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Extending STEM identity to the institutional level: how organizational identity and efficacy shape gender-inclusive practice in out-of-school education

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Abstract

Background While individual STEM identity and self-efficacy are well-established predictors of girls' and women's engagement in science, technology, engineering, and mathematics (STEM), their conceptual equivalents at the organizational level remain understudied. Out-of-school STEM education providers are key actors in addressing gender disparities; however, little is known about how their institutional values and perceived capacities influence program design and delivery.

Purpose Grounded in theories of organizational identity and collective efficacy, this study investigates whether out-of-school STEM providers' organizational identity and efficacy related to the promotion of females in STEM predict five theoretically derived indicators of program success after controlling for program characteristics.

Methods A nationwide survey was conducted among out-of-school STEM education providers in Germany ($N = 209$). Respondents rated their organization's identity and efficacy in promoting females in STEM. Outcome measures included inclusive program planning, long-term focus, environmental integration, engagement in networking and professional development, and self-assessed success.

Results Organizational identity significantly predicted all five success indicators, with the strongest effect for inclusive program planning and engagement in networking and professional development. Organizational efficacy predicted four of the indicators, with the strongest effect for perceived program success. After controlling for program characteristics, the effects of both constructs remained robust, although slightly weaker, suggesting that contextual factors partly account for their influence.

Conclusions This study reveals how organizational-level beliefs shape gender-inclusive practices in STEM education. The findings contribute to research on gender equity in STEM by introducing and validating institutional-level predictors of effective program practice, with practical implications for STEM networks and policy development.

Keywords STEM education, Gender equity, Organizational identity, Organizational efficacy, Out-of-school STEM education

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Introduction

Identity and self-efficacy are crucial in fostering girls' and women's interest and participation in science, technology, engineering, and mathematics (STEM) fields. Research shows that a strong STEM identity predicts choice preferences for optional science learning experiences (Vincent-Ruz & Schunn, 2018) and intentions to pursue a STEM career (Dou et al., 2019). However, forming such an identity is especially challenging for girls, who often face barriers in aligning their self-concept with the predominantly masculine norms of STEM fields (Avraamidou, 2020; Carlone & Johnson, 2007; D'Anna-Hernandez et al., 2025; Flores et al., 2024). Moreover, the early development of STEM-specific self-efficacy is a critical factor influencing girls' academic choices in STEM disciplines (Sakellariou & Fang, 2021).

Research on STEM promotion of girls and women typically assesses and explores both constructs—identity and self-efficacy—at the individual level (Falco & Summers, 2019; Vincent-Ruz & Schunn, 2018). However, little attention has been given to these constructs on the organizational level, particularly concerning out-of-school STEM education program providers and their role in successfully planning and implementing educational offerings for females in STEM. Understanding organizational identity and efficacy at this level is crucial for improving how out-of-school STEM education program providers can sustainably support and promote girls and women in STEM.

To illustrate, an out-of-school STEM education provider may emphasize the support of females if its organizational identity is centered on gender equity, i.e., if it views itself and is recognized by others as an institution that consistently prioritizes and promotes female participation in STEM. Similarly, an out-of-school STEM education provider may emphasize the support of females if its members share the belief that they possess the necessary resources and competencies to implement relevant practices to support females effectively, for example, by recruiting female role models, designing inclusive program materials, or building partnerships with schools to support girls in STEM fields. Together, these constructs can shape program outcomes through complementary mechanisms: organizational identity sets the direction ("who we are and what we stand for"), while organizational efficacy provides the confidence to act on that direction ("what we are capable of doing"). As a result, they can impact program design and delivery, including the integration of female role models, the use of gender-inclusive language, and the development of long-term support structures.

In addition to their independent effects, organizational identity and efficacy may also interact in shaping program outcomes (Sezgin Nartgün & Gülmez, 2024). While a strong organizational identity can set the strategic direction of an organization, organizational efficacy determines whether members believe they can successfully act on that direction, and consequently, do so. Thus, particularly the combination of strong organizational identity and efficacy may foster the successful implementation of gender-inclusive practices in STEM programs.

To sum up, unlike their individual-level counterparts, which typically concern the identity and efficacy beliefs of individual participants in out-of-school STEM education programs and how these beliefs influence their educational and career choices, organizational identity and efficacy in out-of-school STEM program providers capture the collective orientations and shared beliefs of institutions and their members, shaping how programs are designed and implemented to support their participants. Despite the importance of these constructs, organizational identity (Albert & Whetten, 1985) and collective efficacy (Bandura, 1997; Gully et al., 2002; Stajkovic et al., 2009), with organizational efficacy being a subcategory of collective efficacy (Bohn, 2010; Capone & Petrillo, 2015), have rarely been studied in the context of out-of-school STEM education. In other domains, however, they have received considerable attention, including business companies (Amore et al., 2024; Sunyer et al., 2023), small and medium-sized enterprises (Abdullah et al., 2022), nonprofit organizations (Kandel et al., 2023; Li & Zhang, 2020), and educational institutions such as schools (Anderson et al., 2023; Kantos et al., 2023) and universities (Flipse et al., 2024).

Our study addresses the gap by investigating organizational identity and efficacy in the context of out-of-school STEM education providers. These organizations play a crucial role in broadening female participation in STEM, yet little is known about how their organizational identity and organizational efficacy in promoting females in STEM are associated with the success of their programs. To capture the success of out-of-school STEM education providers in promoting females in STEM, it is essential to build on prior research that has identified key conditions for effective interventions. This research provides the theoretical basis for the outcome variables used in this study as indicators of program success in promoting females in STEM.

Research points, for example, to the importance of gender-inclusive program design, including the use of female role models and gender-fair learning opportunities (Gladstone & Cimpian, 2021; Hentschel et al., 2018). Moreover,

networking and professional development activities are considered crucial, as they enable organizations to learn from one another and build capacity for gender-equitable STEM promotion (Henríquez Fernández et al., 2023; Weiss et al., 2025). Studies further emphasize that long-term and continuous activities are more effective than isolated, short-term interventions (Sáinz et al., 2022). Finally, the involvement of relevant social environments such as parents, teachers, and peers has been shown to strengthen girls' persistence and engagement in STEM (Iroaganachi et al., 2021).

The present study examines the relationship between organizational identity and efficacy and the success criteria of STEM education programs for females in STEM, aiming to contribute to a better understanding of organizational-level factors that shape gender equity in STEM education and generate insights that can help program providers support girls and women in STEM more effectively.

Success criteria for promoting females in STEM education programs

Out-of-school STEM education programs, such as STEM workshops, maker spaces, science clubs, and STEM summer camps, provide unique opportunities to develop positive attitudes toward and interest in STEM by offering hands-on learning experiences that go beyond what is possible in schools (Baran et al., 2019; Sonnert et al., 2025; Young et al., 2016). They are also crucial to sparking and sustaining interest in STEM among females, a group that remains underrepresented in these fields (Gecu-Parmaksiz et al., 2021). This is especially important during adolescence when interest in STEM declines without additional support (Babarović, 2022; Frenzel et al., 2010).

Therefore, including females in out-of-school programs is important. However, research suggests that simply including females is not sufficient; programs also need to meet specific success criteria to ensure they really attract females and positively impact their attitudes and interests in STEM. First, research highlights the importance of considering fundamental principles of the effective promotion of females, such as avoiding gender stereotypes and providing adequate female role models, in program advertising, planning, and implementation (Gladstone & Cimpian, 2021; Steegh et al., 2021). For example, negative gender-science stereotypes predict a lower willingness of females to participate in out-of-school programs such as the Mathematical and Science Olympiads (Steegh et al., 2021). Furthermore, females report a lower sense of belonging in advanced mathematics and science classes when they perceive that their group holds more traditional gender-stereotypical beliefs (Barth et al., 2022). Therefore, critically reflecting on existing gender biases is considered an essential aspect of advertising, planning, and implementing STEM education programs for females. For example, the use of gender-fair language is important when reaching out to females and addressing them in programs. Hentschel et al. (2018) found in their study on gender-sensitive language that using only masculine forms in recruitment advertisements for programs negatively affected females' self-ascribed fit, interest in the program, and application intentions. Additionally, the authors highlighted the importance of the images used in advertisements. The effects were negative for advertisements that contained a male-typed image and masculine linguistic forms. Another critical aspect of successful STEM promotion of females is providing female STEM role models for participants in STEM education programs (Gladstone & Cimpian, 2021). For example, González-Pérez et al. (2020) conducted a role-model intervention where females employed in STEM fields visited schools to discuss their careers with female students. The intervention reduced gender stereotypes about mathematical abilities and increased mathematical enjoyment, the perceived importance of mathematics, expectations of success in mathematics, and aspirations for pursuing a career in STEM.

Other criteria that influence the successful promotion of females in out-of-school STEM education include networking opportunities and professional development related to STEM promotion of females for staff who provide STEM education programs (Henríquez Fernández et al., 2023; Weiss et al., 2025). This is important, as research suggests that many teachers believe boys tend to outperform girls in STEM fields and that there is a lack of gender-balanced teaching initiatives in mathematics and science classes, such as presenting female STEM role models (Hand et al., 2017). There is also evidence that teachers who participate in professional development workshops aimed at didactic strategies to engage females in STEM develop a better awareness of the importance of supporting females' STEM engagement and adapt their teaching practices accordingly (Stephenson et al., 2022). Moreover, out-of-school STEM education program providers who are more willing to network and collaborate with other stakeholders in promoting females in STEM, such as other out-of-school STEM education providers, schools, or universities, are more successful in encouraging females to pursue STEM careers. For example, Weiss et al. (2025) argue that many out-of-school STEM programs operate in isolation, which limits opportunities for shared learning and collective improvement.

They propose that establishing structured collaborations among organizations, researchers, and practitioners could enhance the effectiveness of these programs, particularly for underrepresented groups in STEM. Based on qualitative research, empirical findings by Hug and Eyerman (2021) further support the value of networking and collaboration between out-of-school STEM education providers and other stakeholders. Their study demonstrates how collaborations between an after-school STEM program for young women, particularly those from underrepresented backgrounds, and schools strengthen institutional STEM education and create more supportive learning environments that encourage young women to engage with and persist in STEM fields.

Another success criterion in promoting females in STEM fields is long-term support. Short-term interventions can, of course, achieve desired effects. However, follow-up surveys frequently fail to show sustained effects. For example, a study by Shin et al. (2022) demonstrated that the immediate motivational impact of a science utility value intervention for fifth- and sixth-grade students, which consisted of six bi-weekly 40-min sessions, decreased 6 months after the intervention. One reason is that females who participate in such programs return to their usual environments where they are exposed to stereotypical influences, causing the achieved effects to diminish. Ziegler et al. (2012) argue that this is a key challenge in sustaining intervention effects. Thus, only long-term interventions and repeated participation can achieve sustainable promotion effects and lasting STEM engagement of females (Sáinz et al., 2022). In this context, the results of a systematic review of 32 STEM interventions for secondary school girls, conducted by Prieto-Rodriguez et al. (2020), seem particularly noteworthy. About two-thirds of the included interventions were short-term, lasting between 20 min and 2 weeks.

Furthermore, it is crucial to consider different environmental factors influencing attitudes, behaviors, and decisions when promoting females in STEM. These include their teachers, parents, peers, and the media. In their study of junior secondary school girls, Iroaganachi et al. (2021) demonstrated the notable influence of environmental factors, including teacher, parental, peer, and role model influences, on girls' intentions to pursue a STEM career path. In a systematic review of 165 studies on the underrepresentation of females in STEM fields, Msambwa et al. (2025) found that 61% of the studies indicated that environmental factors, such as parental involvement, peer pressure, and teachers' gender bias and competence, contribute to females' low participation in STEM. Therefore, integrating multiple environmental aspects of females' lives into the provision of out-of-school STEM education programs is considered an important aspect of effective STEM promotion for females. This approach may also help to sustain the positive effects of interventions when females return to their environments after participating in the programs.

The role of organizational identity and organizational efficacy for successfully promoting females in out-of-school stem education programs

Identity and self-efficacy in STEM education are primarily investigated at the individual level. For example, research indicates that perceiving STEM as an integral part of one's identity is a critical factor in retention in STEM education and the pursuit of long-term STEM careers (Avraamidou, 2020; Carlone & Johnson, 2007; Çolakoğlu et al., 2023; Dou et al., 2019; Vincent-Ruz & Schunn, 2018). It is also widely recognized in STEM education research that gender differences in self-efficacy contribute to the low participation rates of females in STEM (Benavent et al., 2020; Falco & Summers, 2019; Sakellariou & Fang, 2021). However, thus far, the role of identity and efficacy at an organizational level has barely been explored in the STEM education sector. Nonetheless, studies from sectors outside STEM education indicate their significance for successful STEM education, particularly for females.

Organizational identity

While numerous theoretical perspectives on and conceptualizations of organizational identity exist (Corley et al., 2006; Ravasi & van Rekom, 2003), the seminal and most influential definition comes from Albert and Whetten (1985). They define organizational identity as "a set of *claims* and sustainable stories about the unique nature of an organization" (Ravasi & van Rekom, 2003, p. 123) and conceptualize it as an organization's central, distinctive, and enduring characteristics. There is a broad consensus that organizational identity is a collective-level construct; however, debates persist about the interaction between individual and collective levels (Corley et al., 2006). This may depend on whether one views organizational identity as a property of the organization itself or as the collective beliefs or shared cognitions of the organizational members (Corley et al., 2006; Ravasi & van Rekom, 2003).

Research also highlights methodological challenges in operationalizing and capturing organizational identity, particularly regarding suitable data sources and data collection methods. Approaches range from case studies and interviews to archival analyses and focus groups, but no consistent guidelines have been established (Ravasi & van Rekom, 2003).

In identity research, scholars have emphasized that identity is not only an internal self-definition but also shaped through recognition by significant others. Building on this perspective, Vincent-Ruz and Schunn (2018) conceptualized science identity at the individual level as consisting of two dimensions: an internal component (perceived personal identity), referring to seeing oneself as the kind of person who is associated with science, and an external component (perceived recognized identity), referring to the perception that others such as friends, family, or teachers see one as person who is associated with science.

Transferring this distinction to the organizational level enables a more nuanced understanding of organizational identity. Specifically, it is possible to distinguish between (a) how an organization perceives itself in terms of its core mission and role (perceived organizational identity), and (b) how the organization believes it is recognized by influential others such as clients, partner organizations, funding agencies, or policymakers (perceived recognized organizational identity). This two-dimensional perspective highlights the relational nature of organizational identity and its reliance on both internal self-perceptions and external recognition.

Knorr and Hein-Pensel (2024) demonstrated in their analysis of over 1000 articles referencing Albert and Whetten's concept of organizational identity that the construct has been studied across diverse fields, including business, communication, computer science, economics, education, environment, finance, health, psychology, and sociology. However, to our knowledge, no research has investigated out-of-school STEM education providers' organizational identity for promoting females. Research in other domains, however, provides indirect evidence that an organizational identity related to promoting females in STEM may be linked to several indicators of the successful promotion of females in STEM.

One reason for this assumption is that topics associated with the organizational identity—such as the STEM promotion of females in our context—are perceived as more important and receive greater attention within organizations. This heightened attention can influence organizational behavior and outcomes. When gender equity is central to an organization's identity, it is more likely to be embedded in its mission and values and to receive systematic consideration in program planning and implementation. Evidence from other domains supports this: for example, a green organizational identity has been shown to foster environmentally responsible practices and improve organizational performance in the hospitality sector (Elshaer et al., 2024; Haldorai et al., 2023).

In addition, organizational identity provides orientation for members, encourages knowledge sharing and creativity, and fosters behaviors aligned with organizational goals (Imamoglu et al., 2023; Voss et al., 2006). For STEM education providers, this suggests that a strong gender-equity identity increases the likelihood of implementing program practices that are crucial for successfully promoting girls and women in STEM. Research from educational contexts supports this: Kezar (2021) showed that the identity of intermediary higher education organizations shaped their capacity to scale evidence-based teaching practices. Similarly, Williams et al. (2019) found that schools with a strong, learning-oriented culture demonstrated higher fidelity in implementing evidence-based interventions. Together, these findings suggest that organizational identity is a crucial factor in determining whether and how research-based practices are successfully implemented.

Furthermore, organizational identity in a particular domain is related to organizational members' assessment of their organization's success in reaching identity-related goals. For example, in a study with 73 supervisors and 583 subordinates in small and medium-sized enterprises in different industries in Taiwan, including the electronic information industry and trading companies, Chang and Hung (2021) found that a green organizational identity fostered green product psychological ownership, which in turn positively influenced employees' assessment of their organization's green product development performance. Similarly, we expect that STEM education providers with a strong organizational identity related to the STEM promotion of females are more likely to perceive themselves as successful in achieving this goal.

Based on these findings, it can be expected that organizational identity in the domain of STEM promotion of females in out-of-school STEM education program providers is related to different success criteria in promoting females in STEM: (a) the consideration of fundamental principles of effective STEM promotion of females in program planning and implementation, (b) the implementation of research-based success criteria for promoting females in STEM, and (c) STEM education providers' self-assessed success in promoting females in STEM.

Organizational efficacy

Efficacy beliefs were conceptualized initially as an individual-level construct (Bandura, 1986; Walumbwa et al., 2004). At this level, self-efficacy refers to the belief that an individual can effectively utilize their resources, skills, and competencies to achieve specific goals and outcomes, even in the face of obstacles and resistance (Bandura, 1997; Beierlein et al., 2013; Schaubroeck et

al., 2012). As a construct at the level of groups, collective efficacy is defined as "a group's shared belief in its conjoint capabilities to organize and execute the courses of action required to produce given levels of attainments" (Bandura, 1997, p. 477). According to Goddard and Salloum (2011, p. 644), the key question regarding collective efficacy is: "Can *we* orchestrate the thoughts and actions necessary to successfully perform the task?" Collective efficacy is typically associated with specific domains of activity (Bandura, 1997; Schaubroeck et al., 2012; Stajkovic et al., 2009) and has been studied in various contexts where groups seek to achieve outcomes through collective activities, such as neighborhoods, politics, education, sports teams, and business organizations (Bohn, 2010). In the context of research on business organizations, organizational efficacy has emerged as a subcategory of collective efficacy, focusing explicitly on structured organizations (Bohn, 2010; Capone & Petrillo, 2015).

Meta-analyses indicate that collective (or organizational) efficacy is positively associated with group performance, particularly in conditions of high task interdependence among group members (Gully et al., 2002; Stajkovic et al., 2009). However, organizational efficacy has received little attention in the context of STEM education research. One exception is the study by Niler et al. (2020), which examined how team composition affected team identification and collective efficacy in student teams whose members were predominantly STEM majors, finding that women reported higher team identification and collective efficacy as the percentage of women on their team increased, which positively affected team performance. However, the organizational efficacy of out-of-school STEM education providers in promoting females in STEM has not been studied to date. Nevertheless, research from other domains suggests that organizational efficacy in this area is positively related to indicators of program success.

Evidence from organizational research indicates that efficacy beliefs influence not only the amount of effort organizations invest but also the practices they prioritize. For example, organizational efficacy predicts the adoption of new technologies (Cao et al., 2020), the introduction of innovative processes (Liu et al., 2015; Schwabsky et al., 2019), and the development of more substantial employee commitment, including job satisfaction and institutional belonging (Sánchez-Rosas et al., 2022). These studies indicate that when members collectively believe in their ability to succeed in a domain, the organization is more likely to invest resources, develop effective practices, and sustain long-term engagement in this area.

A central mechanism in this process is the adoption and consistent implementation of evidence-based practices. When organizational members share strong efficacy beliefs, organizations are more likely to direct sustained effort toward their objectives and to maintain practices that align with strategic goals. In the context of STEM education providers, this suggests that high organizational efficacy in promoting females will increase the likelihood of systematically integrating gender-equity principles into program planning, implementing research-based success criteria such as networking and professional development, and designing long-term and sustainable activities that involve relevant social environments like parents, teachers, and peers. Evidence from other organizational contexts supports this assumption. For example, Nichols et al. (2020) demonstrated that schools with higher collective teacher efficacy showed greater fidelity in implementing evidence-based behavioral interventions. Dagne et al. (2021) demonstrated that nurses with stronger efficacy beliefs are more likely to implement evidence-based practices consistently. Taken together, these findings suggest that strong efficacy beliefs can motivate organizations to translate their goals into practical actions that align with research-based recommendations.

In addition, research indicates that efficacy beliefs shape how members evaluate organizational performance: for instance, higher collective efficacy among teachers was associated with stronger perceptions of their school's preparedness for future challenges (Heikonen et al., 2024), and organizational efficacy has been linked to higher self-assessed performance in family and nonfamily firms (Stanley & McDowell, 2014). This supports the expectation that STEM education providers with high organizational efficacy in the STEM promotion of females will also perceive themselves as more successful in this domain.

Taken together, prior research indicates that organizational efficacy of out-of-school STEM education providers may affect (a) the consideration of gender-equity principles in program planning and implementation, (b) the implementation of research-based success criteria for promoting females in STEM, and (c) providers' self-assessed success in achieving this goal.

Current study

To date, STEM education research has paid little attention to identity and efficacy at the organizational level. Consequently, little is known about the role of out-of-school education program providers' identity and efficacy in successfully promoting females in STEM. However, based on research in other contexts that has shown relationships between these constructs and organizational success factors, such as focusing on specific aims and

tasks, commitment, behavior, and innovation, a relationship can be expected.

This study examined the role of organizational identity and organizational efficacy in promoting females in STEM within out-of-school STEM education providers, as well as their relationship to successfully promoting females in STEM. Based on research findings on organizational identity (Albert & Whetten, 1985) and collective efficacy (Stajkovic et al., 2009) in other contexts, we hypothesized that the more STEM education program providers identify with the field of STEM promotion of females and the higher they rate their efficacy in this area, the more successful they are in promoting females in STEM. In addition to the main effects, we also hypothesized an interaction effect, expecting that a combination of high organizational identity and high organizational efficacy related to STEM promotion of females in STEM education providers is especially beneficial for the successful promotion of females in out-of-school STEM education programs.

The indicators of program success, i.e., the outcome variables investigated in our study, were selected based on prior research on effective conditions for promoting females in STEM (Gladstone & Cimpian, 2021; Msambwa et al., 2025; Prieto-Rodriguez et al., 2020; Sáinz et al., 2022; Weiss et al., 2025). Specifically, we investigated whether organizational identity and efficacy in promoting females in STEM of out-of-school STEM education providers were positively related to (a) their consideration of fundamental principles of effective STEM promotion of females in program planning and implementation, (b) their implementation of research-based success criteria for successful STEM promotion of females in their organization and programs, such as their interest in networking and professional development related to STEM promotion of females, their focus on the long-term nature and sustainability of STEM promotion of females, and their integration of different environmental aspects into the STEM promotion of females, as well as (c) their self-assessed success in promoting females in STEM. To investigate our research questions, we developed a questionnaire to capture identity and efficacy at the organizational level.

In addition to organizational identity and efficacy, program-level characteristics can also contribute to explaining variation in program success. Structural and thematic features such as gender focus, target groups, program formats, and disciplinary fields may influence how successfully programs promote girls and women in STEM and the extent to which gender-inclusive principles are considered. To account for these contextual influences, we included these characteristics as covariates in our analyses.

Method

Sample and procedure

For our study, we conducted a Nationwide survey of STEM education providers in Germany on behalf of "MINTvernetzt," the Competence and Networking Centre for Extracurricular STEM Education in Germany. MINTvernetzt was funded during its first funding phase by the Federal Ministry of Education and Research (BMBF) and is operated by teams at five institutions in different federal states (the Körber Foundation in Hamburg, matrix gGmbH in Düsseldorf, the National STEM Forum e.V. in Berlin, the Stifterverband in Berlin, and the University of Regensburg). The focus of the "STEM and Gender" sub-project of MINTvernetzt at the University of Regensburg is to provide solutions to the STEM community to increase the participation of females in STEM.

The survey was implemented in Lamapoll as an online survey and was sent out in November 2022 to 1504 STEM education providers that are members of MINTvernetzt. The questionnaire was answered by 527 participants (35%). Data were collected cross-sectionally at a single point in time.

There were two questionnaire versions: one for "STEM education providers" and another for "organizations that support or are interested in STEM education", e.g., foundations or media. Participants were assigned to the two groups based on their answers to the question "Is the organization you work for a provider of STEM education?". Participants who answered with "Yes" were assigned to Group 1 "STEM education providers", participants who answered with "No, but our organization supports STEM education or is interested in STEM education" were assigned to Group 2 "organizations that support or are interested in STEM education". 414 participants were assigned to Group 1, "STEM education providers", 113 were assigned to Group 2, "organizations that support or are interested in STEM education".

In this study, we focused exclusively on the first group, i.e., actual providers of STEM education programs. A detailed overview of the program characteristics, as reported by the participating STEM education providers, is provided in Table 1. The programs varied widely in their characteristics. Most programs targeted more than one gender, with a smaller proportion focusing exclusively on females or other gender groups. Programs were designed for a broad range of target groups, most frequently lower and upper secondary school students, but also primary school students, university students, teachers, and multipliers of STEM education. The programs

Table 1 Program characteristics reported by participating STEM education providers ($N = 209$)

Program characteristics	Categories	% of programs
Gender focus	More than one gender	82.9
	Exclusively female	14.9
	Exclusively male	2.0
	Exclusively diverse	0.1
Target groups	Lower secondary school students (grades 5–10)	83.3
	Upper secondary school students (grades 11–13)	74.6
	Teachers	50.7
	Primary school students (grades 1–4)	45.9
	University students	38.8
	Coordinators and multipliers of STEM education programs	25.4
	Children in kindergarten or pre-school	19.1
	Students in vocational training	18.7
	Students in dual studies (combination of vocational training and university studies)	17.2
	Early childhood educators	17.2
	Parents	15.8
	School headmasters	13.4
	Scientists	12.4
	Young professionals	9.6
	University teachers	7.7
	Other	7.7
Program formats	Workshops	67.9
	Student research labs	60.3
	Summer programs/academies	57.4
	Action days	55.5
	Career orientation events	51.2
	Professional development	42.6
	Project-based work	39.2
	Networking opportunities	34.9
	Internships	34.4
	Competitions	34.0
	Teaching materials	34.0
	Lectures	30.6
	Counseling	22.0
	Mentoring	20.6
	Exhibitions	15.8
	Conferences	15.3
	Peer learning	13.9
	Other	14.4
STEM fields	Informatics	75.6
	Technology	75.1
	Physics	60.3
	Mathematics	50.7
	Chemistry	50.7
	Biology	44.0
	Other	16.7
	Medicine	7.7

employed a diverse range of formats, including workshops, student research labs, summer academies, action days, and career orientation events. In addition, they covered all STEM fields, most prominently informatics, technology, and physics.

Measures

Dependent variables

Consideration of fundamental principles of effective STEM promotion of females in program planning and implementation We assessed the extent to which STEM education providers considered fundamental principles of effective promotion of females when planning and implementing their STEM education programs with a self-constructed four-item scale. Respondents indicated on a 4-point Likert-type scale, ranging from 1 (completely disagree) to 4 (completely agree), how much they consider fundamental principles of effective promotion of females when planning and implementing their STEM education programs. Sample items read: "In our STEM education programs, the concepts are free of stereotypes" and "In our STEM education programs, we feature appropriate female STEM role models." Cronbach's alpha was .72.

Interest in networking and professional development related to STEM promotion of females We assessed respondents' interest in networking and professional development related to STEM promotion of females with a self-constructed three-item scale. Respondents indicated their level of interest in participating in networking and professional development activities on a 4-point Likert-type scale, ranging from 1 (completely disagree) to 4 (completely agree). A sample item reads: "In our STEM education programs, we want to participate in networking events on the topic of effectively promoting females in STEM." Cronbach's alpha was .89.

Focus on the long-term nature and sustainability of STEM promotion of females We assessed respondents' consideration of long-term and sustainability aspects in their STEM education programs with a self-constructed three-item scale. Respondents indicated their level of agreement on a 4-point Likert-type scale, ranging from 1 (completely disagree) to 4 (completely agree), regarding how much they focused on the long-term effects and sustainability of their STEM education programs. A sample item reads: "In our STEM education programs, we not only offer short-term activities, but also ensure long-term support." Cronbach's alpha was .72.

Integration of different environmental aspects into the STEM promotion of females We assessed respondents' integration of different environmental aspects in their

promotional offerings with a self-constructed three-item scale. Respondents indicated on a 4-point Likert-type scale, ranging from 1 (completely disagree) to 4 (completely agree), how much attention they pay to integrating as many environmental aspects as possible into their STEM education programs. A sample item reads: "In our STEM education programs, we make sure to include as many environmental areas (e.g., friends, parents, media, teachers) of the participants as possible." Cronbach's alpha was .62.

Self-assessed success in promoting females in STEM We asked respondents to assess their success in promoting females in STEM with a self-constructed five-item scale. Respondents indicated on a 4-point Likert-type scale, ranging from 1 (completely disagree) to 4 (completely agree), how successful they consider themselves in achieving various goals in the STEM promotion of females. A sample item reads: "In our STEM education programs, we manage to get the participating females excited about STEM." Cronbach's alpha was .81.

Independent variables

Organizational identity related to STEM promotion of females We assessed respondents' organizational identity related to STEM promotion of females with a six-item scale. The scale is an adapted and extended version of the Science Identity Scale from Vincent-Ruz and Schunn (2018). A unique aspect of our adapted scale is that it measures the identity of institutions or organizations, rather than that of individuals. In analogy with the science identity scale from Vincent-Ruz and Schunn (2018), our scale consists of two components: (1) perceived organizational identity and (2) perceived recognized organizational identity related to STEM promotion of females. For the first component, consisting of one item, respondents indicated on a 4-point Likert-type scale, ranging from 1 (completely disagree) to 4 (completely agree), how much they see their organization as an actor in the field of STEM promotion of females. The item reads: "We see ourselves as actors in the STEM promotion of females." For the second component, consisting of five items, respondents indicated on a 4-point Likert-type scale the extent to which they perceive that influential others on the institutional level (participants, funding agencies, STEM teachers, policymakers, the STEM community) see their organization as an actor in the field of STEM promotion of females. A sample item reads: "The STEM community sees us as an organization that focuses on the STEM promotion of females." Cronbach's alpha was .93.

Organizational efficacy in STEM promotion of females We assessed respondents' organizational efficacy in STEM promotion of females with a three-item scale. The scale is an adapted version of the short scale for measuring individual general self-efficacy beliefs from Beierlein et al. (2013). A unique aspect of our adapted scale is that it measures the efficacy of institutions or organizations, rather than the self-efficacy of individuals. Respondents indicated on a 4-point Likert-type scale, ranging from 1 (completely disagree) to 4 (completely agree), how highly they rate their institution's efficacy in STEM promotion of females. A sample item reads: "In our STEM education programs, we can cope well with most of the problems regarding the STEM promotion of females on our own." Cronbach's alpha was .85.

Data analysis

Pearson correlations were calculated between organizational identity related to STEM promotion of females, organizational efficacy in STEM promotion of females, and the five indicators of successful STEM promotion for females. These indicators were: (a) consideration of fundamental principles of effective STEM promotion of females in program planning and implementation, (b) interest in networking and professional development related to STEM promotion of females, (c) focus on the long-term nature and sustainability of STEM promotion of females, (d) integration of different environmental aspects into the STEM promotion of females, and (e) self-assessed success in promoting females in STEM.

We then conducted multiple linear regressions (method: enter) to test whether organizational identity and organizational efficacy related to STEM promotion of females predicted the five outcome indicators. For this purpose, the success criteria were included as dependent variables in the regression models.

Predictor variables were entered in two steps. In Step 1, organizational identity and organizational efficacy related to STEM promotion of females were entered as independent variables, along with their interaction term. To test for interaction effects, both predictors were mean-centered prior to creating the product term.

In Step 2, we added program-level control variables to account for structural and thematic heterogeneity across programs (see Table 1). These included:

Gender focus: A dummy variable indicating whether more than 50% of a provider's STEM programs specifically target girls (12.0% of cases coded as 1).

Target groups: Four binary variables were created to capture whether a provider targeted specific educational groups. Each variable was coded as 1 if at least one of the original categories belonging to that group was reported as part of the provider's target audience, and 0 otherwise. The categories in parentheses reflect the original categories reported in Table 1. The four groups included (a) early childhood and primary education (children in

Table 2 Descriptive statistics of the scales (N = 209)

	M	SD	Min	Max	Skewness	Kurtosis
Organizational identity related to STEM promotion of females	2.66	0.77	1.00	4.00	0.02	−0.57
Organizational efficacy in STEM promotion of females	2.80	0.70	1.00	4.00	−0.37	0.23
Consideration of fundamental principles of effective STEM promotion of females in program planning and implementation	3.13	0.59	1.25	4.00	−0.34	−0.30
Interest in networking and professional development related to STEM promotion of females	3.04	0.77	1.00	4.00	−0.51	−0.28
Focus on the long-term nature and sustainability of STEM promotion of females	2.77	0.71	1.00	4.00	−0.14	−0.35
Integration of different environmental aspects into the STEM promotion of females	2.39	0.69	1.00	4.00	0.08	−0.30
Self-assessed success in promoting females in STEM	3.18	0.52	1.60	4.00	−0.18	−0.43

Table 3 Correlation coefficients for organizational identity related to STEM promotion of females, organizational efficacy in STEM promotion of females, and the five investigated success criteria for STEM promotion of females (*N* = 209)

	1	2	3	4	5	6
(1) Organizational identity related to STEM promotion of females	–					
(2) Organizational efficacy in STEM promotion of females	.47**	–				
(3) Consideration of fundamental principles of effective STEM promotion of females in program planning and implementation	.52**	.45**	–			
(4) Interest in networking and professional development related to STEM promotion of females	.38**	−.01	.26**	–		
(5) Focus on the long-term nature and sustainability of STEM promotion of females	.36**	.38**	.46**	.21**	–	
(6) Integration of different environmental aspects into the STEM promotion of females	.25**	.23**	.34**	.01	.46**	–
(7) Self-assessed success in promoting females in STEM	.33**	.50**	.35**	−.03	.27**	.17*

Pearson correlation coefficients (two-sided) are reported; $^{\dagger}p < .10$; $^{*}p < .05$; $^{**}p < .01$

kindergarten or preschool, primary school students; 47.4% of cases coded as 1), (b) secondary education (lower and upper secondary school students; 89.5%), (c) vocational and higher education (students in vocational training, university students, students in dual studies, young professionals, scientists, university teachers; 49.8%), and (d) educational professionals and stakeholders (teachers, school principals, parents, early childhood educators, coordinators and multipliers of STEM education programs; 56.5%).

Program formats: Four binary variables were created to capture whether a provider offered specific types of program formats. Each variable was coded as 1 if at least one of the original categories belonging to that format type was reported, and 0 otherwise. The categories in parentheses reflect the original categories reported in Table 1: (a) hands-on and experiential formats (workshops, student research labs, project-based work, summer programs/academies, competitions, internships; 95.2%), (b) information and orientation formats (lectures, career orientation events, counseling, conferences, exhibitions; 70.3%), (c) networking and support formats (networking opportunities, mentoring, peer learning; 50.2%), and (d) capacity-building and resource formats (professional development, teaching materials; 55.5%).

STEM fields: Seven binary variables were created to capture the disciplinary orientation of providers. Each variable was coded as 1 if the provider indicated offering programs in the respective disciplinary field (mathematics, informatics, biology, chemistry, physics, technology, medicine), and 0 otherwise.

To avoid problems of multicollinearity, we examined intercorrelations among all control variables. The highest observed correlation was $r = .53$ (between targeting educational professionals and stakeholders and capacity-building and resource formats), suggesting no critical multicollinearity.

All analyses were conducted using IBM SPSS Statistics (Version 29).

Results

Descriptive statistics

Table 2 presents descriptive statistics (means, standard deviations, minimum and maximum values, skewness, and kurtosis) for organizational identity related to STEM promotion of females, organizational efficacy in STEM promotion of females, and the assessed success criteria concerning the successful promotion of females in extracurricular STEM education programs. The participants in our study reported relatively high levels of self-assessed success in promoting females in STEM, as well as a strong consideration of the fundamental principles of effective STEM promotion of females in their education programs. However, other aspects, such as focus on the long-term nature and sustainability of STEM promotion of females and integration of different environmental aspects into the STEM promotion of females, were rated comparatively lower. Similarly, the mean values of organizational identity related to STEM promotion of females and organizational efficacy in STEM promotion of females were in the moderate range.

Correlations

Table 3 presents the correlations between organizational identity related to the STEM promotion of females, organizational efficacy in STEM promotion of females, and the assessed success criteria in the STEM promotion of females. Organizational identity related to STEM promotion of females showed low to high correlations (Bortz & Döring, 2006) with the assessed success criteria (between .25 and .52). A low correlation was found with integration of different environmental aspects into the STEM promotion of females, medium correlations were found with interest in networking and professional development related to STEM promotion of females, focus on the long-term nature and sustainability of STEM promotion of females, and self-assessed success in promoting females in STEM; a high correlation was found with consideration of fundamental principles of effective STEM promotion of females in program planning and implementation.

Organizational efficacy in STEM promotion of females showed low to high correlations with four of the assessed success criteria (between .23 and .50). No significant correlation emerged for organizational efficacy in STEM promotion of females with interest in networking and professional development related to STEM promotion of females. A low correlation was found with integrating different environmental aspects into the STEM promotion of females. Medium correlations were found for organizational efficacy in STEM promotion of females with a focus on the long-term nature and sustainability of STEM promotion of females and the consideration of fundamental principles of effective STEM promotion of females in program planning and implementation; a high correlation was found with self-assessed success in promoting females in STEM.

Regression analyses

We tested within our sample whether organizational identity related to STEM promotion of females, organizational efficacy in STEM promotion of females, and their interaction term predicted the five investigated success criteria for promoting females in STEM. As shown in Table 4, in Step 1 the predictors explained between 8% and 33% of the variance across the five models. After adding program-level covariates in Step 2, the explained variance increased to between $R^2 = .27$ and .41, indicating that structural and thematic program characteristics accounted for a meaningful additional portion of variance in program success.

In Step 1, organizational identity related to STEM promotion of females significantly predicted all five investigated success criteria. However, it was only a marginally significant predictor of self-assessed success in promoting females in STEM. The strongest effects were found for interest in networking and professional development related to the STEM promotion of females, as well as for the consideration of fundamental principles of effective STEM promotion of females in program planning and implementation.

Organizational efficacy in STEM promotion of females predicted four of the investigated success criteria. It was not a significant predictor of integrating different environmental aspects into the STEM promotion of females at this stage. The strongest prediction was found for self-assessed success in promoting females in STEM. Interestingly, organizational efficacy showed a negative relationship with interest in networking and professional development related to STEM promotion of females, i.e., the higher program providers' organizational efficacy in STEM promotion of females was, the less they were interested in networking and professional development related to STEM promotion of females.

The interaction term of organizational identity related to STEM promotion of females and organizational efficacy in STEM promotion of females was only a marginally significant predictor of interest in networking and professional development related to STEM promotion of females.

After controlling for program characteristics in Step 2, the effects of organizational identity and efficacy remained largely robust, though slightly reduced in strength. The overall pattern of results was consistent with Step 1, but two notable changes emerged. First, for the integration of environmental aspects, organizational efficacy (rather than identity) became the significant predictor. Second, the previously marginally significant interaction effect was no longer significant, suggesting that the relationship between identity and efficacy is largely independent once program heterogeneity is taken into account.

In addition, several program-level covariates emerged as significant or marginally significant predictors (see Table 4). Specifically, STEM education providers with a stronger emphasis on girls (i.e., programs targeting female participants only, with more than 50% of their offerings) tended to show marginally higher levels of interest in networking and professional development, as well as greater integration of environmental aspects.

Programs addressing secondary education reported significantly higher levels of consideration of fundamental principles of effective STEM promotion of females and stronger integration of environmental aspects. Programs targeting educational professionals and stakeholders also showed a higher integration of environmental aspects and perceived themselves as more successful in promoting females in STEM. In contrast, programs focusing on vocational or higher education showed marginally lower interest in networking and professional development, as

Table 4 Results of the multiple linear regressions for organizational identity related to STEM promotion of females and organizational efficacy in STEM promotion of females predicting success criteria for STEM promotion of females ($N = 209$)

	Consideration of fundamental principles of effective STEM promotion of females in program planning and implementation		**Interest in networking and professional development related to STEM promotion of females**		**Focus on the long-term nature and sustainability of STEM promotion of females**		**Integration of different environmental aspects into the STEM promotion of females**		**Self-assessed success in promoting females in STEM**	
	β	***R*²**	***β***	***R*²**	***β***	***R*²**	***β***	***R*²**	***β***	***R*²**
Step 1: Organizational identity and efficacy		.33		.20		.19		.08		.26
Organizational identity related to STEM promotion of females	.40**		.47**		.25**		.19*		.13†	
Organizational efficacy in STEM promotion of females	.26**		−.20**		.25**		0.13		0.44**	
OI × OE[a]	−.01		.12†		−.07		−.05		−.01	
Step 2: + Control variables		.41		.31		.27		.28		.33
Organizational identity related to STEM promotion of females	.35**		.37**		.20*		.12		.16†	
Organizational efficacy in STEM promotion of females	.26**		−.19*		.23**		.16*		.45**	
OI × OE[a]	.01		.10		−.09		−.03		−.01	
Gender focus: Proportion of STEM programs with focus on girls only > 50%	.10		.12†		−.01		.13†		.03	
Target group: Early childhood and primary education	−.00		.05		−.03		.11		.09	
Target group: Lower and upper secondary education	.22**		−.08		.09		.22**		.01	
Target group: Vocational and higher education	.08		−.12†		.03		−.02		−.12†	
Target group: Educational professionals and stakeholders	.01		−.03		−.04		.19*		.21**	
Format: Hands-on & experiential formats	−.12†		−.00		.03		−.00		−.02	
Format: Information and orientation formats	.03		.16*		−.06		−.03		−.01	
Format: Networking and support formats	.09		.06		.16*		.03		−.04	
Format: Capacity-building and resource formats	.03		−.06		.09		.00		−.11	
STEM field: Mathematics	−.02		−.12		.00		−.03		−.03	
STEM field: Informatics	−.05		.26**		.16*		−.08		−.00	
STEM field: Biology	.11		.06		−.08		−.02		.00	
STEM field: Chemistry	−.07		.01		.16†		.15		−.05	
STEM field: Physics	.07		.09		.06		.11		.08	
STEM field: Technology	−.13†		−.06		−.14†		.02		−.10	
STEM field: Medicine	−.01		−.09		−.01		−.03		.05	

Significance levels for beta coefficients: †$p < .10$; *$p < .05$; **$p < .01$

[a]OI × OE = interaction term of mean-centered organizational identity and organizational efficacy related to STEM promotion of females

well as marginally lower self-assessed success in promoting females in STEM.

Regarding program formats, information and orientation formats were positively associated with interest in networking and professional development, whereas networking and support formats predicted a stronger long-term orientation in promoting females in STEM. By contrast, hands-on and experiential formats were marginally less likely to consider fundamental principles of gender-inclusive practice.

Finally, disciplinary orientation also played a role. Programs in informatics reported a significantly stronger interest in networking and professional development and a more pronounced long-term focus on promoting females in STEM. In contrast, technology-oriented programs were marginally less likely to integrate gender-inclusive practices and to emphasize long-term STEM promotion of females.

Discussion

The present study adopted an institutional perspective to examine how program providers' organizational identity and efficacy in promoting females in STEM relate to their success in supporting female participation in STEM. We hypothesized that out-of-school STEM education providers with a stronger organizational identity related to the STEM promotion of females and higher organizational efficacy in the STEM promotion of females would be more successful in achieving this goal. Specifically, we expected these providers to (1) integrate fundamental principles of effective STEM promotion of females into the planning and implementation of their programs, (2) adopt more research-based criteria for successful STEM promotion of females in their organizations and programs, and (3) perceive themselves as more successful in promoting females in STEM. Overall, our results highlight the critical role of organizational identity and efficacy in enabling STEM education program providers to achieve effective STEM promotion of females and support this group at the institutional level.

Our findings showed that organizational identity related to STEM promotion of females was a predictor for all assessed success criteria before accounting for program-level characteristics. Notably, organizational identity related to STEM promotion of females was a particularly strong predictor of the consideration of fundamental principles of effective STEM promotion of females in program planning and implementation. Providers of out-of-school STEM education programs who strongly identified as organizations committed to promoting females in STEM were more likely to prioritize and actively integrate these principles into their offerings. This is consistent with Albert and Whetten's (1985) conceptualization of organizational identity as a key factor influencing an institution's strategic orientation and priorities (Albert & Whetten, 1985). Similar patterns have been observed in the development of green organizational identity in business organizations (Elshaer et al., 2024; Haldorai et al., 2023). However, research also highlights that alignment among all organizational members—both leadership and staff—is crucial for successfully embedding identity-related goals into practice. Disagreements or a lack of clear direction in key focus areas can impede transformation processes and undermine organizational success (Kloser et al., 2018; Voss et al., 2006). Future research may benefit from surveying multiple representatives within STEM education organizations, including decision-makers and staff members, to assess how variations in their perceptions of organizational identity influence organizational outcomes.

Furthermore, the results revealed that providers of out-of-school STEM education programs with a stronger organizational identity related to STEM promotion of females were more likely to adopt research-based criteria for successful STEM promotion of females within their organizations and programs. In addition to focusing on the long-term nature and sustainability of STEM promotion of females, organizational identity also predicted the integration of different environmental aspects—such as parents, teachers, and the media—into efforts to promote females in STEM. However, after controlling for program-level characteristics, this relationship was no longer significant, suggesting that identity-related effects in this domain may be partly explained by structural or thematic program features.

In addition, organizational identity related to STEM promotion of females emerged as a particularly strong predictor of providers' interest in networking and professional development in this area. STEM education providers with a stronger organizational identity in this domain expressed significantly greater interest in engaging in networking and professional development opportunities related to the STEM promotion of females. Among all variables measured, this was the strongest effect observed for organizational identity. These findings align with research in other educational contexts, such as studies from the Chinese art education sector, which highlight the role of organizational identity in fostering employees' motivation to develop their professional skills and competencies (Zhang & Chienwattanasook, 2024). Moreover, Zhang and Chienwattanasook (2024) emphasize the importance of leadership in creating a supportive environment that facilitates training and development opportunities aligned with an organization's core values.

Interestingly, organizational identity related to STEM promotion of females was only a marginally significant predictor of how successful providers of out-of-school STEM education programs perceive themselves in this area. While prior research suggests that high levels of organizational identity are linked to organizational members' perceptions of their organization's success in achieving identity-related goals (Chang & Hung, 2021), our findings indicate that a strong organizational identity related to STEM promotion of females does not necessarily correspond to a high self-assessment of the organization's success or performance in this area.

Organizational efficacy significantly predicted four out of five success criteria; however, the patterns of association differed. As expected, based on research from other contexts (Cao et al., 2020), organizational efficacy in STEM promotion of females predicted the consideration of fundamental principles of effective STEM promotion of females in program planning and implementation. This suggests that organizations with higher perceived efficacy feel more capable of applying best practices in this context. However, the weaker predictive power of efficacy compared to organizational identity indicates that an organization's confidence in its capabilities alone may not be sufficient to ensure the systematic integration of these fundamental principles.

Regarding the question of whether STEM education program providers adopt more research-based criteria for successful STEM promotion of females within their organizations and programs, the patterns of association for organizational efficacy in STEM promotion of females differed compared to those for organizational identity. While organizational efficacy was a positive predictor of the focus on the long-term nature and sustainability of STEM promotion of females—equally strong as organizational identity—it did not emerge as a significant predictor of the integration of different environmental aspects, such as parents, teachers, peers, and the media, into STEM promotion efforts for females in the initial model. However, after controlling for program-level characteristics, organizational efficacy—rather than identity—became the significant predictor, suggesting that confidence in an organization's own capabilities plays an important role in supporting the integration of environmental aspects into STEM education programs that promote females in STEM once structural and thematic heterogeneity is considered. This finding can be explained in two ways: First, integrating environmental aspects may depend on perceptions of organizational efficacy related to these specific areas, such as working with parents, teachers, or peers. Some STEM education providers may lack confidence in their ability to effectively address these aspects in their programs. Second, many providers might be unaware of the importance of integrating different environmental factors into their STEM promotion efforts for females to achieve sustainable outcomes. While they may recognize the necessity of a long-term commitment to STEM promotion for females, they might not fully consider the role of broader environmental contexts in ensuring lasting effects. Although they may feel efficacious at the institutional level in promoting females in STEM, they may underestimate the value of involving these broader environmental contexts to achieve sustained impact.

Furthermore, organizational efficacy in STEM promotion of females negatively predicted interest in networking and professional development in this domain. In other words, the lower the program providers rated their organizational efficacy, the more interested they were in external capacity-building activities. One possible explanation for this result is that organizations with lower efficacy are more likely to seek external support and learning opportunities to compensate for perceived limitations, whereas organizations with higher efficacy may rely more heavily on internal resources and thus feel less of a need to engage in external professional development and networking activities. These findings align with research on teacher innovation, indicating that individuals with lower efficacy beliefs seek external support and professional development opportunities to address perceived skill gaps, particularly when they exhibit strong help-seeking tendencies (Budhi Santosa et al., 2024).

From a practical perspective, this finding suggests that professional development initiatives and networks may be particularly attractive to STEM education providers with lower organizational efficacy, who may also benefit the most from them. Engaging providers with higher efficacy levels in STEM promotion of females may require different strategies, as they might underestimate not only the added value of external exchange for themselves but also their role in contributing experiences to networks that support providers with lower efficacy.

These results also raise questions about how interest in networking and professional development related to STEM promotion of females was measured in this study. Future research could benefit from a distinction between these two aspects to examine whether high organizational efficacy is differently related to one of those constructs. Such insights could provide valuable information for networking and capacity-building activities in the context of STEM promotion of females.

In contrast to organizational identity, organizational efficacy in STEM promotion of females emerged as a strong predictor of self-assessed success, consistent with

findings from other organizational contexts (Heikonen et al., 2024; Stanley & McDowell, 2014). This suggests that STEM education program providers who perceive themselves as highly efficacious in promoting females in STEM are also more likely to assess their success in this domain more favorably. In other words, the greater their institutional confidence in their ability to implement STEM promotion efforts for females, the higher they rate their success in this area.

Finally, our interaction analyses revealed no significant effects on considering fundamental principles for effective STEM promotion of females, the focus on long-term sustainability, the integration of different environmental aspects, or self-assessed success. This suggests that organizational identity and efficacy are largely independent predictors of these success criteria. A marginally significant interaction emerged for interest in networking and professional development related to STEM promotion of females but this effect should be interpreted with caution given its marginal nature. Moreover, as the subsequent analyses revealed, this interaction did not remain significant once program-level heterogeneity was controlled for, indicating that it may reflect contextual differences rather than a stable relationship between identity and efficacy.

To better understand this tentative pattern, we examined the nature of the interaction. The results suggest that STEM education program providers with low organizational identity but high organizational efficacy tend to show less interest in these activities. In contrast, when organizational identity is high, interest in networking and professional development remains consistently high regardless of efficacy levels. Although this pattern might indicate that STEM education providers with a strong organizational identity engage in networking and professional development opportunities not merely as a compensatory strategy but as part of a broader commitment to continuous learning and collaboration, the result should be viewed as exploratory rather than conclusive. Future research could further investigate whether and under which conditions organizational identity and efficacy together shape providers' interest and motivation to engage in networking and professional development. As noted above, examining networking and professional development separately in future studies may help clarify their distinct relationships with organizational identity and efficacy.

After accounting for structural and thematic program characteristics, the core effects of organizational identity and efficacy on program success largely remained robust. This stability suggests that organizational processes and beliefs play an important role in promoting females in STEM, even when contextual heterogeneity across programs is taken into consideration. Interestingly, while organizational identity initially predicted the integration of environmental aspects into the STEM promotion of females, this effect shifted to organizational efficacy once program-level characteristics were controlled for. This pattern suggests that confidence in an organization's own capacity is particularly relevant for embedding broader contextual and sustainability considerations into program practice. In contrast, the disappearance of the previously marginal interaction effect indicates that the relationship between organizational identity and efficacy operates largely independently once program characteristics are controlled for.

Thus, even though structural and thematic characteristics explained additional variance, the main effects of organizational identity and efficacy remained stable. Beyond these core relationships, program-level covariates also revealed that contextual and design-related factors contribute to explaining variation in program success. Programs with a strong gender focus on female participants only and those targeting secondary education or educational professionals tended to report higher levels of gender-inclusive planning, contextual integration, and perceived success, whereas offerings focusing on vocational or higher education tended to show lower engagement in networking and professional development as well as lower self-assessed success in promoting females in STEM. Likewise, program formats emphasizing information, orientation, and networking appeared beneficial for fostering professional exchange and a long-term focus on the promotion of females in STEM. Finally, differences across disciplinary fields point to distinct professional cultures, with informatics programs showing particularly strong engagement in networking and long-term efforts to promote females in STEM, whereas technology-oriented initiatives were marginally less likely to emphasize gender-inclusive practices and long-term promotion strategies for females in STEM.

Taken together, these findings suggest that while organizational identity and efficacy represent important factors of program success, their expression and impact are embedded within broader structural and thematic contexts. The shift from organizational identity to efficacy in predicting environmental integration highlights that the relative influence of these organizational factors may depend on program-specific contexts and structures. Addressing both organizational processes and program design features may therefore be crucial for strengthening the effectiveness and sustainability of initiatives aimed at promoting females in STEM.

Our findings offer a novel perspective on the role of identity and efficacy for promoting females in STEM by shifting the focus from individual participants in STEM education programs to the institutional level, namely, STEM education providers. Our results suggest that providers are more successful in promoting females in STEM—meaning, they consider more fundamental principles in program planning and implementation, implement more research-based criteria, and assess themselves as more successful—when they have a strong organizational identity related to the STEM promotion of females and a high perception of their organizational efficacy in this domain.

Furthermore, our findings highlight the importance of strengthening both organizational identity and efficacy among STEM education providers to improve their support of females in STEM. This could, for example, be achieved through engagement in STEM education networks. Close collaboration and inter-organizational networking among STEM initiatives, institutions, projects, and stakeholders are increasingly recognized as essential for the sustainable promotion of (females in) STEM. These collaborations leverage available knowledge, expertise, and resources within STEM networks to maximize their impact (Hill, 2020; Liou & Daly, 2021). They can also help raise awareness of the importance of promoting females in STEM through events and collaborations, and provide access to research-based criteria for successful and sustainable STEM promotion (Santangelo et al., 2021).

Practical implications

The findings of this study have several practical implications for providers of out-of-school STEM education. Strengthening organizational identity and efficacy at the institutional level can positively influence gender-inclusive practices. In the following sections, we will discuss the implications of our findings on three levels: organizational, programmatic, and network-based.

At the organizational level, STEM education providers may benefit from cultivating an identity related to gender equity and promoting females in STEM, as well as from fostering a strong sense of organizational efficacy in this area among their members. Embedding gender equity into the organizational mission and values, ensuring that it is actively discussed among team members and communicated to stakeholders, and making it visible in communication and outreach materials can help strengthen internal culture (Hall et al., 2023). Professional development opportunities that build members' confidence and skills in enacting gender-inclusive practices are also important. Peer-learning formats, training workshops, and participation in professional networks can further reinforce collective efficacy and support the translation of organizational identity into everyday practice (Loughland & Ryan, 2022; Sun et al., 2021).

At the programmatic level, STEM education providers should ensure that programs are designed and delivered in ways that foster inclusive and engaging learning environments. This can include the deliberate integration of female role models, the use of hands-on and experiential learning opportunities, the provision of mentoring structures, and the connection of STEM content to real-world contexts (Msambwa et al., 2025). Moreover, aligning short-term activities with long-term support structures and involving parents, teachers, and peers as important social agents in girls' educational pathways can further enhance program effectiveness (Iroaganachi et al., 2021; Sáinz et al., 2022). Such practices reflect organizational priorities and contribute to the sustainability and long-term success of interventions designed to support girls and women in STEM.

At the network level, STEM education providers can benefit from active engagement in networks that focus on promoting girls and women in STEM (Gold et al., 2022). Such networks provide access to research-based insights, strategies, and best practices, and they can be particularly valuable for providers with lower efficacy, who gain resources and support through external exchange. At the same time, providers with higher efficacy play a key role by contributing expertise, mentoring peers, and helping to build a collective community of practice. In this way, networks function as a resource for professional development and as a community that reinforces organizational identity and efficacy across the STEM education landscape.

Overall, STEM education providers can leverage organizational identity and efficacy related to the STEM promotion of females to strengthen their internal culture, improve the design and delivery of programs, and learn and contribute to a broader community of practice. This may foster a sustainable out-of-school STEM education landscape in which girls and women are supported and experience lasting benefits.

Limitations

A distinguishing feature of our study is the assessment of identity and efficacy at the institutional level rather than the individual level. To achieve this, we formulated our survey items from the perspective of "we as a provider of STEM education programs," capturing the institutional viewpoint and shifting the focus, for example, from efficacy perception at the individual level to the collective level (Goddard et al., 2004; Stajkovic et al., 2009). However, it is important to note that the scale values in our study are based solely on the individual assessments of a single representative from each organization rather than on aggregated data from multiple respondents. This

reliance on a single respondent may limit the reliability of our findings, as it might not entirely reflect the broader institutional perspective. Future research may employ an approach that facilitates the aggregation of assessments from multiple representatives within each organization, including both employees and management. This approach would enable a more comprehensive and stable assessment of institutional-level constructs in STEM education by capturing diverse perspectives and mitigating potential biases associated with single-respondent assessments.

Furthermore, it is possible that some institutions in our sample had multiple representatives responding, which we could not account for in our analysis due to the anonymous nature of the survey, preventing the identification of multiple responses from the same institution. This may have led to multiple representatives from the same organization being treated as separate STEM education programs, potentially introducing bias into the results. However, it is unlikely that a significant number of individuals from the same organization participated in our survey, as it was primarily distributed to central contact persons within organizations who registered in a dedicated distribution list beforehand.

Additionally, our findings on the successful promotion of females in STEM are based solely on self-assessments by program providers. Future studies could use methods to complement these subjective assessments with objective measures, such as content analyses of websites, expert evaluations of program implementation, or feedback from former participants. This would provide a more objective understanding of the effectiveness of these programs in successfully promoting females in STEM.

Moreover, while the measures of organizational identity and organizational efficacy were based on existing scales, they were adapted for the specific context of out-of-school STEM education providers and have not yet been validated in this form. In addition, all scales to assess the dependent variables (i.e., the success criteria of STEM promotion of females) were adapted or newly developed for this study, and some demonstrated only moderate internal consistencies (Cronbach's alpha = .69–.72). While these measures still captured meaningful variance, their results warrant cautious interpretation. Future research would benefit from extending these scales with additional items to increase reliability and from conducting validation studies to establish their psychometric properties more firmly. To enhance transparency, we provide the complete list of administered items and standardized factor loadings for each construct in the Appendix (see Table 5).

A further limitation concerns the inclusion of program-level characteristics. In our analyses, we controlled for key structural and thematic features such as gender focus, target groups, program formats, and STEM fields. However, additional characteristics—for example, program duration or frequency of implementation—were not available and could not be considered. Such factors may also influence program success or interact with organizational identity and efficacy. Moreover, some subgroups were relatively small, which limited statistical power for detecting effects of specific program types. Future research should therefore adopt designs that systematically capture variation at both the organizational and program levels to allow for a more nuanced understanding of how structural, thematic, and organizational factors influence the success of efforts to promote girls and women in STEM.

Finally, this study employed a cross-sectional design, collecting data at a single point in time. This limits the ability to examine relationships between variables or to observe how organizational identity and efficacy develop over time. Experimental and interventional studies, as well as longitudinal research, would be particularly valuable for examining how these constructs change over time and how changes in these constructs are related to program success in promoting females in STEM.

Conclusion

The present study highlights organizational identity and organizational efficacy in promoting females in STEM as critical factors for the success of out-of-school STEM education programs in supporting girls and women in STEM. Future work may focus on developing interventions to enhance organizational identity and efficacy among STEM education providers, aiming to increase their effectiveness in promoting females in STEM. Moreover, STEM education providers must have access to research-based insights, such as the role of integrating environmental factors into their efforts, as well as opportunities to network with other organizations to exchange practical experiences. STEM education networks offer a valuable platform, providing online and offline communication opportunities that foster idea exchange and increase awareness among STEM education providers about promoting females in STEM. Examining how changes in STEM education providers' identity and efficacy translate into measurable gains in program effectiveness, and in the long run, in girls' and women's STEM engagement and retention may represent a promising direction for future research.

Appendix

See Table 5.

Table 5 Items and standardized factor loadings for the study constructs

Construct	Item wording	Standardized factor loading
Organizational identity related to STEM promotion of females (α = .93)	Participants see us as an organization that focuses on the STEM promotion of females	.89
	Funding agencies see us as an organization that focuses on the STEM promotion of females	.89
	The STEM community sees us as an organization that focuses on the STEM promotion of females	.89
	STEM teachers see us as an organization that focuses on the STEM promotion of females	.85
	We see ourselves as actors in the STEM promotion of females	.83
	Policymakers see us as an organization that focuses on the STEM promotion of females	.81
Organizational efficacy in STEM promotion of females (α = .85)	In our STEM education programs, we can cope well with most of the problems regarding the STEM promotion of females on our own	.90
	In our STEM education programs, we are usually able to handle demanding and complex tasks in the STEM promotion of females effectively	.90
	In our STEM education programs, we can rely on our ability to deal with challenging situations in the STEM promotion of females	.83
Consideration of fundamental principles of effective STEM promotion of females in program planning and implementation (α = .72)	In our STEM education programs, we use gender-fair language and images in our communication	.76
	In our STEM education programs, we have a good knowledge of research findings on the promotion of girls and women in STEM	.76
	In our STEM education programs, we feature appropriate female STEM role models	.72
	In our STEM education programs, the concepts are free of stereotypes	.69
Interest in networking and professional development related to STEM promotion of females (α = .89)	In our STEM education programs, we want to participate in networking events on the topic of effectively promoting females in STEM	.92
	In our STEM education programs, we want to take part in professional development activities related to girls and women in STEM	.91
	In our STEM education programs, we want to exchange ideas about the challenges faced by girls and women in STEM	.89
Focus on the long-term nature and sustainability of STEM promotion of females (α = .72)	In our STEM education programs, we not only offer short-term activities, but also ensure long-term support	.81
	In our STEM education programs, we make sure to provide follow-up or advanced courses for our participants	.81
	In our STEM education programs, we inform participants about opportunities to continue in STEM education after they complete our programs	.78
Integration of different environmental aspects into the STEM promotion of females (α = .62)	In our STEM education programs, we make sure to include as many environmental areas (e.g., friends, parents, media, teachers) of the participants as possible	.84
	In our STEM education programs, we involve parents (e.g., through parent evenings, interactive workshops, or informational materials)	.74
	In our STEM education programs, we make sure that school-based and out-of-school offerings complement each other well	.68
Self-assessed success in promoting females in STEM (α = .81)	In our STEM education programs, we achieve our goals in the STEM promotion of females	.81
	In our STEM education programs, we manage to get the participating females excited about STEM	.79
	In our STEM education programs, we succeed in sustainably engaging girls and women in STEM	.75
	In our STEM education programs, we reach—as intended—the target group of girls and women	.72
	In our STEM education programs, we enhance the STEM competencies of the participating girls	.70

Author contributions
M.H., H.S., and A.Z. designed the study. M.H., H.S., S.S., and A.Z. conceptualized the questionnaires. M.H. and S.S. collected and prepared the data for analysis. M.H. conducted the data analysis and drafted the manuscript. All authors contributed to reviewing and editing the manuscript and approved the final version.

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

Declarations

Ethics approval and consent to participate
This study was conducted in accordance with ethical standards for research involving human participants. All data were collected anonymously. Participation in the survey was voluntary, and informed consent was obtained from all participants at the beginning of the questionnaire.

Competing interests
The authors declare no competing interests.

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