Shifting Attitudes Toward Science and Identities During the Middle School Transition

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Abstract

The decline in science interest during adolescence is a well-documented phenomenon; however, its dynamics within Latin American educational systems remain underexplored. This cross-sectional study investigates the trajectory of Attitudes Toward Science and Science Identity among 1,147 students in grades 4-8 from public and private schools. Using validated instruments, we employed linear regression models to analyze trends and Cohen's d to pinpoint critical transition points, with analyses stratified by gender and school type. Results revealed a non-linear trajectory, characterized by a significant decline in most attitude and identity constructs during the transition to secondary school (6th-7th grade), followed by a rebound in the 8th-grade cohort. This decline was more pronounced among girls, particularly in self-efficacy and Science Identity. While both school types showed a similar decrease in Science Identity, private schools exhibited a protective effect on students' self-efficacy and perceived utility of science. Findings indicate that the attitudinal decline is not linear but concentrated in key transitions and is significantly moderated by gender and school context.

Keywords: Attitudes Toward Science, Science Identity, School Transition

Introduction

Adolescents' declining interest and attitude in science is a documented social and scientific problem (Krapp & Prenzel, 2011). In primary education, students typically show interest in school science, viewing it as accessible, relevant, and applicable to their environment (Turner & Ireson, 2010). This interest tends to decrease during adolescence, when students begin to associate science with increased perceived difficulty, less enjoyment, and vital irrelevance (Barmby et al., 2008). This global, decades-long pattern has prompted interventions in Global North countries like the United States (Sorge, 2007; Mattern & Schau, 2002), the United Kingdom (Murphy & Beggs, 2003), and Canada (Potvin & Hasni, 2014), where scientific development is considered a strategic economic pillar (McQuillan et al., 2023). The impact of this decline includes a decrease in the number of STEM professionals (George, 2006), limited advancements in technology, medicine, and pharmacology (Gottfried & Oliver, 2009), and adverse effects on socioeconomic development and the quality of life for the population (Lehmann-Hasemeyer et. al., 2023)

Attitudes toward science are a central construct in science education research, defined generally as learned predispositions to respond favorably or unfavorably to scientific objects or situations. This construct is typically conceptualized as multidimensional, comprising affective (e.g., interest, enjoyment), cognitive (e.g., beliefs about the relevance of science), and behavioral (e.g., participation intentions) components (Osborne et. al., 2003). However, defining and assessing attitudes operationally is challenging, mainly due to difficulties in distinguishing their components from related constructs, such as interests or specific scientific beliefs (Schibeci, 1984; Blalock et al., 2008). Additionally, it is necessary to differentiate the general “Attitude Toward Science”, understood as a social enterprise and a domain of knowledge, from the “Attitude Towards School Science” which is focused on the subject matter, the learning experiences, and the teacher’s approach (Osborne et al., 2003; Tytler & Osborne, 2012). Therefore, a student might value the social dimension of science but exhibit unfavorable dispositions towards classroom science due to pedagogical or curricular factors. Educational experiences, family environment, and media representations shape both attitudinal dimensions, which in turn affect student engagement, academic paths, and future civic participation in socio-scientific issues (Kind et. al., 2007).

Science Identity, an increasingly relevant construct in the learning trajectories of young people, entails methodological and analytical complexities. It is defined as an individual's self-perception concerning science, encompassing components such as personal interest, perceived self-efficacy in scientific activities (Vincent-Ruz & Schunn, 2018), perceiving oneself as science-capable (Brickhouse et al., 2000) or as a scientist (Tan et al., 2013; Trujillo & Tanner, 2014), and recognition by others (Carlone & Johnson, 2007; Hughes et. al., 2020; Vincent-Ruz & Schunn, 2018). This construct develops progressively through an individual's lived experiences and daily practices (Aschbacher et al., 2010; Calabrese Barton et al., 2013), involving a continuous interplay of internal factors (e.g., intrinsic interest, scientific self-efficacy) and external factors, such as support and recognition from significant figures, including teachers, mentors, family, and peers. Science Identity is also shaped by structural factors, including gender stereotypes, disparities in educational access, and prevailing cultural narratives about who is perceived to belong in science and who can succeed in it (Brickhouse et al., 2000). Science Identity is considered a key factor for persistence and retention in scientific careers (Chemers et al., 2011; Tai et al., 2006).

Although Attitude Toward Science and Science Identity are distinct constructs, studying them together is fundamental to understanding how young people's engagement with science is shaped (Vincent-Ruz & Schunn, 2018; Hallajow, 2018). A bidirectional relationship has been proposed: a sustained positive attitude can strengthen science identity, which, in turn, can foster and maintain favorable attitudes. Among the factors that modulate this dynamic, school transitions (e.g., from primary to secondary school) are a critical period, as they are associated with attitudinal changes that impact student adaptation and interest in science (Crockett et al., 1989; Carolan, 2013; Lofgran et al., 2015). The impact of these transitions is mediated by variables such as available social support, pedagogical practices, and the student's characteristics (Sundqvist et al., 2024; Logan & Skamp, 2013; Benner et al., 2017).

The transition to secondary education presents well-documented challenges in the curriculum. It often involves emphasis on symbolic representations, abstract theoretical models, and increased demands for mathematical reasoning, particularly in physics and chemistry, which can create cognitive difficulties and negatively affect students' science self-efficacy (Shayer & Adey, 1981; Potvin & Hasni, 2014). Additionally, secondary school pedagogy tends to prioritize information transmission over knowledge construction approaches, such as Inquiry-Based Science Education (IBSE), despite the documented positive effects of the latter on interest and conceptual understanding (Furtak et al., 2012). From the perspective of Expectancy-Value Theory (Wigfield & Eccles, 2000), the attitudinal decline is explained by a reduction in the value students attribute to science, especially when the content is perceived as disconnected from their lives or plans (Lyons & Quinn, 2010; Gaspard et al., 2015).

Diverse contextual and social factors also modulate attitudes and identity. At the classroom level, teacher training—including pedagogical content knowledge and teachers' attitudes—is a crucial factor in students' learning experiences (Kind, 2014; Van Aalderen-Smeets et al., 2012). Externally, family “science capital” (Archer et al., 2015), exposure to gender stereotypes, and cultural narratives about who is perceived to belong in science shape the development of this identity (Brickhouse et al., 2000). These stereotypes can trigger the phenomenon of stereotype threat, with negative consequences for performance and engagement, mainly affecting students from historically underrepresented groups in scientific fields (Carlone & Johnson, 2007; Hazari et al., 2010).

Despite their relevance, knowledge about science attitudes and identity exhibits significant gaps, particularly in Latin America, where research is scarce (Montes et al., 2018). This scarcity is especially pronounced at the pre-university level, a critical stage for career decisions, as most international research has focused on primary or early secondary education. The few studies in the region, such as those reviewed by Pelcastre et al. (2015), present a fragmented picture, with inconsistent findings regarding gender differences and the overall attitudinal profile of students. This variability suggests that context-specific factors are crucial; however, the challenge is compounded using instruments that often lack psychometric and cultural validation for these populations, thereby restricting their utility for cross-cultural comparison (Van de Vijver & Hambleton, 1996)

Furthermore, the influence of the region's educational system structure—a key contextual factor—on these constructs remains largely unknown. In many Latin American countries, school segmentation (between public and private schools) reflects and perpetuates social inequities, creating highly asymmetric science learning environments. In the public sector, conditions such as high student-teacher ratios and limited resources hinder active pedagogies like inquiry-based learning, which can foster an abstract perception of science and impede identification with it (Furtak et al., 2012; Lyons & Quinn, 2010). In contrast, private institutions often provide an environment with greater resources and family science capital (Archer et al., 2015), facilitating the development of interest and self-efficacy. This set of structural disparities and its effects on Attitudes Toward Science and Science Identity remain insufficiently explored within the region.

To address this knowledge gap, this study examines Attitudes Toward Science and Identity among students in public and private schools in Mexico, across various primary and secondary grades. Specifically, this study seeks to answer the following research questions:

How do students' Attitude Toward Science and Science Identity evolve as they advance through school grades?

Does gender moderate the developmental trajectory of Attitude Toward Science and Science Identity?

Are there differences in Attitude toward Science and Science Identity between students from public and private schools, after controlling grade level?

What are the inflection points or critical transitions in the educational trajectory where Attitude Toward Science and Science Identity show the greatest variations?

Methodology

Data Collection

The sample consisted of 1,147 students from grades 4 to 8, representing the upper levels of primary education and the lower secondary level. This selection was intended to capture the scientific attitudinal profile of students transitioning from childhood to early adolescence. Participants were distributed across 33 schools (19 public and 14 private) located in both urban and rural areas. Schools were randomly selected to increase representativeness and reduce potential selection bias, resulting in a heterogeneous sample across school type and sociodemographic context.

Data collection was conducted in person through paper-based surveys consisting of 14 questions with 5 Likert scale responses. Questionnaires were printed and distributed to each student during visits to the participating schools. As an initial step, a pilot test was conducted using the Think Aloud protocol with a group of 25 students, who completed the questionnaire individually. Informed consent was obtained from parents, and assent was obtained from the students prior to participation. The wording of items with possible double negatives was clarified to avoid confusion.

Attitude Toward Science Instrument

Science education research in Mexico is characterized by a scarcity of psychometrically robust instruments validated for local populations.To address this gap, this study adapted the Spanish-School Science Attitude Survey (S-SSAS; Toma & Villagrán, 2019). The S-SSAS was selected because it is a validated Spanish adaptation of the original SSAS (Kennedy et al., 2016), has been previously tested in a Latin American context (Chile), and evaluates key dimensions, including Enjoyability, difficulty, self-efficacy, usability, and relevance.

The S-SSAS was further adapted for the present study by removing the "Intention" subscale, which was contextually irrelevant to the Mexican compulsory education system. As a result of this structural modification, a new psychometric validation was required. A Confirmatory Factor Analysis (CFA) was performed using the entire sample, following the recommendation that, in applied research, factor analysis is most informative when conducted on the full dataset (Streiner, 2003). The model evaluation yielded good fit indices (CFI = .956, TLI = .951, RMSEA = .050), consistent with established benchmarks (Hu & Bentler, 1999), thereby providing evidence for the instrument's structural validity. Finally, the internal consistency for the resulting five-construct scale was high (Cronbach's $\alpha = .833$).

Science Identity instrument

Science Identity was evaluated using an instrument based on the work of Vincent-Ruz and Schunn (2008). This scale quantifies the construct through items related to an individual's self-recognition as a "science person" and their perception of external recognition from others. The development of this instrument is situated within a body of research on science identity that includes detailed theoretical frameworks on its formation and loss in high school students (e.g., Aschbacher et al., 2010; Shanahan, 2009). For this study, the Vincent-Ruz and Schunn scale was selected due to its focus on these core, quantifiable components of identity. The adaptation process included a back-translation to Spanish and two modifications: (1) the response format was changed to a five-point scale with a neutral midpoint, and (2) one item was added ("My parents would like me to choose a scientific career"). The psychometric properties of the adapted instrument were then evaluated. Internal consistency was high

(Cronbach's α = .892). Confirmatory Factor Analysis (CFA), conducted on the full sample, demonstrated satisfactory model fit indices (CFI = .980, TLI = .949, RMSEA = .048).

Analysis

The data were analyzed using a two-stage quantitative approach in R (v. 4.4.2). In the first stage, to address the research questions regarding overall trends and the influence of gender and school type, we employed linear regression models. This approach, consistent with foundational studies in the field (e.g., Potvin & Hasni, 2014), is appropriate for modeling the linear relationship between a continuous outcome variable and a predictor variable. In each model, the scores of the attitude and identity constructs served as the dependent variables, while school grade was entered as the independent (predictor) variable. The regression slope (b) was interpreted as the average rate of change in attitude or identity per grade level. Separate models were run for three groupings: (1) the overall sample, (2) stratified by gender (girls and boys), and (3) stratified by school type (public and private), to test for differential trends in these subpopulations.

In the second stage, to complement the trend analysis and pinpoint the moments of substantial change, we calculated Cohen's d effect sizes. While linear regression provides an overall trend, it can mask abrupt shifts that occur at specific points of transition. By comparing the mean scores between consecutive grade pairs (e.g., fourth vs. fifth, sixth vs. seventh), Cohen's d allowed us to quantify the magnitude of change at each educational stage. Effect sizes were interpreted according to established conventions (Cohen, 1988). The statistical significance of the mean differences for each pair was confirmed using independent samples t-tests.

Results

The results of the linear regression analysis are presented below to address the four research questions. The overall trend of the sample is examined first, followed by the analysis by gender, and finally by school type. The section concludes with an analysis of the effect size of the transition between school grades.

The linear regression analysis for the overall sample revealed a statistically significant downward trend in most attitude constructs (self-efficacy, relevance, usability) as well as Science Identity, as school grade increased (Table 2). In contrast, the perception of difficulty showed a significant increase, while Enjoyability did not exhibit a statistically significant trend.

The analysis by gender revealed a significant interaction between gender and school grade, particularly for the Enjoyability and self-efficacy constructs (Table 2). For girls, both constructs showed a statistically significant decline across school grades. In contrast, for boys, these trends were not significant. Additionally, although both genders showed a significant increase in perceived difficulty and a decline in usability and Science Identity, the magnitude of these changes, as indicated by the greater absolute value of the slope, was considerably steeper for girls.

The analysis stratified by school type (Table 3) revealed divergent attitudinal trajectories. In public schools, but not in private, statistically significant declines were observed in self-efficacy (slope = -10, $p = .01$), relevance (slope = -0.08, $p < .001$), and usability (slope = -

0.12, $p < .001$). The Science Identity construct, however, declined significantly in both types of schools. This decline was more pronounced in public schools (Slope = -0.15, $p < .001$) compared to private schools (Slope = -0.12, $p = .014$).

To pinpoint when the most substantial changes occur along the school trajectory, the regression analysis was supplemented by calculating effect sizes (Cohen's d). This method quantifies the magnitude and direction of change at specific transitions by comparing the mean scores for each construct between consecutive grade pairs. The results are presented in Table 4.

The effect size analysis revealed that the most pronounced changes were concentrated during the transition from primary to secondary education. Specifically, a moderate but consistent decline was observed during the transition from sixth to seventh grade for Enjoyability ($d = 0.29$), relevance ($d = 0.27$), usability ($d = 0.44$), and Science Identity ($d = 0.31$). Notably, this trend reversed in the subsequent year. During the transition from seventh to eighth grade, a positive rebound occurred, with mean scores increasing for Enjoyability ($d = -0.27$), self-efficacy ($d = -0.34$), and Science Identity ($d = -0.27$).

Discussion

The results of this study contribute to the literature by revealing a non-linear pattern of association with school grades, rather than a simple, continuous decline. Specifically, our cross-sectional data indicate a decrease in Attitudes Toward Science and Science Identity scores coinciding with the transition to secondary education, followed by an apparent rebound in the eighth-grade cohort. The following discussion explores plausible interpretations for this pattern, examining how these differences are moderated by gender and school type.

Our analysis reveals a differentiated effect on the constructs assessed. Science Identity declines at an earlier stage (grades 4-5), while Attitude Toward Science constructs do not decline until the transition to secondary school (grades 6-7). These results are consistent with research that suggests disconnection from science occurs before the formal transition from elementary to secondary education (Murphy & Beggs, 2003; Pell & Jarvis, 2001). This early decline in identity is explained by its relationship to self-concept, which becomes vulnerable in late elementary school when social comparison begins to shape beliefs about one's abilities (Shavelson et al., 1976; Eccles & Wigfield, 2002). In contrast, constructs such as perceived Usability of science, supported by social and familial discourses, may remain stable for longer as they are less dependent on personal performance in the classroom.

The development of self-concept does not occur in isolation, but interacts with family science capital (Archer et al., 2015). The literature establishes that identity is not only built on academic competence, but on a sense of belonging and recognition (Carlone & Johnson, 2007; Gee, 2000). Low scientific capital can generate a “cultural distance” that presents science as an alien field (Archer et al., 2015; Bourdieu, 1986). It is this distance that can transform a challenge of academic competence into a problem of identity, as the difficulty is interpreted as a sign of not belonging (Aschbacher et al., 2010). This mechanism would explain the more pronounced decline of identity in the public system (Table 3), where family science capital is, on average, lower. Therefore, the lack of symbolic resources at home may amplify the vulnerability of identity to academic difficulties (Hill et al., 2018).

Furthermore, our findings confirm that school transitions are critical periods for attitudinal shifts, affecting post-transition adaptation and interest in science (Potvin & Hasni, 2014). A study by Fontaine et al. (2017) suggests that this transition may be the first significant challenge many young people face, testing their resilience. During this stage, young people construct identities based on their attitudes towards themselves, the social roles they play, the groups they belong to, and how they believe they are perceived by “generalized others”. The social norms of secondary school have a direct influence on this identity negotiation, particularly in STEM fields (Paul et al., 2020). For girls, for instance, social pressures can create a conflict where prioritizing a "feminine" identity may come into tension with a "scientist" or "engineer" identity.

The attitudinal recovery observed in eighth grade is a counterintuitive finding, as it suggests a non-linear pattern of decline and recovery, contrasting with the literature, which often documents continuous declines during school transitions (Lofgran et al., 2015). Remarkably, this non-linear pattern is not unique to the Mexican context; a similar rebound was documented in Quebec, Canada, by Potvin & Hasni (2014) following the difficult elementary-to-secondary transition. However, this recovery must be interpreted with caution, as our study only tracked students up to eighth grade, and it remains unknown if this trend continues or reverses in subsequent years. The explanations for this observed rebound diverge, highlighting a key difference between educational systems. The Canadian study attributed the recovery to specific, external curricular and pedagogical shifts. This explanation is difficult to transfer given the structural differences between Anglo-Saxon and Latin American educational systems.

In contrast, our findings suggest a more transferable, internal mechanism, a process of student adaptation to the school system rather than a re-engagement with the scientific content of the curriculum. This recovery is selective, focusing on self-concept-related constructs (self-efficacy, Identity) but not on those measuring the perceived value of content (relevance, usability). Two complementary factors can explain this adaptation. On one hand, the improvement in self-efficacy can be attributed to mastery experiences (Britner & Pajares, 2006). By overcoming the evaluative challenges of their first year in secondary school, students demonstrate competence in navigating the new academic environment, thereby strengthening their confidence regardless of whether the content is perceived as relevant. This is consistent with the distinction made by George (2006) between attitudes toward "school science" and the "utility of science," indicating that student adaptation occurs without the school necessarily improving how it presents the value of the discipline. On the other hand, the stabilization of the social environment also likely contributes to this. By eighth grade, students have formed new peer support networks and adapted to teacher dynamics, which facilitates coping with academic tasks and reinforces motivation (Wentzel, 1998).

The cross-sectional design of this study necessitates that the results be interpreted with caution. It cannot be determined whether the observed "rebound" is a sustained recovery or a cohort-specific fluctuation. Divergence from findings such as those of Lofgran et al. (2015) also highlights the need to investigate the role of specific educational contexts. Therefore, longitudinal research in the region is necessary to track these trajectories and examine the interaction between student adaptation and the structural characteristics of school systems.

Our results underscore the non-gender-neutral trajectory of decline in science, with both sexes experiencing an increase in perceived Difficulty and a decrease in usability and

Identity. However, the magnitude of this decline is more pronounced for girls, revealing a gender gap in self-identification as "science people". This finding aligns with international literature regarding girls' vulnerability in constructs such as self-efficacy and interest (Hill et al., 2018; McQuillan et al., 2023). The absence of gender differences in self-efficacy in other studies (Toma & Villagrán, 2019) suggests that these differences may become more evident as students advance into pre-adolescence or adolescence.

The phenomenon of stereotype threat (Steele & Aronson, 1995; Shapiro & Williams, 2012) explains the more pronounced decline in attitudinal outcomes observed in girls. During the high-demand transition to secondary school, latent stereotypes associating science with masculinity may be activated, a perception that has been shown to persist from childhood in the region (Bardullas & Leyva-Figueroa, 2024). Under this threat, performance can be affected, and both self-efficacy and identification with the field can weaken (Paul et al., 2020). This effect is, in turn, reinforced by the implicit biases of parents, teachers, and peers (Hill et al., 2018).

Similar patterns in attitudes observed between public and private schools challenge the notion of intrinsic superiority in the private education sector. This result aligns with research conducted in Latin America, which indicates that students' socioeconomic backgrounds primarily influence cognitive achievement gaps between these two systems. When accounting for this factor, these gaps often diminish or disappear (Cervini, 2003). Likewise, our results show that key constructs such as Science Identity, Enjoyability, and perceived difficulty follow indistinguishable trajectories between the two school types. Our findings on the convergence in students' science identity are consistent with previous regional research pointing in a similar direction. For instance, when analyzing the appeal of scientific careers, Polino (2012) found no significant differences between the responses of students from public and private schools, suggesting that school type is not a determining variable in this vocational aspect. Likewise, the lack of difference in Enjoyability and difficulty is consistent with the conclusion that the public-private distinction accounts for a minimal portion of the variance in attitudes toward school subjects after adjusting for contextual factors (Cervini, 2003).

Taken together, the observed decline in both school systems suggests that, despite differences in resources, they may share a similar pedagogical culture that is ineffective in promoting positive Attitudes Toward Science and Science Identity. This common educational approach emphasizes the transmission of "science as a body of knowledge" instead of engaging students in scientific inquiry (Furtak et al., 2012). As a result, it presents a limited view of science by not addressing the creativity, argumentation, and uncertainty that characterize real scientific work (Chinn & Malhotra, 2002). This disconnect could contribute to the decline in students' scientific identity, as a lack of opportunities to "act like a scientist" limits their ability to envision themselves in that role (Carlone & Johnson, 2007).

Study Limitations

The findings of this study should be considered considering several methodological limitations. First, the cross-sectional design, while effective for identifying patterns and differences between grade levels, does not allow for the tracking of individual developmental trajectories over time. Consequently, the "rebound" observed between the 7th and 8th-grade cohorts must be interpreted with caution. While we have proposed plausible mechanisms of adaptation, we cannot definitively disentangle this from a potential cohort or survivor bias.

Confirming whether this pattern represents an actual individual recovery process requires longitudinal research that follows the same students over time.

Second, although the sampling strategy was designed to ensure a diverse sample, the voluntary participation of schools may introduce a potential selection bias. Schools with a particular interest in science education or with more administrative resources might have been more inclined to participate, and their characteristics may not be fully representative of all schools in the region.

Third, this study utilized school type (public/private) as a proxy for socioeconomic status and science capital. While this is a common and helpful approach in large-scale educational research, particularly in Latin American contexts where these factors are highly correlated (Cervini, 2003), it is an indirect measure. This approach does not capture the considerable socioeconomic heterogeneity that exists within each school system. Future studies would benefit from incorporating more direct measures of family socioeconomic status and science capital to provide a more fine-grained analysis of their influence (Archer et al., 2015).

Finally, all attitude and identity constructs were measured using self-report instruments. In the instrument used for this study, we adapted the original wording of the items to refer specifically to *natural sciences* rather than *science* in general. While these scales demonstrated strong psychometric properties, self-report measures are susceptible to social desirability biases (Paulhus, 1991). Future research could complement these findings with alternative assessment methods, such as observational data of classroom engagement or performance-based tasks, to provide a more triangulated understanding of student engagement with science.

Conclusion

The decline in young people's engagement with science is not a linear process, but a complex one, concentrated at key transitions and differentiated by gender and school context. Our central finding is a decoupling between Science Identity and Attitudes Toward Science is a fragile construct that begins to decline in primary school, well before attitudes falter during the transition to secondary school. This suggests that many students, particularly girls and those in the public system, may arrive at secondary school science with an already compromised sense of belonging.

This decoupling calls for a differentiated intervention strategy. Efforts to protect identity must begin earlier, in upper primary school, to foster competence and a sense of belonging before the pressures of a formalized curriculum and social comparison take hold. Furthermore, the fact that a shared, transmissive pedagogy appears to undermine identity in both school systems reveals a key insight: fostering identity is a different challenge than improving attitudes. The former requires a fundamental shift toward inquiry-based pedagogies that allow students to "do" science.

Finally, the attitudinal "rebound" observed in eighth grade, whether a result of adaptation or a selection effect, highlights the limitations of cross-sectional data. Confirming these trajectories and identifying the mechanisms of resilience requires longitudinal tracking of student cohorts. Understanding not only what drives disconnection but also how and why some students "reconnect" is essential for designing educational systems that foster equitable and lasting scientific engagement.

Disclosure statement

The authors report there are no competing interests to declare

Ethics statement

We obtained all data used in this study with informed consent. Study was under the Ethical Code of the Institution and approved by the Research Ethics and Evaluation Committee with registration number CEEIP/23-09-01

Funding

This research received no specific grant from any funding agency, public or private.

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Table 1. Results of the linear regression using school grades as a predictor of Attitude and Identity Toward Science in the overall sample

Attitude constructs	N	Intercept	Slope	p
Enjoyableness	1141	4.36	-0.04	0.06
Difficulty	1138	1.61	0.20	**<0.001**
Self-efficacy	1137	3.75	-0.07	**<0.01**
Relevance	1143	4.65	-0.09	**<0.001**
Usability	1147	4.84	-0.12	**<0.001**
Identity construct				
Identity	1128	3.78	-0.14	**< 0.001**

Table 2. Results of the linear regression using school grade as a predictor of Attitude and Identity Toward Science in the sample divided by gender

Attitude constructs	Gender	N	Intercept	Slope	p
Enjoyableness	Girls	564	4.53	-0.06	**0.04**
	Boys	566	4.16	-0.18	0.58
Difficulty	Girls	559	1.20	0.28	**<0.001**
	Boys	567	2.03	0.12	**<0.01**
Self-efficacy	Girls	558	3.99	-0.10	**0.01**
	Boys	567	3.56	-0.04	0.206
Relevance	Girls	562	4.88	-0.12	**<0.001**
	Boys	569	4.46	-0.06	**0.013**
Usability	Girls	564	4.14	-0.16	**<0.001**
	Boys	571	4.59	-0.07	**0.009**
Identity construct					
Identity	Girls	555	3.90	-0.17	**<0.001**
	Boys	562	3.68	-0.11	**<0.001**

Table 3. Results of the linear regression using school grades as a predictor of Attitude and Identity Toward Science in the sample divided by type of school

Attitude constructs	**Type of school**	**N**	**Intercept**	**Slope**	**p**
Enjoyableness	Public	941	4.36	-0.03	0.14
	Private	197	4.18	-0.03	0.49
Difficulty	Public	937	1.70	0.17	**<0.001**
	Private	197	1.60	0.26	**<0.001**
Self-efficacy	Public	938	3.90	-0.10	**0.01**
	Private	195	3.18	0.03	0.58
Relevance	Public	942	4.68	-0.08	**<0.001**
	Private	197	4.31	-0.06	0.14
Usability	Public	943	4.90	-0.12	**<0.001**
	Private	197	4.26	-0.06	0.17
Identity construct					
Identity	Public	923	3.81	-0.15	**<0.001**
	Private	181	3.63	-0.12	**0.014**

Table 4. Effect size of the transition between school grades for each construct of Attitudes Toward Science and Science Identity

Grade	**4th**	**5th**	**6th**	**7th**	**8th**
N	283	210	327	209	113

Transition	**4 - 5**	**5 - 6**	**6 - 7**	**7 - 8**
Enjoyability	- 0.5	0.6	**-0.29*****	**0.27****
Difficulty	**0.22***	0.13	0.15	0.03
Self-efficacy	-0.06	-0.15	-0.13	**0.34***
Relevance	-0.13	-0.06	**-0.27****	0.10
Usability	-0.15	0.04	**-0.44*****	0.12**
Identity	**-0.40*****	-0.16	**-0.31*****	**0.27***

The decimal values correspond to the resulting Cohen's d. Bold decimals indicate a small effect size. Positive values indicate an increase in the mean when transitioning to the next grade, while negative values indicate a decrease. Student's t-tests were used to confirm the results, with significant differences denoted by asterisks. *p<0.05; **p<0.005; *p<0.001.