.335.

[25] C. Mateus, R. Campis, I. Aguaded, A. Parody, F. Ruiz, Analysis of personality traits and academic performance in higher education at a Colombian university, Heliyon 7 (5) (2021), e06998, https://doi.org/10.1016/j.heliyon.2021.e06998.

[26] X. Liu, X. Cao, W. Gao, Does low self-esteem predict anxiety among Chinese college students? Psychol. Res. Behav. Manag. 15 (2022) 1481–1487, https://doi.org/10.2147/PRBM.S361807.

[27] X. Liu, X. Gao, S. Ping, Post-1990s college students academic sustainability: the role of negative emotions, achievement goals, and self-efficacy on academic performance, Sustainability 11 (2019) 3, https://doi.org/10.3390/su11030775.

[28] T. Tikhomirova, A. Malykh, S. Malykh, Predicting academic achievement with cognitive abilities: cross-sectional study across school education, Behav. Sci. 10 (2020) 10, https://doi.org/10.3390/bs10100158.

[29] F. Cruz-Jesus, et al., Using Artificial Intelligence Methods to Assess Academic Achievement in Public High Schools of a European Union Country, Heliyon, 2020, https://doi.org/10.1016/j.heliyon.2020.e04081.

[30] H.P. Phan, Prior academic achievement, effort, and achievement goal orientations: a longitudinal examination, J. Educ. Dev. Psychol. 2 (2) (2012) 57–71, https://doi.org/10.5539/jedp.v2n2p57.

[31] A. Gareau, P. Gaudreau, L. Boileau, Past academic achievement contributes to university students' autonomous motivation (AM)which is later moderated by implicit motivation and working memory: a Bayesian replication of the explicit-implicit model of AM, Learn. Indiv Differ 73 (2019) 30–41, https://doi.org/10.1016/j.lindif.2019.05.004. August 2018.

[32] S.R. Jimerson, Meta-analysis of grade retention research: implications for practice in the 21st century, Sch. Psychol. Rev. 30 (3) (2001) 420–437, https://doi.org/10.1080/02796015.2001.12086124.

[33] L.C. Nunes, A. Balcão Reis, C. Seabra, Is retention beneficial to low-achieving students? Evidence from Portugal, Appl. Econ. 50 (40) (2018) 4306–4317, https://doi.org/10.1080/00036846.2018.1444261.

[34] B. Jacob, L. Legfren, The effect of grade retention on high school completion, Am. Econ. J. Appl. Econ. 1 (3) (2009) 33–58.

[35] A.J. Martin, Holding Back And Holding Behind : Grade Retention And Students ' Non-Academic And Academic Outcomes, 2011, pp. 739–763, https://doi.org/10.1080/01411926.2010.490874, 37, no. 5.

[36] B.G.E. Anderson, A.D. Whipple, S.R. Jimerson, Mental Health Outcomes, 2001, pp. 133–136.

[37] S.N. Georgiou, C. Christou, P. Stavrinides, G. Panaoura, Teacher attributions of student failure and teacher behavior toward the failing student, Psychol. Sch. 39 (5) (Sep. 2002) 583–595, https://doi.org/10.1002/pits.10049.

[38] A. Tolen, L. Quinlin, The Efficacy of Student Retention : A Review of Research & Literature, 2017.

[39] A. Portes, R.G. Rumbaut, Introduction: the second generation and the children of immigrants longitudinal study, Ethn. Racial Stud. 28 (6) (2005) 983–999, https://doi.org/10.1080/01419870500224109.

[40] F.K. Mensah, K.E. Kiernan, Gender differences in educational attainment: influences of the family environment, Br. Educ. Res. J. 36 (2) (2010) 239–260, https://doi.org/10.1080/01411920902802198.

[41] M. Brunner, S. Krauss, M. Kunter, Gender Differences in Mathematics: Does the Story Need to Be Rewritten? Intelligence, 2008 https://doi.org/10.1016/j.intell.2007.11.002.

[42] R. Kubey, Internet use and collegiate academic performance decrements: early findings, J. Commun. 51 (2) (2001) 366–382, https://doi.org/10.1093/joc/51.2.366.

[43] A. Toozandehjani, Z. Mahmoodi, M. Rahimzadeh, A. Jashni Motlagh, M. Akbari Kamrani, S. Esmaelzadeh Saeieh, The predictor role of Internet addiction in high- risk behaviors and general health status among Alborz students: a structural equation model, Heliyon 7 (2021) 5, https://doi.org/10.1016/j.heliyon.2021.e06987.

[44] A.J. Bowers, M. Berland, Does recreational computer use affect high school achievement? Educ. Technol. Res. Dev. 61 (1) (2013) 51–69, https://doi.org/10.1007/s11423-012-9274-1.

[45] S. Simões, T. Oliveira, C. Nunes, Influence of computers in students' academic achievement, Heliyon 8 (3) (2022), e09004, https://doi.org/10.1016/j.heliyon.2022.e09004.

[46] J.C. Torres-Díaz, J.M. Duart, H.F. Gómez-Alvarado, I. Marín-Gutiérrez, V. Segarra-Faggioni, Internet use and academic success in university students, Comunicar 24 (48) (2016) 61–70, https://doi.org/10.3916/C48-2016-06.

[47] K.N. Hampton, C.T. Robertson, L. Fernandez, I. Shin, J.M. Bauer, How variation in internet access, digital skills, and media use are related to rural student outcomes: GPA, SAT, and educational aspirations, Telematics Inf. 63 (2021), 101666, https://doi.org/10.1016/j.tele.2021.101666. June.

[48] H.M. Judi, N.S. Ashaari, N.A.M. Zin, Z.M. Yusof, Framework of ICT impact on adolescent, Procedia Technol 11 (2013) 1034–1040, https://doi.org/10.1016/j.protcy.2013.12.291.

[49] V. Venkatesh, M.G. Morris, G.B. Davis, F.D. Davis, User acceptance of information technology: toward a unified view, MIS Q. 27 (3) (2003) 425–478.

[50] J.E. Rockoff, The impact of individual teachers on student achievement : evidence from panel data source : , vol . 94 , No . 2 , papers and proceedings of the one hundred sixteenth annual meeting of the American economic association san diego , CA, Amer," *Am. Econ. Rev.* 94 (2) (2004) 247–252. Published by.

[51] S. Sousa, M. Portela, C. Sá, Teacher Characteristics and Student Progress, Sch. Econ. Manag. Univ. Minho, 2016, https://doi.org/10.1002/tea.3660060408.

[52] H. de Boer, A.C. Timmermans, M.P.C. van der Werf, The effects of teacher expectation interventions on teachers' expectations and student achievement: narrative review and meta-analysis, Educ. Res. Eval. 24 (3–5) (2018) 180–200, https://doi.org/10.1080/13803611.2018.1550834.

[53] L. Romano, G. Angelini, P. Consiglio, C. Fiorilli, Article academic resilience and engagement in high school students: the mediating role of perceived teacher emotional support, Eur. J. Investig. Heal. Psychol. Educ. 11 (2) (2021) 334–344, https://doi.org/10.3390/ejihpe11020025.

[54] L.P.W. Wong, M. Yuen, G. Chen, Career-related teacher support: a review of roles that teachers play in supporting students' career planning, J. Psychol. Couns. Sch. 31 (1) (2021) 130–141, https://doi.org/10.1017/jgc.2020.30.

[55] J.J.L. Chen, Relation of academic support from parents, teachers, and peers to Hong Kong adolescents' academic achievement: the mediating role of academic engagement, Genet. Soc. Gen. Psychol. Monogr. 131 (2) (2005) 77–127, https://doi.org/10.3200/MONO.131.2.77-127.

[56] S.R. Sirin, Socioeconomic status and academic achievement: a meta-analytic review of research, Rev. Educ. Res. 75 (3) (Sep. 2005) 417–453, https://doi.org/10.3102/00346543075003417.

[57] Fan, M. Chen, Parental involvement and studnet's academic achievement: a meta-analysis, Educ. Psychol. Rev. 13 (1) (2001) 1–22.

[58] N.E. Hill, L.C. Taylor, Parental school involvement and children's academic achievement pragmatics and issues, Curr. Dir. Psychol. Sci. 13 (4) (2004) 161–164.

[59] J.S. Lee, N.K. Bowen, Parent involvement, cultural capital, and the achievement gap among elementary school children, Am. Educ. Res. J. 43 (2) (2006) 193–218, https://doi.org/10.3102/00028312043002193.

[60] A.D. Benner, A.E. Boyle, S. Sadler, Parental involvement and adolescents' educational success: the roles of prior achievement and socioeconomic status, J. Youth Adolesc. 45 (6) (2016) 1053–1064.

[61] K. Poon, The impact of socioeconomic status on parental factors in promoting academic achievement in Chinese children, Int. J. Educ. Dev. 75 (2020), https://doi.org/10.1016/j.ijedudev.2020.102175.

[62] N. Ali, et al., School role in improving parenting skills and academic performance of secondary schools students in Pakistan, Heliyon 6 (2020) 11, https://doi.org/10.1016/j.heliyon.2020.e05443.

[63] R. Steinmayr, F.C. Dinger, B. Spinath, Parents' education and children's achievement: the role of personality, Eur. J. Pers. 24 (2010) 535–550. February 2010.
[64] E. Tomul, H.S. Savasci, Socioeconomic determinants of academic achievement, Educ. Assess. Eval. Account. 24 (3) (2012) 175–187.
[65] J. Chesters, A. Daly, Do Peer Effects Mediate the Association between Family Socio-Economic Status and Educational Achievement ?, 2017, pp. 63–77, https://doi.org/10.1002/ajs4.3. **May 2016**.
[66] C.Y. Tan, B. Peng, M. Lyu, What types of cultural capital benefit students' academic achievement at different educational stages? Interrogating the meta-analytic evidence, Educ. Res. Rev. 28 (May) (2019), 100289, https://doi.org/10.1016/j.edurev.2019.100289.
[67] S. Archibald, Narrowing in on educational resources that do affect student achievement, Peabody J. Educ. 81 (4) (2006) 23–42, https://doi.org/10.1207/s15327930pje8104_2.
[68] D. Delen, A comparative analysis of machine learning techniques for student retention management, Decis. Support Syst. 49 (4) (2010) 498–506, https://doi.org/10.1016/j.dss.2010.06.003.
[69] S. Tang, M.E. Patrick, Technology and interactive social media use among 8th and 10th graders in the U.S. and associations with homework and school grades, Comput. Hum. Behav. 86 (2018) 34–44, https://doi.org/10.1016/j.chb.2018.04.025.
[70] A. Veas, J.L. Castejón, R. Gilar, P. Miñano, Academic achievement in early adolescence: the influence of cognitive and non-cognitive variables, J. Gen. Psychol. (2015), https://doi.org/10.1080/00221309.2015.1092940.
[71] J. Henseler, C.M. Ringle, R.R. Sinkovics, The use of partial least squares path modeling in international marketing, Adv. Int. Market. 20 (2009) 277–319, https://doi.org/10.1108/S1474-7979(2009)0000020014, 2009.
[72] J.C. Anderson, D.W. Gerbing, Structural equation modeling in practice: a review and recommended two-step approach, Psychol. Bull. 103 (3) (1988) 411–423, https://doi.org/10.1037/0033-2909.103.3.411.
[73] C.M. Ringle, S. Wende, J.-M. Becker, 'SmartPLS 3.' Boenningstedt, SmartPLS GmbH, 2015, 2015.
[74] C.N. McIntosh, J.R. Edwards, J. Antonakis, Reflections on partial least squares path modeling, Organ. Res. Methods 17 (2) (2014) 210–251, https://doi.org/10.1177/1094428114529165.
[75] M. Sarstedt, C.M. Ringle, J.F. Hair, Handbook of Market Research, September, 2017.
[76] C. Fornell, D. Larcker, Structural equation models with unobservable variables and measurement error, J. Mar. Res. 18 (1) (1981) 39–50.
[77] J.F. Hair, C.M. Ringle, M. Sarstedt, J.F. Hair, C.M. Ringle, M. Sarstedt, PLS-SEM : Indeed a Silver Bullet, 2014, pp. 37–41, https://doi.org/10.2753/MTP1069-6679190202.
[78] V. Vizek Vidović, Self-referenced cognitions and mathematics grades in secondary school, Stud. Psychol. 41 (2) (1999) 133–142.
[79] R. Zhao, Y.-L. Kuo, The role of self-discipline in predicting achievement for 10th graders, Int. J. Intell. Technol. Appl. Stat. 8 (1) (2015) 61–70, https://doi.org/10.6148/IJITAS.2015.0801.05.
[80] Y.K. Türel, M. Toraman, The relationship between internet addiction and academic success of secondary school students, Anthropol. 20 (1–2) (2015) 280–288.
[81] D. Rozgonjuk, K. Täht, K. Vassil, Internet use at and outside of school in relation to low- and high-stakes mathematics test scores across 3 years, Int. J. STEM Educ. 8 (1) (2021), https://doi.org/10.1186/s40594-021-00287-y.
[82] T.Z. Keith, P.B. Keith, K.J. Quirk, J. Sperduto, S. Santillo, S. Killings, Longitudinal effects of parent involvement on high school grades: similarities and differences across gender and ethnic groups, J. Sch. Psychol. 36 (3) (1998) 335–363, https://doi.org/10.1016/S0022-4405(98)00008-9.
[83] I. Altschul, Linking Socioeconomic Status to the Academic Achievement of Mexican American Youth Through Parent Involvement in Education, 2012, pp. 13–30, https://doi.org/10.5243/jsswr.2012.2, vol. 3, no. 1.
[84] A.D. Benner, C.C. Fernandez, Y. Hou, C.S. Gonzalez, Parent and teacher educational expectations and adolescents' academic performance: mechanisms of influence, J. Community Psychol. 49 (7) (2021) 2679–2703, https://doi.org/10.1002/jcop.22644.
[85] P. Bourdieu, J.-C. Passeron, Reproduction in Education, Society and Culture, vol. 4, Sage, 1990.
[86] J.P. Ponte, Literacia Matemática, 2003 no. January 2003.
[87] A. Gregory, R.S. Weinstein, Connection and regulation at home and in school: predicting growth in achievement for adolescents, J. Adolesc. Res. 19 (4) (2004) 405–427, https://doi.org/10.1177/0743558403258859.
[88] J.M. Cerdeira, L.C. Nunes, A.B. Reis, C. Seabra, Predictors of student success in Higher Education: secondary school internal scores versus national exams, High Educ. Q. 72 (4) (2018) 304–313, https://doi.org/10.1111/hequ.12158.
[89] S.C. Joshi, G. Rose, Information technology, internet use, and adolescent cognitive development, Proc. 2018 3rd Int. Conf. Comput. Syst. Inf. Technol. Sustain. Solut. CSITSS (May) (2018) 22–28, https://doi.org/10.1109/CSITSS.2018.8768780, 2018.
[90] M. Goos, B. Belfi, Effectiveness of Grade Retention in Primary and Secondary Education : A Systematic Review, January, 2013.
[91] G. Schwerdt, M.R. West, M.A. Winters, The effects of test-based retention on student outcomes over time : regression discontinuity evidence from Florida ☙, J. Publ. Econ. 152 (2017) 154–169, https://doi.org/10.1016/j.jpubeco.2017.06.004.
[92] N.M. Stephens, M.Y.G. Hamedani, M. Destin, Closing the social-class achievement gap: a difference-education intervention improves first-generation students' academic performance and all students' college transition, Psychol. Sci. 25 (4) (2014) 943–953, https://doi.org/10.1177/0956797613518349.
[93] L. Aceves, M.Y. Bámaca-Colbert, R.W. Robins, Longitudinal linkages among parents' educational expectations, youth's educational expectations, and competence in Mexican-origin families, J. Youth Adolesc. 49 (1) (2020) 32–48, https://doi.org/10.1007/s10964-019-01161-5.
[94] W.H. Jeynes, A meta-analysis: the effects of parental involvement on minority children's academic achievement, Educ. Urban Soc. 35 (2) (2003) 202–218, https://doi.org/10.1177/0013124502239392.
[95] N. Crato, Curriculum and educational reforms in Portugal: an analysis on why and how students' knowledge and skills improved, in: Audacious Education Purposes: How Governments Transform the Goals of Education Systems, 2020, pp. 209–232.
[96] S. Zhao, L. Chen, R.B. King, Y. Nie, H. Du, P. Chi, When adolescents believe that SES can be changed, they achieve more: the role of growth mindset of SES, Pers. Indiv. Differ. 183 (2021), 111104, https://doi.org/10.1016/j.paid.2021.111104. October 2020.
[97] Á. Choi, M. Gil, M. Mediavilla, J. Valbuena, Predictors and effects of grade repetition, Rev. Econ. Mund. 48 (2018) 21–42, 2018.
[98] Eurydice, Grade Retention during Compulsory Education in Europe: Regulations and Statistics, European Education and Culture Executive Agency, Brussels, 2011.