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Are Integrated STEM Educational Reforms at Risk? Teachers' Motivations and Perceived Barriers to Integration

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ABSTRACT

Integrated STEM education (iSTEMe) is increasingly emphasized in educational reforms around the world. These reforms prompted curricular changes in many countries, including Spain. In the Autonomous Community of Valencia, a new curriculum model was introduced that organized both STEM and non-STEM subjects into broader interdisciplinary domains, designed to be taught through an integrated approach. However, the success of such reforms largely depends on teachers, who are the primary agents of educational change. This underscores the importance of understanding their motivation and intention to implement iSTEMe. Drawing on the expectancy-value-cost model, this study examined secondary education teachers' motivations toward iSTEMe, with a particular focus on STEM teachers, who comprised 70.2% of the total sample ($N = 439$). The research addressed four key questions: RQ1. What are secondary school teachers' expectancies for success, values, perceived costs, and intentions to implement iSTEMe?; RQ2. How do secondary school teachers' expectancies for success, values, perceived costs, and intentions to implement iSTEMe vary according to sociodemographic characteristics?; RQ3. To what extent are secondary school teachers' expectancies for success, values, and perceived costs related to their intentions to implement iSTEMe?; and RQ4. To what extent do sociodemographic characteristics mediate the relationship between teachers' expectancies for success, values, and costs and their intention to implement iSTEMe? Multivariate analysis and Partial Least Squares Structural Equation Modeling revealed that teachers generally feel unprepared to implement iSTEMe, perceive limited pedagogical value in it, and associate it with significant instructional and learning challenges. Consequently, their intention to adopt iSTEMe was low, and this was associated with the perceived lack of pedagogical value. These findings raise concerns about the feasibility of iSTEMe reforms, which may struggle to succeed without stronger support and greater teacher engagement.

1 | Introduction

Integrated STEM education (iSTEMe), a teaching approach that integrates content and skills from Science, Technology, Engineering, and Mathematics, has received significant attention over the past decade (English 2016; Martín-Páez et al. 2019; NAE and NRC 2014; Sanders 2009). This has led to educational reforms worldwide demanding its implementation. Johnson and Czerniak's (2023) review highlights iSTEMe as a growing global movement, with the USA, Asia, and Europe at the forefront, and extending to Australia and parts of Africa. Despite its popularity, the STEM agenda faces several criticisms. Scholars have pointed to its roots in capitalist and neoliberal frameworks, noting that it is often workforce-driven and aimed at boosting economic growth (Carter 2017; Hoeg and Bencze 2017). Its epistemological and ontological foundations are still underdeveloped and not yet consensual (Akerson et al. 2018; Erduran 2020; Johnson and Czerniak 2023; Lyons 2020, Toma et al. 2024). In addition, it is argued that there is limited empirical evidence on its effectiveness, feasibility, relevance, and overall coherence (Giffney and Lane 2025; Hytten and Stemhagen 2020; Martín-Páez et al. 2019; McComas and Burgin 2020; Quílez 2022; Toma and García-Carmona 2021; Weinstein et al. 2016). The implementation of iSTEMe has also been found to present practical challenges. Teachers are often required to teach outside their areas of expertise, a phenomenon known as out-of-field teaching, which poses a major challenge for teachers (Hallström et al. 2024; Hobbs and Porsch 2021; Du Plessis 2020). As a result, teachers often report low self-efficacy in iSTEMe, primarily due to limited content knowledge and the appropriate pedagogical strategies, as well as a decline in teaching enthusiasm, attitudes, and motivation (García-Carmona and Toma 2024; Du Plessis 2020; El-Deghaidy et al. 2017; Thibaut et al. 2019).

Despite ongoing critiques, there is a strong emphasis on the implementation of iSTEMe. It is suggested that iSTEMe allows students to apply STEM knowledge and practices in realistic scenarios that mirror real-world problems (Roehrig et al. 2021). Proponents argue that it helps prepare students for STEM careers and jobs (Takeuchi et al. 2020) and builds skills needed to address global issues, such as environmental challenges (Moore et al. 2014; Martín-Páez et al. 2019). Researchers also emphasize that learning isolated facts is no longer sufficient to develop competencies to successfully meet the problems and challenges of the 21st century (Bybee 2018; Roehrig et al. 2021). Indeed, traditional subject boundaries may limit students' ability to integrate and apply knowledge in meaningful ways (Kelley and Knowles 2016).

The success of the iSTEMe educational reform depends on teachers, who are responsible for applying it in schools. Teachers' decisions to adopt new policies are shaped by their beliefs, context, and perceptions of feasibility (Porter and Allen 2025). If teachers question a reform's value or practicality, they are likely to resist it (Cohen and Mehta 2017). Understanding these motivations is therefore crucial. This study aims to identify and model the key factors influencing teachers' motivation toward iSTEMe. To this end, this investigation draws on the Expectancy-Value-Cost theory (EVC, Barron and Hulleman 2015) and focuses specifically on the recent educational reform in Spain (Royal Decree 217/2022 (2022)) from the implementation of a new education law (Organic Law 3/2020 (2020)). The last curricula introduced a new, globalized, and interdisciplinary STEM competence that requires the explicit integration of disciplines, serving as a representative example of the broader international movement toward iSTEMe. This is a timely and novel endeavor that provides valuable insights for policymakers and researchers invested in this approach. While situated in Spain, this study has international significance due to the global demand for iSTEMe (Johnson and Czerniak 2023). The research questions are fourfold:

- RQ1. What are secondary school teachers' expectancies for success, values, perceived costs, and intentions to implement iSTEMe?
- RQ2. How do secondary school teachers' expectancies for success, values, perceived costs, and intentions to implement iSTEMe vary according to sociodemographic characteristics?
- RQ3. To what extent are secondary school teachers' expectancies for success, values, and perceived costs related to their intentions to implement iSTEMe?
- RQ4. To what extent do sociodemographic characteristics mediate the relationship between teachers' expectancies for success, values, and costs and their intention to implement iSTEMe?

2 | Theoretical Underpinnings

2.1 | Defining iSTEMe

Since its inception, iSTEMe has been a source of much ambiguity, leading to diverse interpretations and even disagreements about its implementation (McLure et al. 2022; Takeuchi et al. 2020). Therefore, it has been a major source of confusion among researchers and teachers (Dare et al. 2019; Wong et al. 2016). Sanders' (2009) definition refers to a contextualized problem-solving approach that combines at least two STEM disciplines. Kelley and Knowles (2016) consider it an approach to teaching two or more STEM domains linked by STEM practices in an authentic context to enhance student learning. Other authors (e.g., Cunningham 2018; Quinn et al. 2020) conceptualize STEM through an engineering lens, which requires teaching STEM content through engineering design. After a literature review, Martín-Páez et al. (2019) concluded that it is "(…) a teaching approach that integrates content and skills specific to science, technology, engineering, and mathematics" (p. 815). The aim is to integrate STEM content and skills into the teaching process, creating opportunities to learn and use it in realistic scenarios similar to real-world problems (NAE and NRC 2014; Roehrig et al. 2021).

Indeed, progress has been achieved in how iSTEMe is conceptualized. For example, Kelley and Knowles (2016) defined iSTEMe through a framework emphasizing situated learning, engineering design, scientific inquiry, technological literacy, and mathematical thinking as an integrated system, particularly relevant for secondary education. Bybee (2018) provided guidelines for designing STEM units and using them to support teacher professional development. Roehrig et al. (2021) proposed a conceptual framework with seven key characteristics to guide research on iSTEMe's specific components. Toma et al. (2024) have introduced a socioconstructivist didactic model aimed at helping teachers develop iSTEMe teaching units in elementary education through inquiry-based teaching and engineering design.

Yet not all that glitters is gold. iSTEMe is still a loosely defined and investigated approach that has impact in the highest levels of educational policy (Lyons 2020). Further growing criticisms regarding its propagandistic use and lack of educational novelty are also on the rise (Blackley and Howell 2015). Akerson et al. (2018) argued that the nature of STEM as a construct is unclear. The conceptualization of Technology and Engineering in iSTEMe is also debated, with some educators viewing E as inherent to T, while others define E as a distinct discipline that should be promoted within the curricula (García-Carmona and Toma 2024; Hallström et al. 2024; NAE and NRC 2014; Quinn et al. 2020).

2.2 | Pedagogical and Theoretical Issues of Integrated STEM Education

Although the viability and effectiveness of an authentic iSTEMe in the classroom is currently inconclusive, it is alive and well in curriculum reforms worldwide (Johnson and Czerniak 2023). One of the main barriers to iSTEMe is that a consensus on how it should be designed, implemented and assessed in the classroom is yet to be achieved (White and Delaney 2021). Consequently, diverse models, frameworks and approaches for its implementation exist in the literature. For some, it entails promoting cross-cutting themes among the practices of various disciplines (Reynante et al. 2020). Others suggest an approach to iSTEMe that combines real-world problems (Kelley and Knowles 2016; Moore et al. 2014), which may also include non-STEM subject or content (Roehrig et al. 2021; Sanders 2009). Likewise, others view it as promoting engineering design practices; hence, iSTEMe should pivot around engineering design practices (Quinn et al. 2020; Roehrig et al. 2021), even though engineering, unlike the remaining STEM subjects in the acronym, is not a specific formal subject in the educational curriculum (García-Carmona 2023).

Consequently, there is still no consensus on several pedagogical aspects of iSTEMe. For instance, some authors propose to integrate a minimum of two STEM disciplines (Kelley and Knowles 2016), while others advocate for all four (Martín-Páez et al. 2019). Also, the spectrum for integration ranges from disciplinary to transdisciplinary approaches (Bybee 2018; Gresnigt et al. 2014). The pedagogical strategies for the implementation of iSTEMe are also not established, with researchers promoting a myriad of approaches, including inquiry, project-based learning, engineering design, or design-thinking, to name a few (Kelley and Knowles 2016; Margot and Kettler 2019; McLure et al. 2022; NAE and NRC 2014; Roehrig et al. 2021). Some iSTEMe proposals emphasize connecting content across subjects, while others prioritize a specific context or discipline, like engineering, giving it dominance (Martín-Páez et al. 2019; Roehrig et al. 2021). Further complicating these issues, new acronyms have emerged, like STEAM (including arts) and STREAM (adding robotics), which have raised questions about how, what and why to integrate such disciplines (Mejias et al. 2021; Quílez 2022; Toma and García-Carmona 2021). This lack of clarity has led to the proliferation of ill-defined and educationally deficient proposals promoted under the iSTEMe umbrella (McComas and Burgin 2020; NAE and NRC 2014).

In this study, we have adopted the conceptualization reflected in the new reform-oriented curricula from the Spanish context, which has informed this investigation. This new educational regulation frames iSTEMe as the combination of disciplines, selected by schools, into broader curricular domains. These domains may include both STEM and non-STEM subjects and must integrate at least two disciplines. Although we agree that integrated STEM proposals should ideally reflect the integration of all four disciplines within the acronym, as advocated by Martín-Páez et al. (2019), we also recognize the need to analyze how these broader, more flexible approaches, such as those promoted in the Spanish curriculum, affect teachers' motivations. This curriculum reform is detailed in the following section.

2.3 | iSTEMe in Spain

Spain is no stranger to the promotion of iSTEMe. The implementation of a new education law in Spain (Organic Law 3/2020) led to a curricula reform, which established a new globalized, and interdisciplinary *STEM competence*. This reform plan resembles international praxis and conceptualizations of iSTEMe (Kelley and Knowles 2016; Sgro et al. 2020). Its promotion requires explicit integration of content and learning goals across STEM and non-STEM areas. This curricular reform was extended to the whole Spanish territory from 2022 (Royal Decree 217/2022 (2022)). However, the Community of Valencia, an autonomous community of Spain, was at the forefront of its implementation since it brought this educational policy forward 2 years ahead of the one planned for the entire country (Council of Education Culture and Sports 2020). Starting in the 2020/2021 academic year, this regional educational reform required that schools had to compulsorily create new, broader curricular domains resulting from the integration of several subjects. The most chosen arrangement by schools involved three subjects. Specifically, in the case of the STEM area: Biology, Math and Technology and for the non-STEM domain: Spanish, Valencian, and Geography, although in the reform document, there were instances of schools integrating STEM and non-STEM subjects: Spanish, Geography, Biology, and Technology subjects (Council of Education, Culture and Sports 2020, 18362).

Although the official curriculum for individual subjects remained unchanged, schools were required to develop alternative programming to support integrated instruction. The official resources provided to teachers were several examples of instructional units featuring real-life contexts and emphasizing a competency-based, student-centered approach. All of these were in line with the usual suggestions for the implementation of iSTEMe (Kelley and Knowles 2016; Roehrig et al. 2021). In the case of STEM teachers, this meant that, although they were specialists in only one subject (e.g., Biology), they were now expected to teach additional subjects (e.g., Mathematics and Technology) in an integrated manner. This out-of-field teaching posed a challenge, particularly when having to teach subjects beyond their teaching specialization. The total number of hours per week allocated to implement each newly created domain depended on the subjects that had been integrated, as this amount resulted from the sum of the previously existing weekly workload for each subject separately. For example, the STEM domain mentioned retained a total of 9 weekly hours, reflecting the sum of each subject's prior allocation.

These aspects presented a mismatch between teachers' training and the new reform's demands. As in many countries, in Spain, secondary school teachers specialize through a 4-year university degree in a specific discipline (e.g., University Degree in Biology) and a 1-year master's degree in its specific pedagogy that allows them to teach subjects related to their discipline (e.g., Biology in secondary school). While each subject had a specialized teacher, this reform involved a sudden change in the teachers' role, as they had to teach subjects outside of their field, despite their lack of expertise and formal training in the added subjects. This shift prompted significant opposition from teachers, which eventually led to several lawsuits (ANPE National Association of Teaching Professionals 2022). As a consequence, the compulsory aspect of the reform was revoked. Starting in the 2023/2024 academic year, schools were given the option to implement it if they considered it appropriate. This shift raises important questions about teachers' willingness to adopt it and the factors that may influence or moderate their intentions.

2.4 | Challenges in the Implementation of iSTEMe

Several authors have raised concerns about the implementation of the iSTEMe educational reform. Lederman and Lederman (2013) and the NAE and NRC (2014) noted that, despite long-standing efforts at integration, empirical support remains equivocal. This lack of evidence for iSTEMe persists nowadays (Johnson and Czerniak 2023). A major contributing factor might be the persistence of discipline-based approaches in teacher education. Initial and ongoing professional development programs still focus on single subjects, confining teachers within their disciplinary specialties (Montero and García-Carmona 2018). Consequently, many teachers are assigned to teach subjects for which they lack formal qualifications and training (Johnson and Czerniak 2023; Sgro et al. 2020), a questionable practice known as out-of-field teaching (Hobbs and Porsch 2021; Luft et al. 2020).

As briefly pointed out above, out-of-field teaching constitutes a significant barrier to effective iSTEMe implementation (Akerson et al. 2018; Quílez 2022). Teachers often feel unprepared to integrate disciplines beyond their area of expertise, lacking both the content and pedagogical knowledge necessary for interdisciplinary instruction (García-Carmona and Toma 2024; Margot and Kettler 2019; Thibaut et al. 2019). This sense of unpreparedness hampers their ability to understand and apply iSTEMe approaches effectively (Aydin-Gunbatar et al. 2020). Despite pedagogical content knowledge being a critical component of teacher quality that affects student achievement (She et al. 2025), iSTEMe often requires teaching beyond teachers' areas of expertise, contributing to a shortage of qualified educators (Johnson and Czerniak 2023). Secondary science teachers frequently lack the content and pedagogical knowledge for unfamiliar subjects (Perl-Nussbaum et al. 2025; Kind 2014), especially in engineering (Love and Love 2023). Integrating engineering into science and math classes is particularly difficult due to limited disciplinary and pedagogical knowledge (García-Carmona and Toma 2024; Guzey et al. 2019; Zhan et al. 2021; Love and Hughes 2022). This also raises safety concerns with engineering lab tools (Love 2022).

Teachers also struggle to understand technology's role in iSTEMe and its links to other subjects (Ring-Whalen et al. 2018). As a result, iSTEMe often leads to superficial interdisciplinary practices misaligned with curriculum goals (Hasni et al. 2015; McLure et al. 2022). Hence, out-of-field teaching affects teachers' self-efficacy and enthusiasm (Handtke and Bögeholz 2023), which may be related to poor curricular choices and difficulty addressing student misconceptions (Du Plessis 2020; El-Deghaidy et al. 2017). Indeed, students taught by out-of-field teachers perform worse than those taught by certified teachers (Van Overschelde 2022; Sheppard et al. 2020).

2.5 | Interpretative Lens to Study Teacher's iSTEMe Motivation: EVC Theory

The adoption of iSTEMe is a multifaceted challenge, complicated by the widespread practice of out-of-field teaching, where educators are assigned subjects beyond their expertise. Because iSTEMe requires strong content and pedagogical knowledge across multiple disciplines, this practice creates significant barriers for teachers. In this study, however, out-of-field teaching is considered a contextual factor rather than a central interpretative lens. Our primary framework for understanding teachers' willingness to adopt iSTEMe is from a motivational perspective, which is of utmost importance in understanding the success of educational reforms (Porter and Allen 2025).

Indeed, previous research has examined teachers' perceptions of iSTEMe. Margot and Kettler (2019) reviewed 25 studies and found that, although teachers generally value STEM education, they face multiple barriers. These include pedagogical, curricular, and structural challenges, as well as concerns related to assessment and limited support. Similarly, Martynenko et al. (2023) conducted a review of 23 studies, identifying that teachers' attitudes toward iSTEMe vary depending on country and educational context. While existing literature highlights the obstacles perceived by teachers (Giffney and Lane 2025; Margot and Kettler 2019), it lacks a focus on the motivational factors that influence their intentions to adopt iSTEMe. Although much is known about teachers' attitudes, barriers, and challenges, research on the internal drivers behind their decisions to engage with iSTEMe remains scarce.

Given the pedagogical challenges and barriers reported in the literature (Margot and Kettler 2019; Ryu et al. 2019), it is reasonable to consider that teachers' intentions to adopt and implement iSTEMe is low. To test this general hypothesis, the present study draws on the EVC theory and focuses on teachers' expectancies of success, values, and perceived costs of iSTEMe (Barron and Hulleman 2015). This model, rooted in the Situation Expectancy-Value motivational model (SEVT, Eccles and Wigfield 2020), provides a strong theoretical foundation to investigate motivational factors. It has been widely used in education research (Jiang and Rosenzweig 2021) and has proven effective in explaining how motivation shapes individuals' choices, persistence, and performance (Eccles and Wigfield 2020; Rosenzweig et al. 2022). By applying the EVC model, this study aims to go beyond general attitudes and examine the specific motivational processes that are related to teachers' decisions to adopt iSTEMe.

Specifically, SEVT was originally conceptualized as consisting of two key constructs: expectancies of success and task

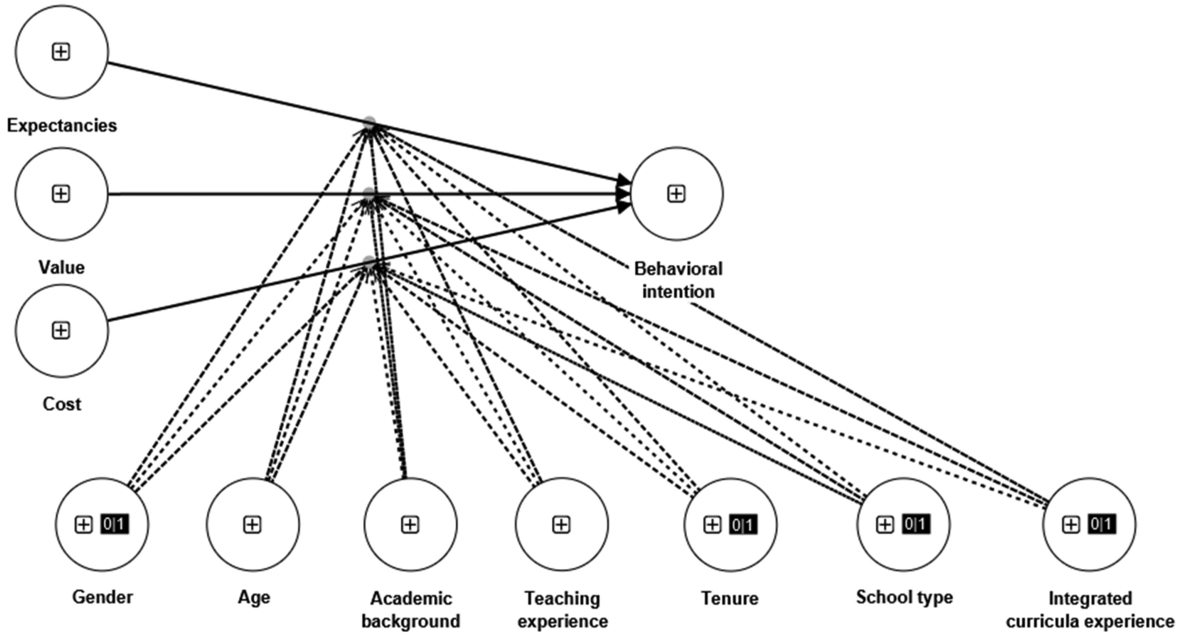

FIGURE 1 | The research model investigated.

values (Eccles and Wigfield 2020). The first construct includes performance-related beliefs, such as completing a specific task successfully. The second construct includes *attainment value* (whether the task is important for one's own identity), *intrinsic value* (the anticipated enjoyment from doing the task), *utility value* (whether the task fits into individuals' present or future plans), and *cost* (negative appraisals about what must be given up or the anticipated effort for task completion) (Eccles and Wigfield 2020).

The SEVT conceptualizes cost as a dimension of the task-value construct (Rosenzweig et al. 2019). However, several studies suggest that cost should be considered a separate first-order construct (Barron and Hulleman 2015; Jiang and Rosenzweig 2021). Cost refers to barriers or negative feelings about what is invested or given up doing a task, such as effort, lost alternatives, or emotional strain like stress and anxiety. Such re-conceptualization is called the EVC model (Barron and Hulleman 2015), which consists of three first-order, unidimensional constructs that draws on empirical results signaling that task-value dimensions tend to load on a single factor (Eccles and Wigfield 2020; Kosovich et al. 2015). This study adopts this conceptualization (Figure 1) (Barron and Hulleman 2015; Eccles and Wigfield 2020; Jiang and Rosenzweig 2021), and extends previous studies on teachers' attitudes toward iSTEMe (Martynenko et al. 2023; Thibaut et al. 2019). The expectancy construct refers to teachers' beliefs about whether they will be successful at adopting iSTEMe. The value construct is defined as teachers' beliefs about whether the adoption of iSTEMe has educational value. Finally, the cost construct refers to teachers' negative appraisals related to the adoption of iSTEMe, and includes aspects related to emotional cost, loss of valued (teaching) alternatives, or the effort it involves to adopt iSTEMe (Eccles and Wigfield 2020; Flake et al. 2015). Sociodemographic variables are included as moderators of the relationship between EVC constructs and behavioral intention to adopt iSTEMe.

Sociodemographic variables are integral to EVC. They influence expectancies for success, task value, and perceived cost, creating varying motivational levels among individuals (Eccles and Wigfield 2020). Consequently, we included several sociodemographic variables as potential mediators. Thibaut et al. (2019) found that personal background characteristics influence teacher attitudes. These characteristics include gender, teaching experience, and previous experience with iSTEMe. Subject discipline also affects adoption. For instance, mathematics teachers often find iSTEMe adoption more difficult (Diego-Mantecon et al. 2021) and tend to have lower self-efficacy for iSTEMe than science-related teachers (Yang et al. 2025). Similarly, school type is a key variable. Private schools appear more supportive of iSTEMe than state-funded schools (Martynenko et al. 2023). We included tenure as a potential moderator. This is supported by Lambriex-Schmitz et al. (2020) who link tenure to greater innovation, likely because familiarity with organizational processes enables teachers to implement new practices.

The EVC framework is deemed appropriate to explain teachers' decisions when faced with curricular reforms. Teachers interpret reforms through their own beliefs, experiences, and contexts, a process known as sensemaking (Allen and Penuel 2015; Porter and Allen 2025). This sensemaking shapes whether reforms are adopted in practice and is highly dependent on teachers' willingness and ability to take on new ideas (Cohen and Mehta 2017). For instance, since reform success hinges on teachers' judgments of its pedagogical value, understanding their perception of iSTEMe is critical. When a reform is seen as low in value and high in cost, teachers may resist or apply it only superficially, which can limit students' access to the meaningful, integrated learning the reform intends to promote (Porter and Allen 2025). Therefore, studying these motivational factors is essential for shaping policies and professional development that can effectively support reform in practice.

3 | Method

3.1 | Design and Context

This is a survey type of research that uses hypothesized predictors (EVC dimensions) to test their relationship with a dependent variable (intentions to adopt iSTEMe). The study targets Spanish secondary school teachers in the Autonomous Community of Valencia during the mandatory educational reform that, as mentioned above, proposed the curricular integration of STEM subjects, also including non-STEM subjects as suggested by various authors (e.g., Roehrig et al. 2021; Sanders 2009) for iSTEMe. Therefore, although the main focus is on STEM disciplines, the study has included both teachers with academic backgrounds in STEM disciplines and teachers with academic backgrounds in non-STEM disciplines, as the latter might be equally responsible for carrying out iSTEMe in the context of the reform. Data were collected through an online survey conducted in 2022. Thus, schools and teachers had a period of 2 academic years to become familiar with the reform or at least to observe its practical implications. Therefore, teachers' responses may reflect a more informed understanding of the reform and its requirements.

3.2 | Sampling Technique and Sample Size

Random stratified sampling was initially designed to gather a representative sample of secondary school teachers from the Autonomous Community of Valencia. Using the Raosoft (2004) formula, the required sample size was established using a 95% confidence interval, a 5% margin error, and assuming a 50% response rate. According to data from the Spanish Ministry of Education and Vocational Training (2022), there were 38,346 secondary school teachers in total. To ensure a representative sample, a minimum sample size of 381 would be required, selected based on three strata: school type (public or private), gender (male or female), and province (Alicante, Castellón, and Valencia).

However, due to Spanish data protection laws, direct contact with individual teachers was not possible; teachers' contact information is not made public. As a result, the sampling strategies consisted of contacting all secondary school centers (715 in total) and being asked to distribute the survey to their teaching staff. Data collection began in May and finished in June, after sending three reminder e-mails every 2 weeks, yielding 439 responses (Table 1). Most participants identified as female (61.7%), worked in a public school (87.2%), and completed a university degree in science, mathematics or engineering fields (70.2%). The mean age was 46.51 years (SD = 8.62) and the most had more than a decade of teaching experience ($M = 16.39$, SD = 10.57). Half of the sample (53.8%) were required to adopt integrated curricula following the new reform.

3.3 | Measures and Outcomes

Several reviews of the international (Potvin and Hasni 2014; Toma and Lederman 2022) and Spanish literature (Toma 2020) failed to find a gold standard instrument for measuring the EVC constructs. Consequently, following the procedures of previous studies that applied this model (Eccles and Wigfield 2020; Flake et al. 2015; Lykkegaard and Ulriksen 2016), survey items were selected and adapted to specifically reference to iSTEMe. Two university professors with extensive expertise in instrument development and validation reviewed existing items from the EVC

TABLE 1 | Sociodemographic characteristics of the sample ($n = 439$).

Variable	*n* (%)
Gender	
Female	271 (61.7)
Male	168 (38.3)
School type	
Public	383 (87.2)
Private	56 (12.8)
Country of birth	
Spain	431 (98.2)
Other	8 (1.8)
Age[a]	
≤ 25	3 (0.7)
26–33	35 (8)
34–41	77 (17.5)
42–50	158 (36)
51–58	115 (26.2)
≥ 59	49 (11.2)
Academic background	
University degree in mathematics	100 (22.8)
University degree in physics	21 (4.8)
University degree in chemistry	39 (8.9)
University degree in life sciences[b]	51 (11.6)
University degree in earth and environmental sciences[c]	9 (2.1)
University degree in engineering or architecture	81 (18.5)
University degree in primary education[d]	7 (1.6)
Other[e]	131 (29.8)
Tenure	
Yes	294 (67)
No	145 (33)
Teaching experience	
≤ 5	106 (24.1)
6–12	70 (15.9)
13–19	75 (17.1)
20–26	101 (23)

(Continues)

TABLE 1 | (Continued)

Variable	*n* (%)
27–33	68 (15.5)
≥ 34	19 (4.3)
Experience with iSTEMe[f]	
Yes	236 (53.8)
No	203 (46.2)

[a]Missing data for two respondents.
[b]Includes biology, biotechnology, medicine, and so on.
[c]Include geology, marine sciences, and so on.
[d]With qualification to teach in secondary education.
[e]Other refers to social sciences' undergraduate degrees (e.g., history, Spanish philology).
[f]If the school center required them to deliver iSTEMe during the 2020–2021 or 2021–2022 academic year.

literature and selected those deemed appropriate for adaptation in this study. For example, the items "This class is too stressful" or "Because of other things that I do, I don't have time to put into this class" from Flake et al. (2015) were adapted as "iSTEMe teaching is too stressful" and "Because of other things I do, I do not have enough time to prepare adequately for iSTEMe." Three secondary school teachers subsequently suggested minor grammatical revisions. The survey included an introductory section clarifying that all items referred to the most recent educational reform requesting the adoption of iSTEMe. The Supporting Information: Data S1 contains the full version of the questionnaire.

Expectancies of success were assessed using four items rated on a five-point Likert scale with labeled endpoints (1 = not at all; 5 = definitely). Example items include: "To what extent do you believe you will be able to teach successfully in the coming years adopting iSTEMe?" and "How successful will you be at teaching using iSTEMe?" These items were designed to assess teachers' confidence and perceived competence regarding the effectiveness and future success of implementing iSTEMe.

Each task-value dimension was measured using three items rated on a five-point Likert scale with labeled endpoints. Example items include: "To what extent is it worth the effort to teach using iSTEMe?" (1 = not worth it; 5 = very worth it) representing attainment value; "How much do you like teaching using iSTEMe?" (1 = not at all; 5 = very much) representing intrinsic value; and "How useful is iSTEMe for effective teaching?" (1 = not useful at all; 5 = very useful) representing utility value. These items were designed to capture the value teachers attribute to teaching with iSTEMe, including perceptions of its worth, importance, interest, reward, and its utility for both student learning and their own teaching.

Each cost-related dimension was measured using two items rated on a five-point Likert scale, with endpoints labeled from 1 (Totally disagree) to 5 (Totally agree). Example items include: "iSTEMe requires me to spend far too much preparation and organization time," representing task-effort cost; "I have so many other commitments that I cannot put forth the effort needed to teach using iSTEMe," representing outside effort cost; "iSTEMe teaching makes me give up too many other activities I value" representing loss of valued alternatives cost; and "iSTEMe teaching is emotionally draining," representing emotional cost. These items were designed to assess teachers' perceived costs of using iSTEMe, including the effort required for preparation and training, the time constraints involved, and potential emotional impacts.

Finally, behavioral intention to adopt iSTEMe was measured using two items rated on a five-point Likert scale, with endpoints labeled from 1 (Totally disagree) to 5 (Totally agree). An example item is: "If I had a choice, I would not adopt iSTEMe to teach my subject." This dimension aimed to determine the teachers' willingness to adopt teaching using iSTEMe.

3.4 | Psychometric Properties of the Questionnaire and Model

The theoretical model proposed was subjected to psychometric analysis to gather evidence of validity and reliability following Hair et al.'s (2022) guidelines. Confirmatory Composite Analysis (CCA) was employed, as it is the standard procedure within Partial Least Square Structural Equation Modeling (PLS-SEM) analysis when using reflective constructs, as in the case of the EVC dimensions (for a rationale, see Hair et al. 2020, 2022). Specifically, outliers were identified using Mahalanobis distance ($n = 21$, 4.8%). Next convergent validity was determined by the average variance extracted (AVE > 0.50), while discriminant validity was evaluated using the Fornell-Larcker criterion. According to this criterion, the square root of the AVE by each construct should be greater than the correlation between such construct and any other construct in the model. To avoid issues of collinearity, items with variance inflation factor (VIF) values > 5 were deleted and the analysis was re-run. Finally, Cronbach's alpha (α) and Composite Reliability (CR) were calculated for internal consistency reliability evidence. The following cutoffs were used: < 0.60 (low reliability), 0.60–0.69 (marginally reliable), 0.70–0.79 (reliable), 0.80–0.90 (highly reliable), > 0.90 (very highly reliable).

Four items from the value construct (V2, V7, V8, and V9) and one item from the cost construct (C6) displayed a VIF value above the cutoff score of 5, suggesting potential issues of collinearity. Hence, they were removed from the model. The remaining model revealed excellent psychometric properties (Table 2). All items had significant loadings above 0.60 on their respective constructs, and the AVE values for each construct exceeded the recommended level of 0.50, indicating adequate convergent validity. Moreover, the Cronbach's alpha and CR values for all constructs were well above 0.80, suggesting highly reliable constructs. Table 3 presents the results of the discriminant validity test based on the Fornell-Larcker criterion. The square root of the AVE of each construct was greater than its correlations with other constructs in the model, thus confirming the discriminant validity of constructs.

3.5 | Data Analyses

Descriptive and inferential statistics were used to examine teachers' expectancies of success, subjective task values, perceived costs, and intentions toward the implementation of iSTEMe (RQ1). Specifically, one-sample *t* tests were conducted to examine if the mean scores for each construct significantly deviated from the midpoints of the scales (Knapp 2018). Cohen's *d* was used to calculate the effect size, with the following cutoff scores: 0.2 (small), 0.5 (moderate), and 0.8 (large). Multivariate analysis of variance (MANOVA) and Pearson correlation were conducted to explore any differences or relations with the background variables (RQ2). It should be noted that for the academic background variable, teachers were grouped based on the secondary school subjects: (i) mathematics (teachers with a background in mathematics); (ii) physics and chemistry (teachers with a background in physics and chemistry); (iii) biology and geology (teachers with a background in life sciences, earth, and environmental sciences); and (iv) other (teachers with a background in other disciplines). This was done to increase statistical power because some groups had small sample sizes (e.g., a university degree in primary education, $n = 7$), hence reducing the likelihood of type II (false negative) errors. Partial eta squared (η_p^2) was calculated to determine the effect size for MANOVA, with the following cutoffs: 0.01 (small), 0.06 (moderate), and 0.14 (large). Statistically significant differences with small effect sizes are not educationally relevant and hence will not be considered important. Data screening confirmed that assumptions for parametric tests were met (Knapp 2018). Normality was established for the *t* test (skewness and kurtosis within ±2). For the MANOVA, assumptions of normality, homogeneity of variance (Levene's test, $p > 0.05$), and homogeneity of variance–covariance matrices (Box's M test, $p > 0.01$) were satisfied. Scatterplot inspection confirmed linearity without multicollinearity ($r < 0.80$) among the motivational variables. Pearson correlation analyses met the assumptions of normality and linearity, as previously indicated.

TABLE 2 | Psychometric properties of the measurement instrument.

Constructs	Items	Loadings	AVE	α	CR
Expectancies of success	E1	0.903	0.817	0.925	0.947
	E2	0.925			
	E3	0.843			
	E4	0.941			
Value	V1	0.909	0.853	0.957	0.967
	V3	0.903			
	V4	0.945			
	V5	0.914			
	V6	0.947			
Cost	C1	0.904			
	C2	0.883	0.675	0.924	0.935
	C3	0.816			
	C4	0.868			
	C5	0.829			
	C7	0.683			
	C8	0.746			
Behavioral intention	Bi1	0.918	0.837	0.805	0.911
	Bi2	0.912			

Abbreviations: α, Cronbach's alpha; AVE, average variance extracted; CR, composite reliability.

PLS-SEM with SmartPLS software (version 4, Ringle et al. 2022) was used to test the hypothesis regarding the relationship between the EVC motivation predictors and intentions to implement iSTEMe (RQ3). The procedure recommended in extant literature (e.g., Hair et al. 2022; Ringle et al. 2022) informed the analyses. The dependent variable was behavioral intention, while the predictors were the three EVC motivational constructs (expectancies of success, values, and cost). Sociodemographic variables were included as moderators. One of these variables is the academic background of teachers, which, as has been noted, includes both those with STEM and non-STEM academic backgrounds, since the two groups of teachers had to implement the iSTEMe proposals integrating STEM and non-STEM subjects. For the analysis, bootstrapping on 5.000 samples was used to determine the statistical significance of the PLS-SEM results, as recommended (Hair et al. 2022; Ringle et al. 2022). Finally, R^2 was assessed to determine the explanatory power of the model based on the following cutoff values (Hair et al. 2022): 0.25 (weak), 0.50 (moderate), and 0.75 (substantial).

3.6 | Statistical Power

G*Power software was used to calculate sample size requirements for achieving 80% power to detect a medium effect size **($f^2(V) = 0.06$)** at $\alpha = 0.05$ (Faul et al. 2007). For RQ2, MANOVA requires a minimum sample size of between 140 and 260 participants, and Pearson correlation requires at least 84 participants. For RQ3, using the most complex regression in our model, which is three predictors (all EVC dimensions) and up to seven moderator variables (sociodemographic variables), requires a minimum sample size of 78 participants. Likewise, for PLS-SEM, a sample

TABLE 3 | Fornell-Larcker criterion for discriminant validity.

	Expectancy	Value	Cost	Behavioral intention
Expectancy	**0.904**			
Value	0.857	**0.923**		
Cost	−0.437	−0.386	**0.822**	
Behavioral intention	0.729	0.850	−0.404	**0.915**

Note: The square root of the AVE of each construct is highlighted in bold.

size to indicator ratio should be at least 10:1; in this study, this represents a minimum sample of 40 participants (three predictors and one dependent variable). Other recommendations include a minimum of 200 participants, which is also satisfied (Hair et al. 2022). Taken together, this study has enough power to answer the research questions formulated.

3.7 | Use of Large Language Models (LLM)

During the preparation of this manuscript, LLMs (ChatGPT and Gemini) were used for English language editing to improve grammar, clarity, and readability. Example prompts include: "Correct the grammar and spelling in this paragraph" and "Improve the readability and clarity of this paragraph." Output was revised, and all conceptual content, arguments, and conclusions reflect the authors' own intellectual contribution and interpretation.

4 | Results

4.1 | Teachers' Motivations (RQ1)

Considering a minimum score of 1 (low) and a maximum of 5 (high), secondary school teachers in this study were not motivated regarding the implementation of iSTEMe. It should be noted that all values exhibited statistical significance when contrasted with the midpoint of the scale, which arguably indicated moderate levels. Specifically, their expectancies of success were low ($M = 2.53$, SD = 1.19, $t = -8.22$, $p < 0.01$, $d = -0.40$). In addition, they considered iSTEMe to be of low value ($M = 2.14$, SD = 1.29, $t = -14.08$, $p < 0.01$, $d = -0.67$). On the other hand, the perceived cost was medium ($M = 3.20$, SD = 1.14, $t = 3.62$, $p < 0.01$, $d = 0.18$), which seemed to indicate that iSTEMe caused cost-related beliefs. Finally, their intention to implement iSTEMe was low ($M = 2$, SD = 1.32, $t = -15.61$, $p < 0.01$, $d = 0.76$).

4.2 | Sociodemographic Differences (RQ2)

Figure 2 shows the MANOVA results with moderate to large effect size differences for each sociodemographic variable.

There were no gender differences in any motivational construct, F (4, 434) = 1.376, $p = 0.241$, Wilks' Lambda = 0.987 (Figure 2a). Likewise, teachers' motivations were not correlated with their age ($r = -0.023$ to 0.137), nor with their teaching experience ($r = -0.080$ to -0.165). There were, however, significant differences by type of school, F (4, 434) = 16.922, $p < 0.01$, Wilks' Lambda = 0.865, $\eta_p^2 = 0.135$ (Figure 2b). Teachers from private schools reported higher expectancies of success ($\eta_p^2 = 0.10$), higher perceived value ($\eta_p^2 = 0.13$), and higher intentions to adopt iSTEMe ($\eta_p^2 = 0.09$). There were no differences regarding the cost construct. There were also differences between teachers holding tenure or not, F (4, 434) = 5.295, $p < 0.01$, Wilks' Lambda = 0.953 (Figure 2c), yet with an overall small effect size ($\eta_p^2 = 0.047$).

Differences also existed between teachers with and without integrated curricula experience, F (4, 434) = 9.72, $p < 0.01$, Wilks' Lambda = 0.918, $\eta_p^2 = 0.082$ (Figure 2d). As expected, teachers who had experiences with such an approach in previous academic years reported higher expectancies of success ($\eta_p^2 = 0.058$) and perceived value ($\eta_p^2 = 0.049$), yet the latter had a small effect size. Intentions to adopt iSTEMe were also higher in teachers with integrated curricula experience, reaching a medium effect size ($\eta_p^2 = 0.06$). There were no differences regarding the cost construct.

Finally, teachers' motivations varied significantly according to academic background, F (12, 1143.26) = 8.44, $p < 0.01$, Wilks' Lambda = 0.799, $\eta_p^2 = 0.072$ (Figure 2e). Overall, teachers with a background in mathematics reported significantly lower expectancies of success ($\eta_p^2 = 0.134$), value ($\eta_p^2 = 0.134$), and intentions to implement iSTEMe ($\eta_p^2 = 0.091$). There were no differences regarding the cost construct.

It should be noted that despite these differences, the participants consistently reported low expectancies of success, low perceived value, medium-to-high perceived costs, and low intentions to implement iSTEMe. In all sociodemographic groups, the mean value was lower than the midpoint of the 5-point Likert scale (2.5 points); therefore, it could be concluded that despite these differences, motivation remained low and that sociodemographic variables had minimal impact on the overall negative perception of this educational reform.

4.3 | Intentions to Implement iSTEMe (RQ3)

Table 4 reports the results of the PLS-SEM analysis with standardized coefficients. The total variance explained by the model was 75.6%, which is substantial ($R^2 = 0.756$). The analysis revealed that, surprisingly, only one of the EVC motivation constructs was statistically significant. Specifically, the perceived value of iSTEMe was the only predictor that significantly affected teachers' intention to implement it, with a coefficient of 0.924 ($t = 4.601$, $p < 0.001$).

4.4 | Mediating Role of Sociodemographic Characteristics (RQ4)

Table 5 reports the results of the moderation analysis with standardized coefficients. The results reveal that none of the sociodemographic variables had a statistically significant impact on the tested relationships between predictors and dependent variables.

5 | Discussion

This study used EVC theory to examine Spanish secondary school teachers' motivations, including expectancies of success, values, and perceived costs of iSTEMe, and their impact on intention to implement this approach. Regarding the first research question (RQ1), teachers reported low motivation. They reported low expectancy beliefs about their ability to implement iSTEMe and below-average value beliefs, suggesting that many do not see it as beneficial for their teaching. Teachers also reported moderate perceived costs associated with implementing iSTEMe. They expressed agreement with items across various cost dimensions.

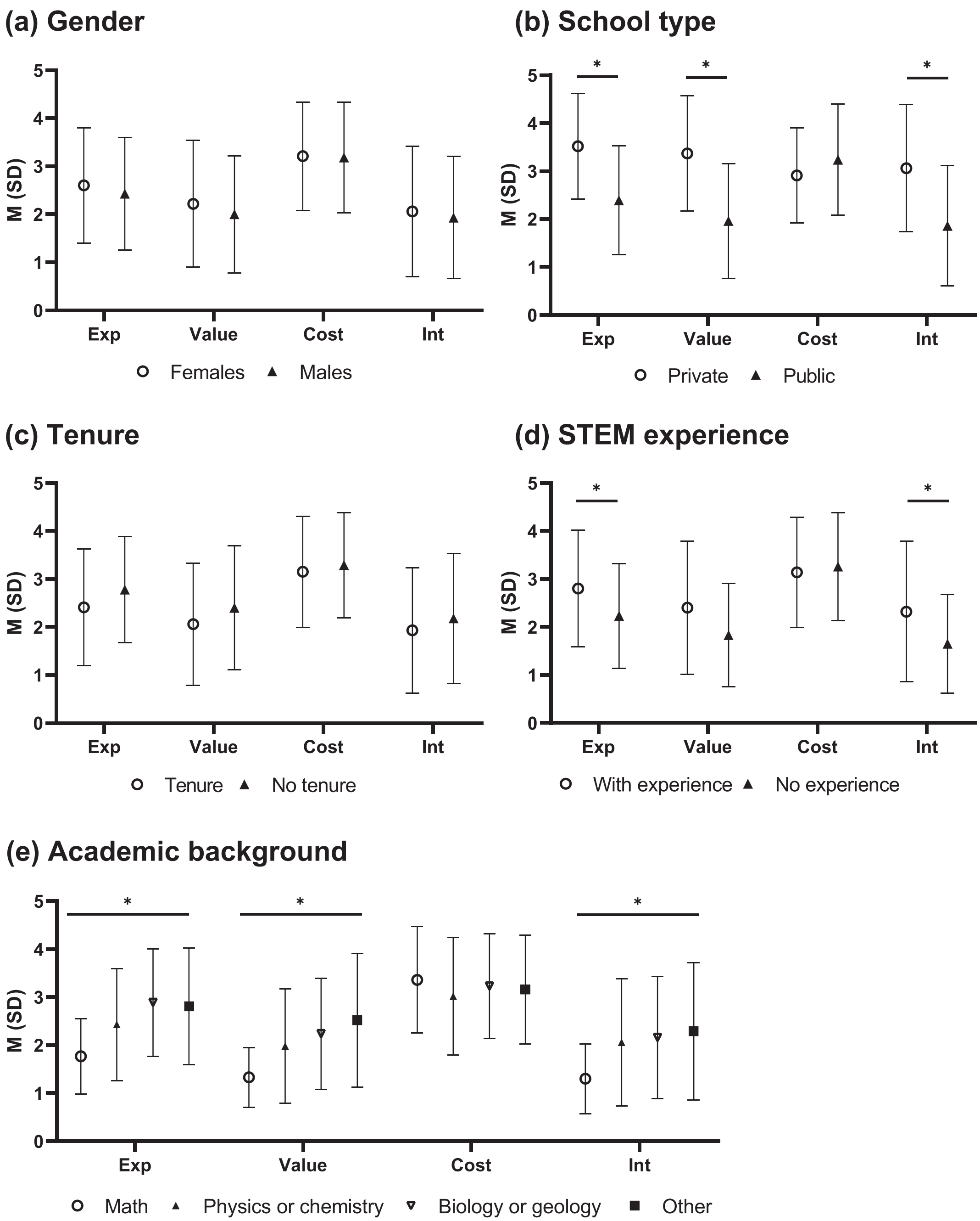

FIGURE 2 | MANOVA results with moderate to large effect size differences. *$p < 0.05$ and $\eta_p^2 \geq 0.06$. Exp, expectancies of success; Int, intentions to adopt; M, mean; SD, standard deviation.

TABLE 4 | Results of PLS-SEM analysis.

Path	Coefficient	*t*	*p*
Expectancy→Behavioral intention	−0.073	0.416	0.677
Value→Behavioral intention	0.924	4.601	< 0.001
Cost→Behavioral intention	−0.167	1.252	0.211

These included the time and effort for preparation and training (task effort cost), competing obligations (outside effort cost), having to forgo other activities (loss of valued alternatives), and emotional demands like stress (emotional cost). Consequently, teachers' intentions to adopt iSTEMe were low.

These findings can be explained through the mechanism underlying the EVC framework (Wigfield and Eccles 2020) and also because of teachers' disciplinary background and training, which leads to teaching outside their expertise when enacting iSTEMe (Giffney and Lane 2025; Hobbs and Porsch 2021).

TABLE 5 | Results of moderation analysis.

Path	Coefficient	*t*	*p*	Moderation
Gender × Expectancy→Behavioral intention	−0.106	0.972	0.331	No
Gender × Value→Behavioral intention	0.010	0.138	0.890	No
Gender × Cost→Behavioral intention	0.009	0.185	0.853	No
Age × Expectancy→Behavioral intention	0.108	1.102	0.271	No
Age × Value→Behavioral intention	−0.122	1.422	0.155	No
Age × Cost→Behavioral intention	0.040	0.850	0.395	No
Academic background × Expectancy→ Behavioral intention	−0.127	1.099	0.272	No
Academic background × Value→Behavioral intention	0.005	0.221	0.825	No
Academic background × Cost→Behavioral intention	0.059	0.828	0.408	No
Teaching experience × Expectancy→Behavioral intention	−0.116	1.065	0.287	No
Teaching experience × Value→Behavioral intention	0.156	1.471	0.141	No
Teaching experience × Cost→Behavioral intention	−0.051	1.009	0.313	No
Tenure × Expectancy→Behavioral intention	−0.123	0.757	0.449	No
Tenure × Value→Behavioral intention	0.067	0.501	0.617	No
Tenure × Cost→Behavioral intention	−0.087	1.034	0.301	No
School type × Expectancy→Behavioral intention	0.102	0.492	0.623	No
School type × Value→Behavioral intention	−0.079	0.376	0.707	No
School type × Cost→Behavioral intention	0.152	1.136	0.256	No
*i*STEMe experience × Expectancy→Behavioral intention	0.029	0.339	0.734	No
*i*STEMe experience × Value→Behavioral intention	−0.190	1.827	0.068	No
*i*STEMe experience × Cost→Behavioral intention	−0.040	0.514	0.608	No

The EVC framework emphasizes that motivation to engage depends on the balance of expectancy beliefs, value beliefs, and perceived costs (Cheng et al. 2020; Eccles and Wigfield 2020). Low confidence in their ability to succeed makes teachers less likely to invest effort in new practices (Ranelluci et al. 2020), like interdisciplinary STEM teaching. Likewise, teachers may show diminished commitment to reform if they view integrated STEM as lacking educational value. Similarly, EVC posits that perceived costs, such as time, effort, and emotional strain, negatively influence behavioral intentions (Jud et al. 2023; Kosovich et al. 2015). The demands of integrating subjects and adapting to interdisciplinary teaching likely make the perceived costs outweigh the potential benefits. Teachers might view iSTEMe as a low-value, high-risk, high-effort undertaking.

The findings for the second research question (RQ2) showed that despite minor differences in sociodemographic variables, there was an overall low motivation toward iSTEMe. In general, teachers expressed low expectations of success, especially among mathematics teachers, those without prior interdisciplinary teaching experience, and those teaching in public/state-funded schools. Teachers, particularly those with tenure, expressed opposition to the educational value of iSTEMe. Furthermore, differences in expectancies of success and task value were observed based on academic background, with mathematics teachers reporting lower ratings in both constructs. These findings are reinforced by previous literature signaling that iSTEMe possesses pedagogical, curriculum, and structural challenges (Margot and Kettler 2019; Martín-Páez et al. 2019; McComas and Burgin 2020; Quílez 2022; Toma and García-Carmona 2021).

Taken together, teachers' motivation for iSTEMe was found to be generally low. Consistent with previous literature on teachers' perceptions and attitudes toward iSTEMe, motivation among secondary school teachers in this study was slightly higher among those working in private schools (Martynenko et al. 2023), those with experience in integrated curricula (Thibaut et al. 2019), and those with nonmathematics backgrounds (Yang et al. 2025). Differences between teachers in public and private schools might be explained by organizational structures. In Spanish public secondary schools, STEM teachers are typically split into separate departments such as physics and chemistry, biology and geology, mathematics, and technology. Rarely is one of these teachers assigned to teach a subject outside their field of specialization. However, private schools, by contrast, often group these subjects into broader areas, making it more likely that a science teacher will be required to teach a subject outside their specialization. Consequently, it is not uncommon for science teachers to be also assigned to teach mathematics and technology. As a result, private school teachers, though usually teaching within their field of expertise, may be more willing to accept the possibility of teaching different STEM subjects than their counterparts in public schools.

Similarly, the lower motivation of math teachers might be explained by disciplinary differences. University mathematics programs often focus on pure or applied mathematics, with limited links to other sciences, unlike other fields such as chemistry, which has close connections and broad shared boundaries with physics, biology, and mathematics. Consequently, mathematics teachers, due to their more specialized training, may feel less prepared and thus uncomfortable teaching other subjects, reducing their confidence in integrating mathematics with other STEM subjects. Indeed, research suggests that the characteristics of mathematics make it harder to integrate with other disciplines, often leading to its neglect in STEM proposals (Diego-Mantecon et al. 2021). In line with this, Yang et al. (2025) found that mathematics teachers were more likely to report low self-efficacy, particularly those without prior experience in integrated STEM teaching, who also showed lower levels of commitment. Furthermore, as noted in other studies on teachers' attitudes toward iSTEMe (Martynenko et al. 2023), no significant differences were observed in teachers' motivations according to gender.

Regarding the third research question (RQ3), the theoretical model used (Barron and Hulleman 2015) revealed that the main reason for their low behavioral intentions is their perceived lack of value in iSTEMe, which was the only EVC motivational construct predicting behavioral intention. It is not the workload or expectations that primarily drive their rejection, but rather the teachers' belief that iSTEMe lacks educational value. Findings also suggest that none of the sociodemographic variables moderated the effect of perceived value on intention to implement iSTEMe. Therefore, this study concludes that the perceived value of iSTEMe was the sole predictor of teachers' low implementation intent. This finding offers a critical insight into the iSTEMe reform. It suggests teachers might have judged the iSTEMe reform as lacking instructional power and pedagogical merit, which undermined their intention to adopt it (Allen and Penuel 2015; Cohen and Mehta 2017). It should be noted that task value explained a very high proportion of the variance in behavioral intentions, suggesting that the EVC framework is highly effective for understanding motivational factors influencing the adoption of iSTEMe among in-service secondary school teachers.

Finally, regarding the fourth research question (RQ4), none of the sociodemographic variables moderated the relationship between expectancies, task value, perceived cost, and intentions to adopt iSTEMe among secondary school teachers. Taking into account the results discussed above, this could be interpreted as indicating that the broad spectrum of STEM teachers, across different generations, academic backgrounds, and teaching experiences, commonly perceive iSTEMe as an educational approach that is difficult to assimilate, one that requires extensive teacher training, and whose educational impact, when compared with the individualized teaching of STEM subjects, may not justify the effort involved. Hence, it is possible to speak of a generalized skepticism among STEM teachers toward approaches aligned with iSTEMe.

Overall, these findings are largely consistent with existing research on the EVC model. Although no previous studies have applied this framework specifically to science teachers' intentions to adopt iSTEMe, relevant evidence exists in other educational contexts. For example, Jud et al. (2023) reported a positive association between values and the promotion of self-regulated learning strategies, though expectancies of success were also strong predictors. Similarly, Ranelluci et al. (2020) found that utility value alone affected preservice teachers' intention to use technology. Furthermore, Cheng et al. (2020) observed that while cost was unrelated to technology integration, both expectancies and values were significant predictors. Collectively, our study and previous literature support the framework's core premise that motivational constructs affect behavioral intentions (Eccles and Wigfield 2020). It should be noted, however, that most existing research has focused on primary and secondary students or preservice teachers. Further research involving in-service teachers is warranted.

5.1 | Educational Implications

This study is both timely and novel, as it is the first to examine the impact of motivational variables on secondary school teachers' intentions to implement iSTEMe. Although conducted in Spain, the findings may offer insights for broader contexts due to shared challenges in iSTEMe globally. However, some results may reflect Spain's specific cultural, curricular, or institutional factors, so caution is needed when generalizing to other countries.

The findings have significant implications. The secondary school teachers surveyed reported low motivation and limited intention to adopt iSTEMe. More importantly, the study reveals that this rejection is mainly because they do not find educational value in the approach. Likewise, they expressed little enjoyment in teaching through an iSTEMe framework and considered that its implementation in their classrooms to be ineffective. This suggests that curricular reforms designed to promote strategies and approaches aligned with iSTEMe are complex and pose challenges at multiple levels, including institutional support, teacher professional development, the design of teaching materials and resources, and working conditions that allow effective implementation. Previous reforms, such as integrated science teaching (Haggis and Adey 1979), inquiry-based science education (NRC 1996), context-based science education (Campbell and Lubben 2000), and design-based science and technology teaching (Fortus et al. 2004), were similarly ambitious but achieved limited classroom adoption, largely because these essential supports were lacking. In this regard, iSTEMe implementation should critically address both the claimed benefits and the challenges observed in earlier approaches. Moreover, iSTEMe reforms must consider that teacher education programs and curriculum structure have remained relatively unchanged (Montero and García-Carmona 2018; García-Carmona and Toma 2024), which makes the path toward iSTEMe particularly demanding and perhaps even more challenging than previous reforms.

These results add new insights to the reported difficulties associated with iSTEMe (Pleasants and Olson 2019; Johnson and Czerniak 2023; Quílez 2022). The findings signal the need to reassess the educational value attributed to iSTEMe. The systematic reviews conducted by Martín-Páez et al. (2019) and McLure et al. (2022) highlight several issues: there are varying theoretical approaches without a clear consensus; there is an absence of detailed descriptions regarding the integration of different STEM disciplines; the significance of the projects labeled as iSTEMe is not well-defined; there is a lack of information on how teachers implement these projects; and it is unclear how STEM skills are incorporated within these projects. It is, therefore, not surprising that teachers are reluctant to adopt it. Thus, any attempt to promote iSTEMe should be done cautiously to address its limitations and challenges, as well as to examine possible negative effects, such as those reported on teacher efficacy, motivation, or achievement (Du Plessis 2020; El-Deghaidy et al. 2017; Van Overschelde 2022), and those related to student motivation (Shekhar et al. 2020).

Furthermore, besides the lack of evidence substantiating the significance and viability of iSTEMe, there are also limitations related to its implementation in the classroom. This constraint was aggravated in Spain, the context of this study. Its mandatory implementation was rushed and lacked proper planning. Teachers were required to adopt this approach without any prior professional development, without new educational resources, and without changes to their organizational structure. They could only rely on a few untested didactic units with limited pedagogical guidelines that were suggested as guiding examples by the educational authorities (Council of Education, Culture and Sports 2020). Thus, it does not seem surprising that teachers' motivation was low. It should be noted that teachers with integrated curricula experience reported higher, though still not positive, expectancies of success and perceived value. One possible interpretation is that teachers recognize integration's value only after careful implementation. This relates to the finding that teachers who perceived low value in iSTEMe reported lower behavioral intentions. Therefore, future studies focusing on teachers who have undergone quality professional development and implemented iSTEMe in practice are needed.

Hence, if iSTEMe continues to be promoted in educational reforms, teachers must receive adequate professional development. Eventually, this training should be able to enable teachers to acquire a basic understanding of how to conceptualize iSTEMe and how to effectively implement it to overcome its current ambiguous operationalization in the curricula (Sgro et al. 2020). This requires both empirical and theoretical grounding to support teachers in critically evaluating which content and disciplines to integrate. Developing coherent iSTEMe instruction often involves significant time and effort in identifying appropriate tasks (Brown and Bogiages 2019). Hence, teachers must be aware of iSTEMe's benefits and potential limitations and learn how to apply it meaningfully in the classroom. This process should be guided by successful, evidence-based practices; however, few authentic examples exist to support such implementation (McLure et al. 2022). Additionally, teachers often struggle with conceptualizing and designing instructional sequences that reflect the defining features of iSTEMe (Margot and Kettler 2019; Toma and Retana-Alvarado 2021). Overcoming these conceptual and didactic challenges remains a complex and ongoing task worth addressing in future studies (White and Delaney 2021).

On the other hand, if iSTEMe is to be successful, it is critical to improve teachers' motivation (Margot and Kettler 2019). Successful iSTEMe reform depends on aligning policy goals with teachers' perceptions and classroom realities. The low teacher intent to implement iSTEMe and the lack of motivation likely reflect concerns about readiness, perceived value, and potential challenges, not a rejection of iSTEMe itself. Without support through ongoing teacher professional development and resources, the hypothesized benefits of iSTEMe, such as the development of interdisciplinary skills and preparing the workforce for 21st century challenges, among others (Bybee 2018; Johnson and Czerniak 2023; Kelley and Knowles 2016; Roehrig et al. 2021), will remain unrealized. Therefore, future efforts to promote this reform need to address the low motivation identified in this study, especially regarding the perceived value of this approach. Also, schools need to build their capacity to support change (Farrell et al. 2022). This means creating structures for collaboration and providing useful iSTEMe resources. This aspect is a significant challenge given the existing criticism and limitations of this approach (Lyons 2020; McComas and Burgin 2020; Quílez 2022; Toma and García-Carmona 2021), and the literature indicating that iSTEMe teacher professional development is a difficult task (Gardner and Tillotson 2019; Johnson and Czerniak 2023).

5.2 | Limitations

Findings should be interpreted considering the following limitations. The conceptual framework adopted in this study prevented the identification of which specific dimensions of the value and cost constructs were more predictive of teachers' intentions to implement iSTEMe. While the EVC framework conceives value and cost as unidimensional constructs (Barron and Hulleman 2015; Kosovich et al. 2015), the literature suggests that both value and cost may be multidimensional constructs (Eccles and Wigfield 2020; Flake et al. 2015). The questionnaire used in this study did include specific items representing such multidimensionality. However, analyzing these dimensions separately requires psychometric studies to provide empirical evidence for the value and cost subdimensions. Such an analysis was hampered in this study due to a low number of items per construct, especially in the case of cost-related subdimensions. This limitation does not undermine the robustness of the findings; instead, it highlights potential avenues for future research. In addition, supplementing the quantitative data reported here with qualitative methods such as in-depth interviews or focus groups would be valuable for gaining deeper insights into the factors that can hinder or facilitate teachers' intentions to implement iSTEMe.

Another limitation concerns the sampling strategy. Although a stratified sampling framework was used, the final sample was based on voluntary participation. The sample size exceeded the minimum required to obtain a representative sample of secondary school teachers in the Autonomous Community of Valencia. However, the findings should be interpreted with caution, as the responses reflect a sample of teachers who chose to participate. This may have introduced nonresponse bias, as those who responded are likely to have had stronger opinions or a greater interest in the subject matter.

6 | Conclusions

This study provides novel insight into the motivational factors influencing secondary teachers' intentions to implement iSTEMe education, revealing a concerning reality: teachers feel unprepared for iSTEMe, see limited pedagogical value in it, and associate it with significant challenges. The perception of a lack of value was the key factor that contributed to their low intentions to adopt this approach. These findings raise questions about the feasibility of iSTEMe reforms without stronger support for teachers and further research on how to cultivate teachers' sense of value toward iSTEMe. Future research, by addressing the motivational barriers identified in this study, can better support the long-term success of iSTEMe reforms. Based on these findings, it is possible to conclude that Spain's new curricular reform promoting iSTEMe has not gotten off to a good start. It seems, therefore, that iSTEMe is at a crossroads and any efforts to implement it may be stumbling in the dark.

Ethics Statement

All procedures performed in studies involving human participants were in accordance with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

Consent

Informed consent was obtained from all participants involved in the study.

Data Availability Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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Supporting Information

Additional supporting information can be found online in the Supporting Information section. **Data S1:** Supporting Information.