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Are students in Italy really disinterested in science? A person-centered approach using the PISA 2015 data

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Abstract

Seen as one of the essential domains for active citizenship, examining how students relate to science has become crucial. Based on a person-centered approach, this article investigates self-related dispositions and motivation in science using the 2015 Programme for International Student Assessment (PISA) data set. By employing a latent profile analysis, student profiles were investigated among 11,583 15-year-old-students in Italy. Five distinct student groups were identified. The index of economic, social, and cultural status (ESCS), immigrant background, gender, study programs, and the accompanying learning environment were also inspected. Each group was observed against particular subdomains in science competence in line with the PISA framework and environmental awareness. The results indicate the profiles differed on the examined covariates and showed distinct patterns relative to achievement and environmental awareness. However, differences in achievement between the profiles could not be explained by students' variability in immigrant background or ESCS across the examined groups.

KEYWORDS

Italy, person-centered approach, PISA, science, student profiles

1 | INTRODUCTION

The quality of science education has been at the forefront of the discussions in education and education policy; importantly, one of these areas for discussion has been seeing science as the basis for fostering critical thinking and future active citizenship, often related to different sustainability issues (Feinstein & Kirchgasler, 2015). Within this context, inquiries have been made about who the students choosing STEM careers are (Wang, Ye et al., 2017) and how to facilitate more students going into a science track (Guo et al., 2015), especially among girls (Nagy et al., 2010), those with an immigrant background and low socioeconomic status (SES) students (Turner et al., 2019). In these discussions, different motivational constructs have conveyed much attention (Guo et al., 2017; OECD, 2019; Wang, Chow et al., 2017). Self-efficacy (Sahin et al., 2017; Schunk et al., 2014) and epistemological beliefs (Chen, 2012; Kampa et al., 2016) have raised the same concerns. Both the former and the latter have been tied to science-related outcomes (Chen et al., 2019; Grabau & Ma, 2017; Jansen et al., 2015; Mason et al., 2013; Trautwein & Ludtke, 2007), but also have been investigated for their mutual interdependency (Mason et al. 2013; Pajares, 2012).

At the same time, although both empirical and review articles have focused on the contextual factors contributing achievement in science (e.g., Alivernini & Manganelli, 2015; Chen et al., 2019; Lam & Lau, 2014), one of the key features across the vast majority of such studies is in their use of a variable-centered approach. Although the method itself certainly has its merits, its sole use across the field may disguise particular students' subgroups (e.g., with a particular set of belief patterns) both within and across samples. Conversely, the person-centered approach assumes the existence of these subgroups, allowing for patterns to be observed within and across populations or reconfirmed across groups belonging to different contexts (Bergman & Trost, 2006; Magnusson, 2003), thus complementing the findings from the former (Fryer & Bovee, 2018). Studies using the person-centered approach are on the rise and have addressed a variety of topics (e.g., Chen, 2012; Fryer & Ainley, 2019; Kampa et al., 2016; Schmidt et al., 2018; Snodgrass Rangel et al., 2020; Wormington & Linnenbrink-Garcia, 2017). Despite this, the field is still very much lacking in attempts that address the different phenomena related to how students experience science from a person-centered perspective and which of these experiences and beliefs may be facilitating in students becoming competent participants of scientific practice (Aditomo & Klieme, 2020). Given the need for understanding a diverse student body and the characteristics of different subgroups in their relationship to the domain of science, the current study contributes by relying on a person-centered approach. We investigate students' personal attributes in connection to science and tie these to science literacy and their environmental awareness while taking into account the students' SES and immigrant background, as well as the gender, study programs they are enrolled in and the accompanying learning environment. Programme for International Student Assessment (PISA) 2015 data are employed in the analyses. The nature of the sample (i.e., a large representative sample) allows for detecting even the smallest student subgroups, thus providing a more in-depth understanding of varied nuances between and among the students.

1.1 | Personal attributes in connection to science

Investigating different personal characteristics about science and the learning of science has been the focus of numerous studies, including those that have been connected to student outcomes (Areepattamannil et al., 2011; Chen et al., 2019; Grabau & Ma, 2017; Jansen et al., 2015; Lam & Lau, 2014; Mason et al., 2013; Trautwein & Ludtke, 2007). Discerning between student, family, and school-level characteristics among the constructs explored, of particular interest here is the concept of self-efficacy. Self-efficacy can be understood as the person's perceived capability for learning or performing an action at the desired level (Bandura, 2001) and is considered a strong predictor of current ability (Jansen et al., 2015) and related outcomes in science (Areepattamannil et al., 2011; Chen et al., 2019; Mason et al. 2013; Pajares, 2006; Trautwein & Ludtke, 2007; Williams & Williams, 2010), including future course and career paths (Bandura et al., 2003; Britner & Pajaras, 2006). According to research, students with strong science self-efficacy beliefs are more likely to select tasks and activities in the science domain and remain on task, even if they encounter obstacles (Patall, 2012). Gender differences in science-related paths can be observed (Bandura et al., 2003; Nagy et al., 2010), and studies suggest that a higher science self-efficacy will facilitate a science career choice even among girls (Sahin et al., 2017). Equally, SES is seen as one of the stronger predictors for future STEM choices (Mau & Li, 2018). A higher SES is associated with lower perceived career barriers in science and higher outcome expectations but not self-efficacy (Turner et al., 2019).

Parallel to this, an essential aspect of students' learning and valuing of a domain and associated competence relates to their beliefs on the nature of knowledge (Hofer & Pintrich, 1997). Over the past few decades, following different traditions, the concept of epistemic beliefs or an individual's representations about knowledge and knowing (e.g., Hofer & Pintrich, 1997; Mason & Bromme, 2010), has been carefully examined and also scrutinized in the context of science and as a predictor to science literacy (Chen, 2012; Kampa et al., 2016; Lee, 2020; She et al., 2019). Contemporary views argue for a multidimensional construct (Conley et al., 2004; Hofer, 2001; Hofer & Pintrich, 1997) with reasonably independent dimensions. However, some features of domain generality have been retained.

A prominent example is a model by Conley et al. (2004), which distinguishes between four different facets of epistemic beliefs related to science. The first, certainty of scientific knowledge, links to the extent knowledge is viewed, either as right or wrong, and stems from one or multiple traditions and paradigms. The second, development of scientific knowledge, refers to how knowledge is considered "static and unchanging". It contrasts with the idea that scientific theories change over time, which is supported by new evidence and approaches. The next dimension, source of scientific knowledge, describes the extent that knowledge is seen as something that resides in external authorities alone (e.g., researchers and teachers). Justification of scientific knowledge refers to viewing knowledge as something discovered through multiple mechanisms, including experiments, observations and reasoning about these. Each dimension operates independently, hence allowing two students to hold beliefs that scientific knowledge may change and develop over time. At the same time, the two students may differ on the notion whether that same knowledge can only come from authorities such as researchers and teachers or if they may "discover" it through inquiry.

How the position of the student is viewed in that discovery very much connects to the possible incentives students may react to in a learning situation. At this point, different motivational constructs come to the fore, namely enjoyment of and interest in science, but also instrumental motivation. All of these constructs have been regarded as the driving force behind students' learning (Wigfield et al., 2016) and recognized as critical student-level factors contributing to optimal student outcomes in science (Areepattamannil et al., 2011; Chen et al., 2019; Lam & Lau, 2014). Interest is explicitly seen as the energizer of task-related behavior across very diverse teaching and learning contexts (Schunk et al., 2014) and an essential outcome of any formal education (Fryer & Ainley, 2019). It has been argued, though, that both interest and enjoyment should go "hand in hand" to foster the positive outcomes (Jack & Lin, 2018; Palmer et al., 2017).

Interest is always conceptualized as a content-specific phenomenon (e.g., science), showing why individuals are motivated to engage with the task and learn specific subject matter (Renninger & Hidi, 2011). Such reasons may include both the engagements that arise because of expectations of achieving desirable outcomes (i.e., extrinsic nature) and intrinsically motivated behaviors of doing something because individuals find the activity interesting or enjoyable (Cerasoli et al., 2014). Both aspects are recognized across several distinctive frameworks that explain what drives human action (e.g., Deci & Ryan, 2012; Hidi & Renninger, 2006; Krapp & Prenzel, 2011). Studies have suggested a higher level of perceived ability is associated with a higher level of engagement in both boys and girls. Solid relationships with adults and peers also seem to be significant for girls' participation in STEM (Fredricks et al., 2018). Informal science venues are seen as relevant in the context of supporting the formation of science identities in girls (Todd & Zvoch, 2019). Some newer findings also indicate a more complex relationship between gender, students' immigrant background, and SES on the one side and particular career choices in science on the other side. These indicate the relationship is mediated by students' attitudes towards science, such as interest and enjoyment (Jeffries et al., 2020). Also, a reciprocal association is reported between self-efficacy and interest (Fryer & Ainley, 2019).

Because much of students' engagement with science still takes places within the school context, the quality of teachers' instructional practices has been the focus of many investigations (Chen et al., 2019). Nevertheless, the findings regarding the influence of different practices on student outcomes have been mixed. Although some studies show students' inquiry practices in the classroom negatively affecting these outcomes (Areepattamannil et al., 2011; Grabau & Ma, 2017), other studies reject such findings, differentiating between the various types of inquiry that may take place in the classroom. For example, Aditomo and Klieme (2020) show that inquiry is positively associated with outcomes when the inquiry incorporates teacher guidance; it is negatively associated with outcomes when it is student lead. In a similar vein, Lau and Lam (2017) show that interactive application (a subconstruct of inquiry teaching that implies a teacher may have a more direct role in the process of inquiry) is also positively associated with student outcomes. Lau and Lam (2017) also indicate that adaptive instruction and teacher-directed teaching has positive predictive effects regarding student outcomes in science, while the direction for students' perceived feedback was negative.

Although the stream of research scrutinizing the links between instructional approaches and students' outcomes is more robust—though not yet conclusive—the research investigating the links between instructional approaches and science-related dispositions is remarkably lacking. In one such attempt, Areepattamannil et al. (2020) show that teacher-directed science instruction is positively associated with students' enjoyment of science. The positive relationship also includes an interest in broad science topics, instrumental motivation to learn science, self-efficacy, and epistemological beliefs about science. Inquiry-based science instruction replicates on all of these, except for epistemological beliefs about science. These findings support the claim that a blend of both teacher-directed and inquiry-based practices could be more appropriate for nurturing students' positive dispositions toward science. However, more inquiry is still needed to determine which of the influences between self-efficacy, interest, engagement, and particular contexts are shared between student subcategories (e.g., boys and girls) and which are distinctive to each of these groups (Fredricks et al., 2018). It is also crucial to uncover any qualitative differences (e.g., motivational patterns between first- and second-generation students; Alivernini et al., 2018 or first-generation and majority population; Snodgrass Rangel et al., 2020). Examining all these aspects can continue to foster our understanding of how particular learning environments may be even more supportive in the process of building a highly competent individual engaged in scientific practice later in life (Aditomo & Klieme, 2020; Freeman et al., 2015; Weeth Feinstein & Kirchgasler, 2015).

1.2 | Affordances of the person-centered approach

Science-related self-beliefs, motivational constructs, and achievement are without a doubt intertwined (e.g., Areepattamannil et al., 2011; Chen et al., 2019; Palmer et al., 2017; Fredricks et al., 2018; Jansen et al., 2015; Jeffries et al., 2020; Lam & Lau, 2014; Mason et al. 2013; Pajares, 2012; Todd & Zvoch, 2019), and the relationship has been investigated thoroughly by relying on the merits of the variable-centered approach. Lately, this has been further strengthened by research on instructional practices and achievement (e.g., Lau & Lam, 2017) and that examining students' self-beliefs in connection to instructional approaches (Areepattamannil et al., 2020). Nonetheless, scholars have still not demonstrated a unified portrait of the domain, and the extent particular relationships may be salient to distinctive student subgroups (Alivernini et al., 2018; Fredricks et al., 2018; Hayenga & Corpus, 2010; Snodgrass Rangel et al., 2020). One reason for this may lie in the dominance of the variable-centered approach itself because it disregards the possible differences between individuals whose measures are being used in evaluating effects and associations (Bergman & Trost, 2006; Magnusson, 2003). A person-centered approach, on the other hand, builds exactly on that assumption.

The variable-centered approach mainly observes self-beliefs and motivational constructs as instrumental to achievement (e.g., Chen et al., 2019), not as the independent outcomes, despite adhering to the idea of the need to follow these as valuable products in the process of formal education as a whole (Fryer & Ainley, 2019) or in science education alone (Schiepe-Tiska et al., 2016). A person-centered approach rests on the latter premise, using such concepts as critical dimensions when discerning among different student subgroups. Thus, although in the current paper we also scrutinize competent individuals in science, we build our investigation on the assumption that the competent participants of scientific practice are also those who possess particular beliefs about science as a field. These may include changing beliefs about the nature of science and an understanding that scientific knowledge is subject to revision and ongoing inquiry (Aditomo & Klieme, 2020; Sandoval et al., 2016). In addition, from the perspective of life-long learning, it is more relevant that a student develops a set of optimal noncognitive characteristics (i.e., self-efficacy and interest) because through these, even students with lower competence have an opportunity to move forward in developing their own skills and can possibly become active citizens engaged in scientific practice and reasoning (Freeman et al., 2015; Weeth Feinstein & Kirchgasler, 2015).

From a methodological perspective, the person-centered approach is grounded on an array of clustering and latent class techniques. A particular case of the latter, the latent profile analysis (LPA), allows for the use of continuous indicators in the analysis. An LPA works by producing solutions with maximally different groups; it assigns individuals (i.e., students) who are similar across examined indicators (i.e., interest in science and enjoyment of science) in one group and individuals who are less related to different groups. The outcome produces homogeneous but mutually exclusive latent groups within a larger heterogeneous population. In this way, each participant is uniquely assigned to a single group. The number and group composition are unknown in advance (Geiser, 2013; Magidson & Vermunt, 2002).

The approach possesses several advantages. Namely, it allows for analyzing distinct groups on a particular set of indicators (Geiser, 2013). Also, the derived groups can be characterized by the inclusion of covariates and inspected further against desired predictors. Significance tests allow for testing the model fit and for testing the group means of the covariates to discern between relevant group differences. Relevant to the context of science, examples may be found in the works of Chen (2012) and Kampa et al. (2016), both of whom rely heavily on the use of LPAs that observe epistemological beliefs related to science. She et al. (2019), using the same approach observe scientific literacy, epistemological beliefs, and affective dispositions, while Snodgrass Rangel et al. (2020) examine math and science beliefs of underrepresented students, with a focus on first-generation college students. Schmidt et al. (2018), on the other hand, rely on the more traditional clustering techniques (i.e., hierarchical cluster analyses and k-means analyses) in discerning what they label "momentary engagement profiles". This is also true for Di Chiacchio et al. (2016), who observe patterns in students who are omitting behaviors in the context of PISA science data.

1.3 | International large-scale assessment and the Italian context

Within the scope of international large-scale assessments (ILSA) and studies such as PISA or Trends in International Mathematics and Science Study (TIMSS), significant cross-country variance on students' attitudes towards science has been reported, differentiating between boys and girls, as well as student background (i.e., SES and immigrant). Conversely, in many countries, female students performed similarly to or better than their male counterparts (Stoet & Geary, 2018). At the same time, both PISA and TIMSS report on student self-belief measures. Together with intrinsic motivation, these constructs are among the strongest predictors of student performance in the field of science (Alivernini & Manganelli, 2015; Chen et al., 2019; Grabau & Ma, 2017; Liou, 2017; Schütte, 2015). Although Grabau and Ma (2017) indicate, a stable association between different aspects of students' engagement and their science achievement, Chen et al. (2019) show that time and involvement in the learning of science and students self-efficacy are among the constructs with the most predictive roles when observing top-performing students in science. She et al. (2019), observing PISA 2015 data, add epistemic beliefs about science to that list. Again, focusing on the top performers, Alivernini and Manganelli (2015) discern self-efficacy and students' SES as vital predictors of this group. Jeffries et al. (2020) also use PISA 2015 data and find a complex relationship between SES measures, immigrant background, gender, attitudes towards science, and future career choice. Both Aditomo and Klieme (2020) and Lau and Lam (2017) emphasize that there is a complex relationship between science literacy and the different aspects of teaching and learning. Lee (2020) adds environmental awareness to this discussion, while Areepattamannil et al. (2020) showcase the importance of further investigating the links between students' self-beliefs and instruction.

Studies using the affordances of the ILSA studies and that address different student profiles are still mostly scarce, independent of the domain (i.e., mathematics and science). Nevertheless, the investigations by both Chen et al. (2019) and Alivernini and Manganelli (2015), although not using the person-centered approach themselves, indirectly point to the conclusion that contrasting student profiles based on achievement might be fruitful and very much needed, especially in the attempt to understand what produces highly competent and versatile STEM workforce later in life (Freeman et al., 2015).

In observing diversification concerning attitudes towards science and performance, Italy is a compelling case. With its performance in science under the international average (481 compared with 493 in OECD countries), boys still perform significantly better than girls. In Italy, there is a 17-point difference compared with girls, while the OECD average is only a 3.5 difference (OECD, 2016). Also, among the top performers in science, boys are more represented than the girls: 5.3% compared with 2.8%. Such a gender gap is reported elsewhere (e.g., Alivernini et al., 2018; De Simone, 2013). The gap between low performers in science relative to their immigrant background is similar to the one in OECD countries (OECD, 2016).

Interestingly a gender gap is visible also when observing student enjoyment, self-efficacy, and involvement in science activities (OECD, 2016). Distinct motivational profiles between boys and girl are reported elsewhere, and these also include first- and second-generation students (Alivernini et al., 2018). Regarding the diversity of the Italian system as a whole, disadvantaged students are more likely to be enrolled in a vocational track, 70% compared with 20%, which is the OECD average. The phenomenon is vital given the fact that tracking occurs before the students participate in PISA. Early tracking has been recognized as one of the significant sources of educational inequality (Le Donne, 2014; Van de Werfhorst & Mijs, 2010), and Italy is battling high levels of intergenerational persistence of educational attainment (Checchi et al., 2013). Finally, differences in science performance between schools are associated with a one-unit increase in their mean PISA index of economic, social and cultural status (ESCS), and add up to 80 points.

1.4 | Research questions and contributions

Grounded in the person-centered approach and the reviewed literature, the aim of the current investigation is to identify subgroups of 15-year-old students in Italy based on their differences regarding self-related dispositions and motivation related to the field of science. The second objective is to analyze the relationships between these profiles against different aspects of science competence, their learning environment, and particular demographic indices.

Although particular scrutiny has guided our investigation from both an empirical and methodological stance, the study builds on the previous literature in several ways. First, using data from PISA allows us to observe student data at the representative level and enhances the generalization of the findings. Second, by employing a person-centered approach, we are in a position to “unravel” diverse student subgroups. These are not merely at the macro level of gender, immigrant background, and SES, but also include self-related dispositions, and motivational constructs students may have in connection to science. In this regard, the use of a person-centered approach allows us to further unravel how students with a particular set of dispositions may be positioned within their learning environment and how this ties back to their outcomes in science.

Finally, the choice of constructs used in the current analyses is in agreement with the premises of a person-centered approach and the empirical investigations examining how student-level factors can contribute to optimal outcomes in science (e.g., Alivernini & Manganelli, 2015; Areepattamannil et al., 2011; Chen et al., 2019; Grabau & Ma, 2017; Lam & Lau, 2014; She et al., 2019) and conducive learning environments (Aditomo & Klieme, 2020; Areepattamannil et al., 2020). The literature, though, does not offer a unified view of the domain that needs further investigations; hence, a study is warranted to help in unraveling the salient and less salient ties between the complexity of students beliefs, their learning environment, and outcomes related to science. Our methodological stance will complement this existing pool of knowledge.

Against the described background, the following research questions are addressed:

(1) Which student profiles can be distinguished when using measures on enjoyment of science, interest in science, instrumental motivation related to science, science self-efficacy, involvement in different science activities, and science epistemological beliefs? Based on studies considering similar person-centered perspectives (e.g., Chen, 2012, Kampa et al., 2016, Schmidt et al., 2018, She et al., 2019, Snodgrass Rangel et al., 2020), the existence of distinctive profiles that combine both adaptive and less adaptive aspects across a number of subgroups and background research on the construct embedded in the profiles (e.g., Alivernini & Manganelli, 2015; Chen et al., 2019; Conley et al., 2004; Palmer et al., 2017; Fredricks et al., 2018; Grabau & Ma, 2017; Jansen et al., 2015; Jeffries et al., 2020; Lam & Lau, 2014; Todd & Zvoch, 2019), we hypothesize the existence of these mixed students profiles as well.

(2) To what extent do distinguished student profiles differ by gender, socioeconomic background, students' immigrant background, and the programs students may be attending? We postulate all four constructs to be relevant correlates within the Italian context and across all the distinguished profiles (Alivernini et al., 2018; De Simone, 2013). More specifically, we assume the profiles with optimal patterns of motivational and belief constructs will be more saturated by students enrolled in grammar school programs (Le Donne, 2014; OECD, 2016; Van de Werfhorst & Mijs, 2010), boys (Jeffries et al., 2020; Sahin et al., 2017), and higher SES and native students (Alivernini & Manganelli, 2015; Jeffries et al., 2020; Turner et al., 2019). Gender differences that favor boys are also expected (Alivernini et al., 2018; De Simone, 2013; OECD, 2016). Despite the finding by Areepattamannil et al. (2020) on some distinctive patterns between epistemological beliefs and teacher-centered and inquiry-oriented instructional practices, we expect student profiles saturated by higher values of self-efficacy, interest and epistemological beliefs to be reporting more salient experiences with their inquiry practices.

(3) What is the relationship between distinguished student profiles and the different aspects of science competence and environmental awareness? Aligned with research on the association between self-efficacy, its association to interest and enjoyment and student outcomes (e.g., Fryer & Ainley, 2019; Jack & Lin, 2018; Jeffries et al., 2020; Mason et al. 2013; Palmer et al., 2017; She et al., 2019), we postulate that the profiles with more adaptive patterns of motivational and beliefs constructs will score the highest across different science subdomains, even when SES and share of immigrant students in different subgroups are included in the model as covariates (Jeffries et al., 2020). In connection to previous, we also postulate these students will exhibit higher levels of environmental awareness (Lee, 2020).

2 | METHODS

2.1 | Participants

In the analyses, we use PISA 2015 science data for Italy. The PISA framework implements strict sampling procedures at the country level, here following a two-step sequence. In the first step, a school sample is selected from a complete list of the schools. The targeted population is 15-year-old students. In the second step, a simple random sample is taken from each selected school (for details, see OECD, 2016). In the 2015 cycle, Italy sampled 11,583 students in 474 schools. About 99% of the students were enrolled in upper secondary programs. A description of the programs is provided in Section 2.2.4. From the total number of students, 5792 are girls (50%).

2.2 | Measures

The PISA survey procedures state that students first take a 2-hour test followed by a contextual questionnaire. The questionnaire captures an array of indices in connection to attitudes, beliefs, and learning environment related to science, which was the domain in focus. Also, since the 2015 cycle, PISA has applied computer-based testing.

The procedures give an incomplete block design for the science (math and reading) test, whereas all the students receive the same items for the contextual questionnaire (OECD, 2016). Among these, we focus on those indices that we perceive as internal student characteristics, namely science self-related beliefs, interest, and motivation. In support of understanding the broader context students are situated in, we also examine variables on the learning environment. Table 1 provides an overview of all the indices used in the analyses. Appendix 1 provides a complete list of items for each of the constructs.

2.2.1 | Interest and motivation to learn science

The PISA framework captures interest in science by using two constructs, interest in broad science topics and enjoyment of science. Both constructs are assessed under the idea that interest and enjoyment are experiential. As such, they are self-determinate and intrinsic (Krapp & Prenzel, 2011), affecting the overall student engagement, activities around learning, performance, and later career choices (Deci & Ryan, 2012). Enjoyment of science requires students to respond on a 4-point Likert scale (categories: “strongly agree” to “strongly disagree”) comprised of five items (e.g., “I enjoy acquiring new knowledge in < broad science >”).

The measure 'interest in science topics” includes topics such as the biosphere, motion and forces, energy and its transformation, and how science can help avoid illness, here using a 5-point Likert scale. The response categories include the following: “not interested,” “hardly interested,” “interested,” “highly interested,” and “I don't know what this is.”

Besides these two composite scores, instrumental motivation is the third measure used. The construct itself is also seen as an essential predictor for course selection, career choices, and performance (Eccles & Wigfield, 1995; Schiepe-Tiska et al., 2016). The measure is set on a 4-point Likert scale (categories: “strongly agree” to “strongly disagree”). Example items include statements such as “What I learn in my < school science > subject(s) is important for me because I need this for what I want to do later on.”

2.2.2 | Science-related dispositions

The 2015 framework includes three constructs that measure science-related dispositions: science self-efficacy, epistemological beliefs about science, and students’ science activities.

The former, following Bandura's (2001) conceptualization, is a composite measure that is based on a 4-point scale. The categories include the following: “I could do this easily,” “I could do this with a bit of effort,” “I would struggle to do this on my own,” and “I couldn't do this,” with items such as “Explain why earthquakes occur more frequently in some areas than in others” or “Describe the role of antibiotics in the treatment of disease.”

The measure of epistemological beliefs in science is closely related to the students’ overall values about science and scientific inquiry (Hofer & Pintrich, 1997); it includes ideas about science as an evolving and changing subject and how individuals justify knowledge and is aligned with the work of Conley et al. (2004). The scale that measures the construct is based on a 4-point Likert scale (categories “strongly agree” to ‘strongly disagree’) and includes items such as “A good way to know if something is true is to do an experiment.”

Involvement in different science activities addresses students’ science activities outside the school environment. The construct is based on a 4-point scale (“very often,” “regularly,” “sometimes,” and “never or hardly ever”). Items include activities such as watching TV programs about < broad science > and reading < broad science > magazines or science articles in newspapers.

TABLE 1 Variables included in the current study

	Competence measures	Missing rate (%)	Scale reliabilities
Achievement in PISA scientific literacy	*M* = 481, *SE* = 2.5	0	/
Students' awareness of environmental matters (ENVAWARE)	A composite score statements ST92Q: 01, 02, 04- 06, 08, and 09, *M* = −0.019, *SE* = 0.010	5.7	0.848
	Demographic variables		
Gender (GENDER)	Categorical, as male and female (coded 0).	0	/
Index of economic, social, and cultural status (ESCS)	Composite score *M* = −0.045, *SE* = 0.009	2.2	/
Study program (PROGRAMME)	Categorical, coded as 0, 1, and 2	0	/
Index of immigrant status	Categorical, coded as 0, 1, and 2	3	/
	Interest and motivation to learn science		
Interest in broad science topics (INTBRSCI)	Composite score, statements ST095Q: 04, 07, 08, 13, and 15; *M* = 0.191, *SE* = 0.008	7.2	0.771
Enjoyment of science (JOYSCIE)	A composite score statements ST094Q: 01-05 *M* = −0.020, *SE* = 0.010	5.4	0.926
Instrumental motivation (INSTSCIE)	Composite score, statements ST113Q: 01-04 *M* = 0.095, *SE* = 0.009	6.5	0.893
	Science-related dispositions		
Science self-efficacy (SCIEFF)	A composite score statements ST129Q: 01-08 *M* = 0.057, *SE* = 0.011	7.6	0.859
Epistemological beliefs about science (EPIST)	Composite score, statements ST131Q: 01, 03, 04, 06, 08, 11; M = −0.099, *SE* = 0.009	7.2	0.840
Students' science activities (SCIEACT)	A composite score statements ST146Q: 01-09 *M* = 0.213, *SE* = 0.010	6.4	0.911
	Teaching and learning environment		
Interactive investigation	A composite score statements ST98Q: 03, 07 and 08; M = .001, *SE* = 0.005	12	0.713
Interactive application	A composite score statements ST98Q: 01, 06 and 09; *M* = .001, SE = 0.003	12	0.710
Teacher support in science classes (TEACHSUP)	A composite score statements ST100Q: 01-05	11.8	0.887

TABLE 1 (Continued)

	Competence measures	Missing rate (%)	Scale reliabilities
	M = −0.185, *SE* = 0.009		
Teacher-directed science instruction (TDTEACH)	A composite score statements ST103Q: 01, 03, 08, and 11 *M* = −0.135, *SE* = 0.008	12.3	0.712
Perceived feedback (PERFEED)	A composite score statements ST104Q: 01-05 *M* = 0.024, *SE* = 0.008	12.8	0.871
Adaption of instruction (ADINST)	A composite score statements ST107Q: 01-03 *M* = −0.109, *SE* = 0.009	14.5	0.762

2.2.3 | Learning environment

In the current study, we have observed student learning environments across five different constructs. These include teacher support in science classes (e.g., "The teacher helps students with their learning"), teacher-directed science instruction (e.g., "The teacher explains scientific ideas"), perceived feedback (e.g., "The teacher states areas the student can still improve in"), and adaption of instruction (e.g., "The teacher adapts the lesson to the class' needs and knowledge"). All students responded on a 4-point Likert scale with the categories "every lesson," "most lessons," "some lessons," and "never or hardly ever."

Finally, taking into consideration the current inconsistencies in the results of the original unidimensional PISA construct on inquiry teaching, we have examined it following the rationale of Aditomo and Klieme (2020) and Lau and Lam (2017). Because the unidimensional solution did not yield a satisfying fit (Comparative Fit Index [CFI] = 0.902, Tucker–Lewis Index [TIL] = 0.869; root mean square error of approximation [RMSEA] = 0.090, and standardized root mean square residual [SRMR] = 0.049), we investigated several two-factor solutions, between which Lau and Lam's (2017) distinction on the interactive investigation (e.g., "Students are required to argue about science questions") and interactive application (e.g., "The teacher explains how < school science > idea can be applied") provided a more robust fit (CFI = 0.985, TIL = 0.971; RMSEA = 0.047, and SRMR = 0.019). This two-factor structure has been retained for the remaining part of the analyses (Table 1).

2.2.4 | Competence in science

Within the PISA framework, scientific literacy is defined as the ability to engage with science-related issues and with the ideas of science. Here, the usage of the term "literacy" stresses the application of scientific knowledge in the context of real-life situations, not neglecting its relevance to the science curricula of the participating countries. In light of this, a scientifically literate person would be a person able to do the following: (1) explain phenomena scientifically (i.e., recognize, offer, and evaluate explanations for a range of natural and technological events), (2) evaluate and design scientific inquiry (i.e., describe and appraise scientific investigations and propose ways of addressing questions scientifically) and (3) interpret data and evidence scientifically (i.e., analyze and evaluate data, claims, and arguments in a variety of representations and draw appropriate scientific conclusions). Against this background, apart from the overall score in science, the competence subscales are also used. These include "explain phenomena scientifically," "evaluate and design scientific inquiry," and "interpret data and evidence scientifically." In parallel, all science items are divided depending on the type of knowledge they require—content versus procedural and epistemic. Finally, the subscales discriminate between knowledge of physical systems, living systems or the Earth, and space systems.

In addition, we also examine the construct of environmental awareness, which examines students' perception of being informed of different environmental issues, such as the increase of greenhouse gases in the atmosphere or nuclear waste. Students have rated their knowledge of a 4-point scale ("I have never heard of this" to "I am familiar with this, and I would be able to explain this well").

2.2.5 | Demographic and status variables

Apart from variables perceived as internal student characteristics, information, on demographic variables is also considered. These include gender, index of ESCS, immigration background, and study programs. The ESCS is a composite score constructed from the indicators of parental education, highest parental occupation, and home possessions.

Data on study programs represent information on all national programs available to 15-year-old students in each participating country. All study programs are classified using the International Standard Classification of Education (OECD, 1999). In the 2015 data set for Italy, we distinguished between three different programs. These include grammar schools (Italian Liceo, a 5-year program, 47%), technical institutes (vocational 5-year programs, 32%), and vocational (professional), 3-year programs (21%). The principal focus of Liceo is to prepare students for university. Technical institutes combine both theoretical and specialization in particular fields of study (e.g., law, economy, accounting, IT and telecommunications, electrical engineering, etc.), hence not limiting entry to higher education. Finally, vocational (professional) programs aim at facilitating students' direct entry into the labor market (e.g., gastronomy and handcrafts).

In Italy, 15-year-old students receive an integrated curriculum in science (2 h per week, 66 h in total). In Liceo, the national curriculum combines topics from chemistry, geography, biology, and earth sciences. In technical institutes and vocational (professional) programs, the emphasis is on topics in physics and chemistry. About 96% of students in Italy attend public schools.

Gender is a dichotomous variable, while the index of immigration status differentiates between native (i.e., students who had at least one parent born in the country), first- and second-generation students (Table 1). The first-generation students are defined as students born outside the country of assessment and whose parents were also born in another country. In contrast, second-generation students comprise those born in the country of assessment, but whose parent(s) were born in another country (OECD, 2017).

2.3 | Analyses

A preliminary exploration of the descriptives for each of the constructs preceded the primary analyses. The steps for multilevel multiple imputations followed and were consistent with the recommendations by Enders et al. (2016) for nested data. Table 1 provides information on the missing rate for each variable.

Investigating students' belief patterns in science was the focus of the first research question, and an LPA was used for that purpose. An LPA is a latent variable mixture modeling technique that allows for the identification of groups of individuals with similar values on the clustering variables used in the analyses (Geiser, 2013). In the current investigation, enjoyment of science, interest in science, instrumental motivation related to science, science self-efficacy, involvement in different science activities, and science epistemological beliefs were used to analyze the distinct student profiles. Models with three through seven latent classes ($k = 3–7$) were tested to reveal the number of profiles that emerged from the data. Mplus 8.4 was used for this (Muthén & Muthén, 2018). Each model was set with an instruction to use 1000 random sets of starting values. After 50 iterations, the 100 best sets of starting values as identified by the highest likelihood values were then selected for final optimization. The nature of the data (i.e., nested) was incorporated into the LPA's syntax with CLUSTER option. Guidelines for the information criteria, the cut-off for the entropy index (Geiser, 2013) and a combination of bootstrapped likelihood ratio test (BLRT), Vuong–Lo–Mendell–Rubin likelihood ratio test (VL-LRT), and the Lo– Mendell–Rubin adjusted LRT test (LMR), as suggested by Muthén and Asparouhov (2012), were considered when choosing the final solution. The final model was again validated using Geiser's (2013) recommendations on the use of the best log-likelihood value.

Subsequent analyses relate to the second and third research questions. In investigating the relationship between distinct student profiles and their socioeconomic backgrounds, the AUXILIARY (e) function in Mplus was used, here testing for the equality of means with variables not used in developing the profiles. In this case, the LPA relies on the assumption that each individual has a probability of belonging to a particular profile compared with the other, which is then used in calculating a Wald χ^2 test statistic to examine whether there is a statistically significant difference in the means across the profiles (Collier & Leite, 2017). The same approach was used in investigating the relationship between distinct student profiles and their environmental awareness and those on the learning environment.

To what extent distinguished student profiles differ by gender, immigrant background, and the programs students may be attending was investigated employing the AUXILIARY (r) function in Mplus. The option allows identification of covariates that might be significant predictors of the previously established distinct profiles. The feature uses pseudo-class draws, that is, posterior-probability-based multinomial logistic regressions of latent classes on a defined set of covariates.

Finally, to assess for the mean differences between distinct student profiles and different aspects of competence in science, SPSS with a macro patch developed for handling the plausible values (OECD, 2009) was used, introducing as covariates students' gender and socioeconomic backgrounds. The analyses incorporated replicate weights.

3 | RESULTS

Tables 1 and 2 provide an overview of the means, standard deviations, reliability, and correlations across the constructs used. Aligned with recommended practices for using LPAs (Geiser, 2013), we tested for a range of solutions. In the process, we took into account the results of previous studies (e.g., in Kampa et al., 2016 the combination of epistemological beliefs in interaction with motivational constructs, in She et al., 2019 the interplay between scientific literacy, epistemological beliefs, and affective dispositions), the empirical background guiding this investigation (e.g., Chen et al., 2019), the profile characteristics within each solution and the interpretability of the solution as a whole.

A five-class model was chosen. Table 3 displays the fit statistics across the solutions. Although the seven-class model produced a nonsignificant result, thus suggesting the six-class model is the optimal one, we selected the five-class model because of the interpretability of the results. In addition, a comparison between the five- and a six-class solution did not provide any new information about the students. From a statistical point of view, a comparison of the two models did not yield a significantly better improvement score for the BIC/AIC values.

The proposed solution was validated using Geiser's (2013) recommendation of the best log-likelihood value repetition. When the validation solution is compared with the proposed five-class model, identical patterns were replicated, thus providing support for the reliability of the selected model. The profiles were distinguished based on measures connected to enjoyment of science, interest in science, instrumental motivation related to science, science self-efficacy, involvement in different science activities, and science epistemological beliefs. The attached labels serve the purpose of exemplifying the distinguishing feature of each of the profiles.

3.1 | Distinguishing among the diverse student profiles

Figure 1 shows a graphical solution of the distinct profiles, labeled as the "uncommitted" group, the "uninterested" group, the "informal inquirers", the "practical inquirers", and the "scientists."

TABLE 2 Correlations between the composite scores used in latent profile analyses

	(1)	(2)	(3)	(4)	(5)	(6)
Interest in broad science topics (1)	1	0.537	0.314	0.254	0.264	0.371
Enjoyment of science (2)		1	0.407	0.307	0.307	0.421
Instrumental motivation (3)			1	0.289	0.158	0.348
Science self-efficacy (4)				1	0.195	0.342
Epistemological beliefs about science (5)					1	0.066
Students' science activities (6)						1

The largest student group (59.5%) comprises students who mainly fulfill their interest in science outside regular school classrooms. These activities may include watching TV programs connected to different topics in science, buying books on the subject, visiting websites covering science topics, including environmental alertness, and attending science clubs or using software that allows for the exploration of different natural phenomena. All these activities require students to invest time, yet given the profile of the answers; they seem to be disconnected from what students may be exposed to through formal instruction. We label these students the "informal inquirers".

The second-largest group labeled as the "uninterested" group (23.8%), comprises students who do not seem to get themselves involved in activities related to science either within or outside the school context. The latter was prominent for the previous group. Students in this profile perceive themselves somewhat less proficient when it comes to the content of science and does not observe the science field as predominantly instrumental to their success. In all, these students genuinely do not seem to enjoy science-related activities.

The third group is the so-called "scientists" (12%). These are the students with, what we might consider the "optimal" or "desired" set of self-related beliefs in connection to science as a subject. These students genuinely enjoy and are interested in science in school and in their own leisure time. They perceive themselves as competent in the domain and observe the science field as relevant to their future strivings. Given their beliefs on the nature of knowledge in science, these students might very well be those who will eventually go into the STEM field.

Following this, a small group (3.1%) of students is not interested, does not enjoy science, does not get involved in science-related activities or perceives it as instrumental to their future success can be found. These students have some of the sturdiest opinions when compared with other groups when it comes to their disinterest in broad topics in science that are more connected to the school environment. However, given the fact that the same negative perceptions about science activities beyond classrooms are expressed, coupled with a lack of enjoyment of science, we label them the "uncommitted" group.

Finally, 1.5% of students perceive themselves as competent in the field. They possess no interest in science within the broad scope of topics which are closer to the school context yet involve themselves in out-of-school activities connected to the subject. At the same time, these students consider science instrumental to their future success in life. We label them the "practical inquirers".

3.2 | Students' profile differentiation by gender, socioeconomic and immigrant background and programs the students are enrolled in

Looking at the profiles when focusing on gender differences provides an even more diverse portrait of the boy-girl diversification scheme (Table 4). One of the straightforward findings is that the boys have almost three times higher odds of belonging to the "scientist" profile, that is, a profile with the most optimal pattern of beliefs. As seen

TABLE 3 LPA model overview

No. of groups	Log likelihood	No. of free parameter	AIC	BIC	SABIC	LMR	BLRT	VL-LRT	Entropy	Smallest class frequency
2	−93196,92	19	186431.840	186571.629	186511.249	0.000	0.000	0.000	.716	33%
3	−91527,412	26	183106.824	183298.114	183215.489	0.000	0.000	0.000	.773	13.6%
4	−90609,425	33	181284.851	181527.641	181422.771	0.000	0.000	0.000	.800	3.8%
5	−90036,66	40	180153.320	180447.612	180320.497	0.0001	0.000	0.0001	.820	1.5%
6	−89742,503	47	179579.006	179924.798	179775.438	0.0006	0.000	0.0005	.825	1.5%
7	−89499,162	54	179106.324	179503.618	179332.012	0.0573	0.0000	0.0534	.847	1.2%

Abbreviations: AIC, Akaike's information criterion; BIC, Bayesian information criterion; BLRT, parametric bootstrapped likelihood ratio test; LMR, Lo–Mendell–Rubin adjusted likelihood ratio test; SABIC, sample-size adjusted BIC; VL-LRT, Vuong–Lo–Mendell–Rubin likelihood ratio test.

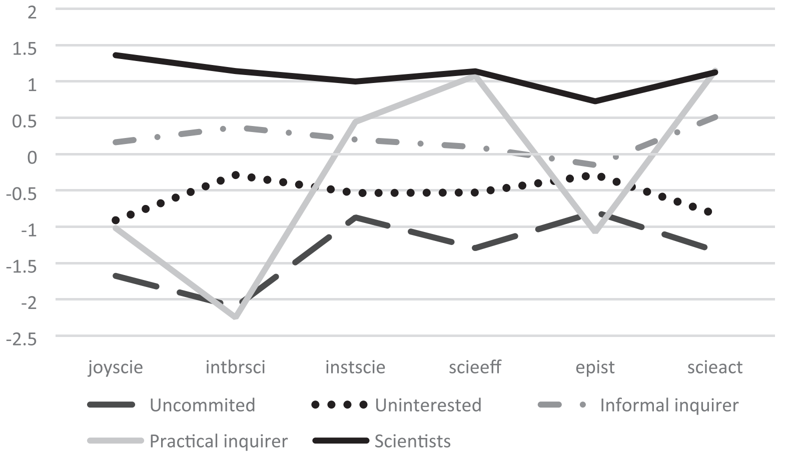

FIGURE 1 Overview of the latent classes. Note: joyscie = enjoyment of science: intbrsci = interest in broad science topics; instscie = instrumental motivation; scieff = science self-efficacy; epist = epistemological beliefs about science; scieact = students' science activities

later, the profile also scores the highest when it comes to the different facets of science and overall achievement in science (see Section 3.4).

At the same time, the boys are two times more likely to belong to the "informal inquirers" profile, the second most successful relative one to achievement, and the "practical inquirers," the lowest-achieving group (see Section 3.4.). Both these groups inform of students' interest in science, even if this is not within school. The finding implies that relatively more interest in science is still found among boys when observing the profiles as a whole. All comparisons were displayed when the "uncommitted" group is the reference profile (See Appendix 2 for a more detailed overview).

Again, students belonging to the "scientists" group are more likely to have higher ESCS status, while both the "uncommitted" and "uninterested" are more saturated with students from the lower ESCS range. The "practical" and "informal" inquirers gather students from the middle ESCS spectrum; that is, mid-income family students are more likely to express their interest in science only in informal settings (Table 5). The finding raises the question regarding to what extent these students are expected to pursue careers in science later in life, if already at this stage science is present only outside the formal school setting.

Finally, an investigation of a possible association between the student profiles and their immigrant background shows significant differences for some second-generation students. Compared with the "uncommitted" group, second-generation students are less likely to belong to both "scientists" and "uninterested" profiles than native students.

TABLE 4 Odds-ratio being in a profile as a function of gender

	Gender (Boys)	
Profile	**Estimate (*SE*)**	***p***
Uninterested	0.808 (0.101)	0.058
Informal inquirer	1.709 (0.206)	0.001
Practical inquirer	2.412 (0.500)	0.005
Scientists	2.643 (0.350)	0.000

Note: Reference profile uncommitted.

TABLE 5 Students' profiles and ESCS

Profile	Mean	SE
Uncommitted	−0.463	0.050
Uninterested	−0.229	0.019
Informal inquirer	−0.026	0.012
Practical inquirer	−0.149	0.076
Scientists	0.297	0.028

Note: See Appendix 2 for significance tests.

3.3 | Students' profile, programs the students are enrolled in, and the learning environment

Significant differences are found when looking at the student profiles compared with the programs the students are attending (Table 6). Compared with the "uncommitted" group, students in grammar schools are nine times more likely to belong to the "scientists" group and four times more likely to be in this group if they attend technical institutes as opposed to the students attending 3-year vocational programs. Interestingly, students attending grammar schools and technical institutes are two to four times more likely to belong to the "practical inquirers" profile when compared with students in the vocational 3-year track. The only pattern that cannot be associated with the different educational trajectories is the "informal inquirer" group. See Appendix 2 for a more detailed overview.

In connection with the particular aspects of the learning environment, we could distinguish some distinctive patterns across the inspected variables. The "scientist" profile is situated in a learning environment that provides the students with opportunities for adapted instruction, feedback, and teacher support in connection to learning science. It is just the opposite for the "uncommitted" profile, a group with the most negative perception of the field. Teacher-directed instruction is also more present in the "scientist" profile compared with the other profiles. Nevertheless, both dimensions of inquiry teaching—interactive investigation and interactive application—are more prevalent in the "uncommitted" and "uninterested" profiles (Table 7).

TABLE 6 Odds-ratio being in a profile as a function of programs and students' immigrant background

	Programs			Immigrant background		
Profile		Estimate (*SE*)	*p*		Estimate (*SE*)	*p*
Uninterested	Grammar school	2.700 (0.421)	0.000	1st generation	0.719 (0.198)	0.157
	Tech Institute	1.682 (0.251)	0.006	2nd generation	0.604 (0.185)	0.032
Informal inquirer	Grammar school	0.904 (0.227)	0.671	1st generation	0.892 (0.229)	0.636
	Tech Institute	0.880 (0.225)	0.557	2nd generation	0.844 (0.238)	0.513
Practical inquirer	Grammar school	4.347 (0.642)	0.000	1st generation	1.614 (0.619)	0.321
	Tech Institute	2.529 (0.349)	0.000	2nd generation	1.195 (0.545)	0.721
Scientists	Grammar school	9.479 (1.679)	0.000	1st generation	0.703 (0.208)	0.152
	Tech Institute	4.111 (0.704)	0.000	2nd generation	0.581 (0.190)	0.028

Note: Reference profile uncommitted and 3 year vocational programs category.

TABLE 7 Students' profiles and the learning environment

Profile	Interactive investigation Mean (*SE*)	Interactive application Mean (*SE*)	Teacher support Mean (*SE*)	Teacher-directed instruction Mean (*SE*)	Perceived feedback Mean (*SE*)	Adaption of instruction Mean (*SE*)
Uncommitted	0.229 (0.030)	0.185 (0.022)	−0.469 (0.070)	−0.552 (0.058)	−0.204 (0.064)	−0.564 (0.064)
Uninterested	0.176 (0.010)	0.135 (0.007)	−0.390 (0.021)	−0.375 (0.018)	−0.234 (0.019)	−0.357 (0.021)
Informal inquirer	−0.026 (0.006)	−0.020 (0.005)	−0.157 (0.012)	−0.098 (0.011)	0.072 (0.012)	−0.069 (0.012)
Practical inquirer	−0.244 (0.058)	−0.147 (0.042)	−0.021 (0.099)	−0.306 (0.095)	0.054 (0.084)	−0.186 (0.091)
Scientists	−0.228 (0.016)	−0.181 (0.012)	0.107 (0.030)	0.243 (0.029)	0.320 (0.031)	0.276 (0.031)

Note: See Appendix 2 for significance tests.

TABLE 8 Student profiles and their achievement in science

Student groups	Practical inquirer *M* (*SE*)	Uncommitted *M* (*SE*)	Uninterested *M* (*SE*)	Informal inquirer *M* (*SE*)	Scientists *M* (*SE*)
Science achievement	413.096 (8.865)	413.510 (8.041)	459.232 (3.409)	484.868 (2.682)	522.543 (4.805)
Competency Subscale-Explain Phenomena Scientifically	415.174 (10.618)	413.186 (8.008)	457.064 (3.605)	485.408 (2.937)	527.537 (5.661)
Competency Subscale-Evaluate and Design Scientific Inquiry	405.821 (11.218)	411.995 (8.608)	457.992 (3.909)	481.772 (3.199)	515.547 (5.728)
Competency Subscale-Interpret Data and Evidence Scientifically	408.718 (11.545)	414.359 (8.337)	460.346 (3.935)	485.864 (2.970)	520.981 (5.357)
Knowledge Subscale-Content	416.873 (10.057)	415.325 (8.806)	459.465 (3.873)	487.419 (2.789)	529.767 (5.780)
Knowledge Subscale-Procedural & Epistemic	410.459 (8.968)	412.837 (8.083)	459.616 (3.411)	483.020 (2.811)	515.237 (5.215)
System Subscale- Physical	411.421 (10.633)	410.326 (7.417)	456.226 (3.902)	482.419 (3.135)	520.520 (5.089)
System Subscale- Living	410.181 (11.656)	410.104 (7.611)	457.673 (4.167)	483.138 (2.969)	519.562 (5.211)
System Subscale- Earth & Science	420.378 (11.198)	415.638 (8.426)	463.065 (3.772)	489.284 (2.972)	527.504 (4.967)
Environmental awareness	−0.600 (0.138)	−1.030 (0.073)	−0.362 (0.019)	0.005 (0.012)	0.853 (0.039)

Note: Across all the subtests, there are no significant differences between the groups "practical inquirers" and "uncommitted", see Appendix 3 for details. See Appendix 2 for details on environmental awareness.

3.4 | Student profiles, science competence, and environmental awareness

Succeeding analyses focused on the relationship between the student profiles and their competence in science (with subdomains included), hereby following the technical guidelines on handling plausible values (OECD, 2009). The results indicate significant mean differences between the groups and that the "scientists" group outperforms the other profiles (522 points). The gap ranges from around 40 points when compared with the informal inquirer's profile (485 points) to a gap of over 100 points for the "practical inquirers" (413). When the pattern is inspected across the science subdomains and content areas, it remains the same. The performance of students belonging to the "scientists" profile is sustained against the other groups.

We also investigated whether the differences between the profiles in their scientific competency are a result of the students' immigrant background or SES. Because the previous analyses show a uniform pattern across all the subdomains and the overall science literacy achievement scale, only the latter scale was used. The analysis was repeated for each plausible value by following the PISA manual guidelines (OECD, 2009, p. 43). Using an ANCOVA with ESCS and immigrant background as the covariates, we found that differences in the achievement across the profiles are not the sole result of the differences in the socioeconomic or immigrant background of the students. A comparison across the profiles shows the same distinctive patterns as identified in Table 8, without the covariates. Detailed statistics are displayed in Appendix 3.

Also, we compared the effect size (i.e., partial Eta squared) values for the two analyses. In the analyses not accounting for the covariates, the effect size was 0.0568. After the covariates were introduced, the average effect size drops to 0.0408. Both values are significant (Cohen, 1988) but show that students' socioeconomic or immigrant background cannot fully explain the differences in achievement across the profiles. Notably, boys are more present in the two most successful groups, as are grammar schools and high ESCS students in the first ranked, the "scientists."

Looking at the particular differences between the student profiles, the largest differences are between the two groups that perceive themselves as the most competent in the domain—the "scientists" and the "practical inquirers." Although the former scores the highest, the latter attains the lowest scores. Both profiles report involvement in a range of science-related activities outside school. However, their most significant differences are in their interest in broad topics in science, which is more connected to the school context, and their beliefs of the nature of scientific knowledge. Although the "scientists" observe scientific knowledge as changeable over time with the need for justification as knowledge evolves (e.g., by means of experiments), the "practical inquirers" do not seem to value this at all. Interestingly both profiles have reported lowest scores in own perceptions of being exposed to inquiry practices within the school context.

The "informal inquirers" are the second most successful student profile relative to the achievement. Although the difference between them and the "scientists" is the least (i.e., around 40 points), it is still significant. The "informal inquirers" demonstrate their interest in science across everyday contexts alone. However, in other dimensions, no particular pattern is revealed, especially in how they perceive their competence in science.

Finally, regarding the students' perceptions of their environmental awareness, significant differences were found between all the profiles. Although the "scientists" exhibit the highest levels of awareness among the five profiles, self-perceptions regarding the environment are the lowest for the "uncommitted" profile. Interestingly, this is not a profile with the lowest registered achievement on the science literacy scale but rather is a profile with the sturdiest negative perception and disinterest in the field. Although the "practical inquirers" score the lowest on the science achievement scales, they observe science as instrumental for their future wellbeing. Such a perception may likely make them more invested in environmental issues compared with the "uncommitted" group.

4 | DISCUSSION

Against the framework described in the first section, three research questions guided our investigation. Based on enjoyment of science, interest in science, instrumental motivation related to science, science self-efficacy, involvement in different science activities, and science epistemological beliefs, five distinctive profiles were extracted. Each of them aids in a deeper understanding of the varying student profiles within the education system in Italy and how these students approach science.

The existence of distinctive profiles that combine both adaptive and less adaptive aspects across several subgroups was anticipated, and the hypothesis was confirmed. Such mixed patterns align with previous research on similar phenomena (Chen, 2012; Kampa et al., 2016; Schmidt et al., 2018; She et al., 2019) and the mutual relationship between the constructs that were used (e.g., Conley et al., 2004; Palmer et al., 2017; Fredricks et al., 2018; Jansen et al., 2015; Jeffries et al., 2020; Lam & Lau, 2014; Todd & Zvoch, 2019). To an extent, an unexpected finding was that almost three-quarters of the students in our sample position themselves within groups that do not seem to be interested in involving themselves in science within the formal constraints of schooling. Instead, they show interest in science in their leisure time (i.e., reading science magazines and visiting websites on different scientific content). Chen et al. (2019) have demonstrated that time spent, and involvement in learning is among the most critical factors contributing to optimal student outcomes in science. As an opposite, skipping lessons (Sälzer & Heine, 2016) and high rates of omission (Di Chiacchio et al., 2016) are tied to unsatisfactory academic outcomes. Our findings could imply that the current formal science education practices in Italy are challenged in finding a way to relate to the interest of students who are seeking outside science content, despite the fact that the students in some of these less adaptive profiles report having more frequent inquiry practices. Although the advantage is that these students are still interested in science, a transformation of current dominant practices is still needed to allow for a meeting point between in- and out-of-school experiences.

We postulated that profiles with adaptive motivational and self-related dispositions constructs would be more saturated by students enrolled in grammar school, boys, students from the higher SES range, and native students (Alivernini & Manganelli, 2015; Alivernini et al., 2018; De Simone, 2013; Jeffries et al., 2020; Le Donne, 2014; OECD, 2016; Sahin et al., 2017; Turner et al., 2019; Van de Werfhorst & Mijs, 2010). Almost all these assumptions were confirmed. As a whole, it can be argued that boys, students with a higher SES and those attending grammar schools are more likely to belong to the more adaptive "scientists" profile. A profile one assumes will find its way to the STEM career more quickly than the other groups. This is an important finding given the gender gap in science (Alivernini et al., 2018; De Simone, 2013), as well as the high levels of intergenerational persistence of educational attainment in Italy (Checchi et al., 2013). Both these imply that students from the lower SES range and girls will be less likely to move into the STEM careers, which is in line with earlier findings (Jeffries et al., 2020; Mau & Li, 2018). Although it is argued that the gender gap in STEM university entry and later graduation can be explained by high school STEM readiness and scientific content (Card & Abigail, 2017), the enrollment rates in Italy also confirm this gap (Anelli & Peri, 2015). Although girls outnumber boys in the overall enrollment rates at the university level, only 38% of first-year students in natural science courses were girls (the academic year 2016/2017; MIUR, 2017).

At the same time, despite the gender gap being in favor of boys, within the "informal inquirers" profile (i.e., students who mainly fulfill their interest in science outside school), no differences across the educational profiles were found. This implies that through the system, at least for the students in our sample, many of them show interest in science, but the system does not successfully attract them to exercise that interest within its constraints, thus inevitably contributing to their poorer outcomes (Chen et al., 2019; Sälzer & Heine, 2016). However, several aspects work in favor of potential intervention. Recent findings indicate that informal science venues support the formation of science identities in girls (Todd & Zvoch, 2019). This idea can be taken as an advantage and purposely embedded in the science instructions to target female students and increase the odds of them pursuing future STEM careers (Nagy et al., 2010), especially because of a previous finding that the quality of instruction is among leading contributors to reach optimal students outcomes (Chen et al., 2019). Second, given the fact that "informal inquirers" are the second-highest achieving group compared with the others, interventions that focus on raising awareness of their ability and how that same ability is perceived would be helpful. Indeed, earlier studies suggest a higher level of perceived ability is associated with a higher level of engagement in both boys and girls (Fredricks et al., 2018; Sahin et al., 2017). Finally, because it is argued that interest and enjoyment ought to come "hand in hand" to foster optimal outcomes (Jack & Lin, 2018; Palmer et al., 2017), taking advantage of the informal science venues associated with enjoyment can work in favor of raising students' interest within school, ultimately attracting more students to future STEM professions (Guo et al., 2015).

The "uncommitted" and the "uninterested" profiles combined amount to one-quarter of all students and, more importantly, are saturated by students from the lower SES range. Given the multifaceted relationship between gender and SES and career choices, these students require interventions focused on their attitudes towards science, such as interest and enjoyment (Jeffries et al., 2020), along with programs focusing on self-efficacy (Bandura et al., 2003; Britner & Pajaras, 2006) because these mediate the effect of SES, providing more equal chances in school. However, whether certain relationships in this triangle are pertinent to boys or girls requires additional inquiry (Fredricks et al., 2018).

The results on the association between the profiles and immigrant background provided significant findings for second-generation students (i.e., less likely to belong to both "scientists" and "uninterested" profiles than the natives) and warrant further exploration to better understanding this positioning. Contrary to the findings of Alivernini et al. (2018) on the different quality of motivation between first- and second-generation students, we find our results inconclusive in that respect. Although differences can be found in comparison to the native students, differentiation is not found between the two immigrant categories. At the same time, we could attribute this to the effect of schooling because, in this investigation, we focus on the 15-year-olds compared with fifth graders in Alivernini et al.'s (2018) study.

Finally, as we assumed, profiles with optimal patterns of motivational and self-related dispositions (e.g., Fryer & Ainley, 2019; Grabau and Ma 2017; Jack & Lin, 2018; Jeffries et al., 2020; Mason et al., 2013; Palmer et al., 2017) scored the highest across the different science subdomains. The outperformance of the "scientists" remained, even when controlled for by student SES and immigrant background. This implies that motivational and self-related dispositions profoundly impact science-related outcomes and learning trajectories (Grabau & Ma, 2017; Jeffries et al., 2020) although student background variables and gender still hold important positions in the discussion on the attitude–outcome continuum (Alivernini & Manganelli, 2015; Chen et al., 2019; Jeffries et al., 2020; Lam & Lau, 2014). The "scientists" also outperform others regarding environmental awareness, which aligns with earlier findings by Lee (2020). At the same time, the lowest level of environmental awareness is not a dominant feature of the lowest-performing profile (i.e., the practical inquirer) when measured by science achievement. Although environmental awareness is often seen as part of scientific competence, the characteristics of the "practical inquirer" profile further stresses the importance of self-belief in understanding these associations across diverse student groups.

Surprisingly, though, the groups that do exhibit interest in science in informal settings show significant variations in their performance. Although the "informal inquirers" were the second-best performing group, the "practical inquirers" scored the lowest. When observing these two groups against each other, the latter is even more detrimental regarding their perception of interest in the broader topics in science, raising issues of their involvement or nonparticipation in those topics in a school setting (Chen et al., 2019). At the same time, their beliefs on the nature of scientific knowledge show a particular quality: they seem to be disconnected from the notion of the necessity to justify scientific knowledge (e.g., in experiments), as well as that over time, the nature of knowledge we claim as accurate in a particular scientific field may change (Conley et al., 2004). We assume that this type of understanding of the nature of science can hinder grappling with the scientific phenomena and the logic of science and facilitate reduced performance in the field. The assumption warrants further investigation but is vital given the instrumental value these students give to science. As additional support for this claim, we find a similar profile in Kampa et al. (2016) relative to students' understanding of the evolving nature of knowledge; these students exhibited similar achievement patterns like the ones in the "practical inquirers" profile.

The learning environment within the school is seen as vital in promoting optimal student outcomes. The strongest achieving group, the "scientists", reported a more supportive environment regarding adaptive instruction, perceived feedback, teacher support and teacher-directed instruction. These results support and contradict the earlier findings of Lau and Lam (2017), where there is the negative association of perceived feedback and positive for other variables (i.e., adaptive instruction and teacher-directed teaching). At the same time, because the "scientists" show the most positive scheme of examined self-perceptions, their positive association to teacher-directed instruction aligns with the findings of Areepattamannil et al. (2020). Conversely, neither of the two dimensions assessing inquiry is reported as the most frequent among the highest performing group. Earlier findings have indicated that teacher-led inquiry is expected to be conducive of student outcomes, while student-lead inquiry is tied to lower achievement (Aditomo & Klieme, 2020; Lau & Lam, 2017). A possible explanation may be because some of the less competent groups that inform of more frequent practices related to the inquiry are also the profiles with the least adaptive combination of self-beliefs in connection to the field of science. Thus, despite the opportunities that inquiry practices may afford in relations to student outcomes, these are hindered by students' negative attitudes to science.

5 | LIMITATIONS AND FURTHER RESEARCH

The focus of the current study was to better understand the versatility of students' attitudes in connection to science. Although we have managed to uncover five distinct student profiles and examined these across gender, educational programs, immigration, and SES, the current study is not without its limitations. Although self-reported measures are prone to social desirability, adopting these has allowed us to use well-established scales and connect the findings to previous studies. At the same time, by using PISA constructs, we were limited by the dimensionality defined in these measures (e.g., only two dimensions of Conley's epistemological framework compared with the four in the full model).

Nonetheless, the results allow us to postulate future steps. From the perspective of an LPA, this can be dual. We can conduct a multigroup comparison across different education systems (Morin et al., 2016), thus widening the national contexts on which the phenomena we investigated are examined. Indeed, PISA data would allow for this. On the other hand, if representative samples (i.e., like in PISA) with multiple time points are an option, this would create opportunities for a longitudinal LPA. This would allow for examining if students shift between profiles throughout these time points or stay in the same. Similar patterns could be observed across countries as well. However, if we depart from an LPA, a mixed-methods approach might reveal the extent to which the profiles established in the present study are recognizable among the students and not merely a measurement artifact.

Finally, the observed differences across educational programs allow us to create new hypotheses of the accumulated effects in the Italian system itself and how possible failures in previous grades when it comes to providing equal opportunities to all students facilitates some of the differences in the motivational and belief systems of the students later on. Although the assumption warrants more fine-grained analyses, it could eventually shed light on different school actors regarding how to support their students for participation in a society that relies more and more on science.

6 | CONCLUSIONS

The focus of the current study was on investigating students' attributes in connection to science and how these are associated with science achievement. In addition, we looked at these against students' SES and immigrant background, as well as gender and the study programs students were enrolled in and the accompanying learning environment. Relying on the affordances of a person-centered approach, we aimed at contributing to the overall discussion on who are the students who may potentially choose STEM paths (Jeffries et al., 2020; Wang, Ye et al., 2017) and what may be possible remedies for attracting more students from vulnerable groups into the field (Nagy et al., 2010; Turner et al., 2019). Analyses were performed using Italy as an example, a country with reported achievement in science below the OECD average and significant differences between boys and girls, the native versus immigrant populations and SES students, both in achievement and attributes, especially when it comes to science (Alivernini et al., 2018; De Simone, 2013; OECD, 2016; Van de Werfhorst & Mijs, 2010). Italy is also an example of a system that implemented early tracking in education (Le Donne, 2014).

Our results differentiate between five student profiles, with both adaptive and less adaptive patterns of motivational and self-related dispositions about science, favoring boys, students from grammar schools, and high SES students in the adaptive profiles. The results relative to students' immigrant background remain inconclusive when compared with earlier results (Alivernini et al., 2018). However, our results also confirm the importance of optimal motivational and self-related dispositions to student achievement, even when accounting for SES and the immigrant background of the students, thus contributing to the ongoing discussions on the relative contribution of particular factors to student outcomes (e.g., Alivernini & Manganelli, 2015; Chen et al., 2019; Jeffries et al., 2020; Lam & Lau, 2014; Snodgrass Rangel et al., 2020). In addition, our findings reveal a number of students who could still be regarded as interested in science, even though they tie this interest primarily to out-of-school experiences. This is especially important to those students from vocational programs. In this way, we were able to demonstrate that interest and engagement cannot be solely viewed as "yes" or "no" categories and should instead be observed on a continuum, intertwining different settings and diverse students' micro and macro categories.

CONFLICT OF INTERESTS

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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APPENDIX 1: OVERVIEW OF THE ITEMS IN CONSTRUCTS USED IN LPA

Overview of the constructs	Items
Interest in broad science topics (INTBRSCI)	To what extent are you interested in the following < broad science > topics? Biosphere (e.g. ecosystem services, sustainability) Motion and forces (e.g. velocity, friction, magnetic and gravitational forces) Energy and its transformation (e.g. conservation, chemical reactions) The Universe and its history How science can help us prevent disease
Enjoyment of science (JOYSCIE)	I generally have fun when I am learning < broad science > topics. I like reading about < broad science > . I am happy working on < broad science > topics. I enjoy acquiring new knowledge in < broad science > . I am interested in learning about < broad science > .
Instrumental motivation (INSTSCIE)	Making an effort in my < school science > subject(s) is worth it because this will help me in the work I want to do later on. What I learn in my < school science > subject(s) is important for me because I need this for what I want to do later on. Studying my < school science > subject(s) is worthwhile for me because what I learn will improve my career prospects. Many things I learn in my < school science > subject(s) will help me to get a job.
Science self-efficacy (SCIEFF)	Recognize the science question that underlies a newspaper report on a health issue. Explain why earthquakes occur more frequently in some areas than in others. Describe the role of antibiotics in the treatment of disease. Identify the science question associated with the disposal of garbage. Predict how changes to an environment will affect the survival of certain species. Interpret the scientific information provided on the labeling of food items. Discuss how new evidence can lead you to change your understanding about the possibility of life on Mars. Identify the better of two explanations for the formation of acid rain.
Epistemological beliefs about science (EPIST)	A good way to know if something is true is to do an experiment. Ideas in < broad science > sometimes change. Good answers are based on evidence from many different experiments. It is good to try experiments more than once to make sure of your findings. Sometimes < broad science > scientists change their minds about what is true in science. The ideas in < broad science > science books sometimes change.
Students' science activities (SCIEACT)	Watch TV programs about < broad science > Borrow or buy books on < broad science > topics Visit websites about < broad science > topics Read < broad science > magazines or science articles in newspapers Attend a < science club > Simulate natural phenomena in computer programs/virtual labs Simulate technical processes in computer programs/virtual labs Visit websites of ecology organizations Follow news of science, environmental, or ecology organizations via blogs and microblogging

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Overview of the constructs	Items
Interactive investigation	Students are required to argue about science questions.
	Students are allowed to design their own experiments.
	There is a class debate about investigations.
Interactive application	Students are given opportunities to explain their ideas.
	The teacher explains < school science > idea can be applied.
	The teacher clearly explains relevance < broad science > concepts to our lives.
Teacher support in science classes (TEACHSUP)	The teacher shows an interest in every student's learning.
	The teacher gives extra help when students need it.
	The teacher helps students with their learning.
	The teacher continues teaching until the students understand.
	The teacher gives students an opportunity to express opinions.
Teacher-directed science instruction (TDTEACH)	The teacher explains scientific ideas.
	A whole class discussion takes place with the teacher.
	The teacher discusses our questions.
	The teacher demonstrates an idea.
Perceived feedback (PERFEED)	The teacher tells me how I am performing in this course.
	The teacher gives me feedback on my strengths in this < school science > subject.
	The teacher tells me in which areas I can still improve.
	The teacher tells me how I can improve my performance.
	The teacher advises me on how to reach my learning goals.
Adaption of instruction (ADINST)	The teacher adapts the lesson to my class's needs and knowledge.
	The teacher provides individual help when a student has difficulties understanding a topic or task.
	The teacher changes the structure of the lesson on a topic that most students find difficult to understand.

APPENDIX 2: OVERVIEW OF THE DIFFERENCES BETWEEN STUDENT PROFILES RELATIVE TO GENDER, ESCS, LEARNING ENVIRONMENT VARIABLES, GENDER, AND EDUCATIONAL PROGRAMS

Comparison groups	ESCS	Interactive investigation	Interactive application	Teacher support	Teacher-directed instruction	Perceived feedback	Adaption of instruction	Environmental awareness
Uncommitted vs. Uninterested	**0.000**	0.098	**0.036**	0.288	**0.004**	0.662	**0.002**	**0.000**
Uncommitted vs. Informal inquirer	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**
Uncommitted vs. Practical inquirer	**0.001**	**0.000**	**0.000**	**0.000**	**0.031**	**0.016**	**0.001**	**0.006**
Uncommitted vs. Scientist	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**
Uninterested vs. Informal inquirer	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**
Uninterested vs. Practical inquirer	0.309	**0.000**	**0.000**	**0.000**	0.478	**0.001**	0.067	0.088
Uninterested vs. Scientist	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**
Informal inquirer vs. Practical inq.	0.107	**0.000**	**0.003**	0.173	**0.030**	0.837	0.208	**0.000**
Informal inquirer vs. Scientist	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**
Practical inquirer vs. Scientist	**0.000**	0.794	0.451	0.215	**0.000**	**0.003**	**0.000**	**0.000**

	Gender (Boys)			
Profile	*p*	*p*	*p*	*p*
Uncommitted	*	0.125	**0.000**	**0.000**
Uninterested	0.058	*	**0.000**	**0.000**
Informal inquirer	**0.001**	**0.000**	*	**0.014**
Practical inquirer	**0.005**	**0.000**	**0.001**	*
Scientists	**0.000**	**0.000**	**0.000**	0.622

Note: * Denotes the reference category.

APPENDIX 3: OVERVIEW OF THE DIFFERENCES BETWEEN STUDENT PROFILES RELATIVE TO THEIR ACHIEVEMENT IN SCIENCE WITHOUT AND WITH COVARIATES

Comparison groups	Science achievement	Competency Subscale-Explain Phenomena Scientifically	Competency Subscale-Evaluate & Design Scientific Inquiry	Competency Subscale-Interpret Data & Evidence Scientifically	Knowledge Subscale-Content	Knowledge Subscale-Procedural & Epistemic	System Subscale-Physical	System Subscale-Living	System Subscale-Earth & Science
Uncommitted vs. Uninterested	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**
Uncommitted vs. Informal inquirer	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**
Uncommitted vs. Practical inquirer	0.399	0.393	0.353	0.365	0.395	0.386	0.396	0.399	0.367
Uncommitted vs. Scientist	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**
Uninterested vs. Informal inquirer	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**
Uninterested vs. Practical inquirer	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**
Uninterested vs. Scientist	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**
Informal inquirer vs. Practical Inq.	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**
Informal inquirer vs. Scientist	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**
Practical inquirer vs. Scientist	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**

Note: Analyses used plausible values simultaneously and was performed for the overall achievement scale (PVSCIE) and its subcomponents.

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Comparison groups	PV1SCIE	PV2SCIE	PV3SCIE	PV4SCIE	PV5SCIE	PV6SCIE	PV7SCIE	PV8SCIE	PV9SCIE	PV10SCIE
Comparison groups	**PV1SCIE**	**PV2SCIE**	**PV3SCIE**	**PV4SCIE**	**PV5SCIE**	**PV6SCIE**	**PV7SCIE**	**PV8SCIE**	**PV9SCIE**	**PV10SCIE**
Uncommitted vs. Uninterested	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**
Uncommitted vs. Informal inquirer	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**
Uncommitted vs. Practical inquirer	1.000	1.000	1.000	1.000	1.000	0.712	1.000	1.000	1.000	1.000
Uncommitted vs. Scientist	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**
Uninterested vs. Informal inquirer	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**
Uninterested vs. Practical inquirer	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**
Uninterested vs. Scientist	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**
Informal inquirer vs. Practical inq.	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**
Informal inquirer vs. Scientist	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**
Practical inquirer vs. Scientist	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**

Note: Analyses with covariates used plausible values for the overall achievement scale (PVSCIE).