Insights and experiences from UGB's Youth in STEM program participants in El Salvador

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Abstract

This study examines perceptions and experiences of participants in the "Youth in STEM" program at Universidad Gerardo Barrios in El Salvador. Using a mixed-methods approach, we analyzed feedback from 32 participants through surveys and conducted a focus group with 5 students. Results reveal high satisfaction with training quality 86%, teaching support 86%, and digital resources 82%. Qualitative analysis identified four key themes: gender inclusivity, self-discovery through practice, mentorship and belonging, and desire for deeper engagement. The program effectively combines situated learning and self-efficacy theory, creating a transformative environment that normalizes gender equity and fosters both technical competence and professional identity development in STEM fields. These findings contribute to understanding effective strategies for increasing youth participation in STEM disciplines while addressing gender gaps in El Salvador's educational context.

Keywords

STEM, gender, education, perceptions

1. Introduction

Science, Technology, Engineering, and Mathematics (STEM) programs have emerged as a response to address the existing gap in these disciplines from an early age. Several institutions have developed programs that combine STEM competencies with strategies aimed at girls and young women to reduce the gender gap from basic to higher levels [1]. According [2], these programs are key to fostering the participation of young people in STEM fields across different educational levels. Complementarily, studies by [3] highlight the need to implement structured programs that consider both the context and individual academic strengths to boost interest and development in these disciplines.

The gender approach in STEM programs is a key element that guarantees inclusion and equity, providing equal opportunities for women and underrepresented groups [4]. The perception of equity directly impacts the motivation and continuity of women in STEM programs, who have historically faced barriers such as stereotypes, the absence of female references, and non-inclusive environments [5]. However, gender-sensitive programs have been able to overcome some of these barriers by providing targeted mentoring, structured support networks, and environments that promote self-efficacy and confidence in their technical abilities [6].

Research on perceptions and experiences in programs highlights their interrelationship and impact on professional development [7]. Perceptions are formed through direct experiences and sociocultural factors [8], while experiences are interpreted through prior perceptions [9]. This bidirectional dynamic is important in gendered STEM programs, where positive experiences can transform negative perceptions about female capabilities in technical areas [10]. Situated learning in STEM communities allows the development of technical competencies and the building of professional identity through interactions with female mentors and peers [11]. Students primarily value clarity of exposition and relevance of content [12] and appreciate soft skills activities for their

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academic and professional transition [13]. Accompaniment transcends the transmission of knowledge as pedagogical mediation [14], while learning is considered a continuous process based on educational pillars [15]. Quality formative experiences develop specific competencies, soft skills improve problem solving and collaboration [16], and mentoring facilitates the construction of professional identity in STEM [11]. Evaluation of STEM programs requires methodologies that integrate both quantifiable outcomes and participant experiences. Recent studies emphasize the importance of combining measurable indicators with analysis of experiences and perceptions to fully understand the impact of these initiatives [17].

This research analyzes perceptions and experiences of participants in the Youth in STEM program at Universidad Gerardo Barrios in San Miguel, El Salvador. The study adopts a mixed-methods approach, grounded in theories of situated learning [18] and STEM self-efficacy [19]. The findings will help identify effective practices to reduce STEM gaps and contribute to STEM equity literature by evaluating a gender-inclusive program in El Salvador's underrepresented context, through combined analysis of outcomes and participant narratives.

2. Youth in STEM Program

The Youth in STEM program [20] is an educational initiative of Universidad Gerardo Barrios aimed at strengthening STEM competencies in students aged 15 to 19, primarily from public education institutions. Through its in-person and virtual dimensions, the program allows young people of both sexes to enroll regardless of their geographic location. The program has evolved significantly, extending its duration from 4 months in 2020 to 6 months in 2022. Starting in 2023, its structure and offerings have focused specifically on STEM in two major areas: technology and engineering, providing training aligned with current requirements for extracurricular programs.

The implementation methodology follows a structured and rigorous process. It begins with an open call through national institutes and social media, followed by a selection process that evaluates both the interest and potential of applicants.

The program structure [20] includes four modules for each learning path, covering two parallel groups for engineering and technology. Each module complements the previous one and is oriented towards meeting the following objectives: achieving practical and experiential learning through real-world projects and challenges, developing important skills such as critical thinking, problem-solving, creativity, logic, analytical reasoning, as well as teamwork and communication skills necessary not only for STEM careers but for any field of study and everyday life.

The modules have evolved in their content as required by the changing job market. In this way, the competencies intended for each area are strengthened. For example, the engineering group has incorporated modules covering different branches of engineering, architectural modeling, digital marketing for this field, as well as artistic and industrial 3D modeling. Meanwhile, the technology group explores programming areas first through segmented code provided by Arduino, introduces graphic design for representing application solution prototypes, then moves to interactive web development where applications are built, and similarly, has included modules on robotics and computer networking.

3. Methodology

This study adopted a mixed methods approach with a sequential explanatory design, following the model proposed by Creswell and Plano Clark [21]. This design is characterized by an initial quantitative phase followed by a qualitative phase, where the qualitative results help explain and interpret the initial quantitative findings.

3.1. Population and sample

The study population consisted exclusively of participants from the 2024 cohort of the "Youth in STEM" program at Universidad Gerardo Barrios, comprising a total of 32 students. For the quantitative phase, we worked with all 32 participants from this cohort, representing 100% of the total number of participants.

For the qualitative phase, following the recommendations of [22] on the size for focus groups in educational research, 5 participants in total were selected for the focus group. This number facilitated dynamic interaction and allowed for deeper exploration of individual experiences, ensuring that all participants had sufficient time to express their detailed opinions and perspectives about the program.

3.2. Ethical considerations

This research was conducted under fundamental ethical principles established in [23]. Informed consent was obtained from the participants following the principles of autonomy and respect, informing them about the study objectives, their voluntary participation, and their right to withdraw without consequences. Confidentiality was ensured by coding personal information and maintaining anonymity in all reports using pseudonyms. Following the principle of justice, equitable treatment was guaranteed, ensuring that all participants received the same attention and respect, without discrimination.

3.3. Techniques and instruments

For data collection, two main techniques were employed with their respective instruments:

The survey, applied to the entire population through a structured questionnaire in Google Forms with closed questions using a 5-level Likert scale. Distribution was conducted through institutional communication channels. To ensure the validity and reliability of the instrument, the following were performed: (a) a pilot test with 30 participants [24], and (b) reliability analysis using Cronbach's Alpha coefficient [25], which yielded a result of $\alpha = 0.886$ with 13 items, indicating high internal consistency of the instrument.

The questionnaire was structured around four dimensions: training quality (relevance of content, teaching methodology, evaluation methods), soft skills development (critical thinking, communication, teamwork), support received (teacher support, digital tools, availability of complementary resources), and learning components (theoretical mastery, practical skills, peer interaction, adoption of program values). A full version of the survey instrument is provided in **Appendix A** to evidence transparency of the study.

A focus group, with 5 participants, using a semi-structured interview guide (**Appendix B**) with open-ended questions to facilitate group discussion and promote reflection on experiences in the program. The session was conducted virtually through Microsoft Teams, with an approximate duration of 60 minutes. The instrument was validated through peer review.

3.4. Data analysis

Following the sequential explanatory design of Creswell [21], data analysis was conducted in three stages:

Quantitative analysis: Descriptive statistical techniques were employed to analyze data obtained through the questionnaire applied to the 32 participants of the 2024 cohort. For each evaluated dimension (training quality, soft skills development, support, and learning), frequencies and percentages were calculated and represented through stacked bar graphs that allowed visualization of the response distribution on the Likert scale.

Qualitative analysis: The qualitative component of this study was done using thematic analysis in Atlas.ti v25 and following Braun and Clarke's model [26]. The analysis gave equal importance to convergent and divergent participants' perspectives. A visual elicitation activity was conducted as a supporting narrative to their verbal responses.

Triangulation: A methodological triangulation strategy was implemented that integrated quantitative and qualitative findings through systematic comparison between statistical results and thematic categories, identification of convergent and divergent patterns, and contextualizing within the framework of situated learning [18] and self-efficacy [19], allowing for validation of results and revealing nuances that would not be evident through a single approach.

4. Discussion of results

This section presents and discusses the findings of the study, encompassing both quantitative results derived from statistical analysis and qualitative insights emerging from thematic interpretation of the data.

4.1. Quantitative Analysis

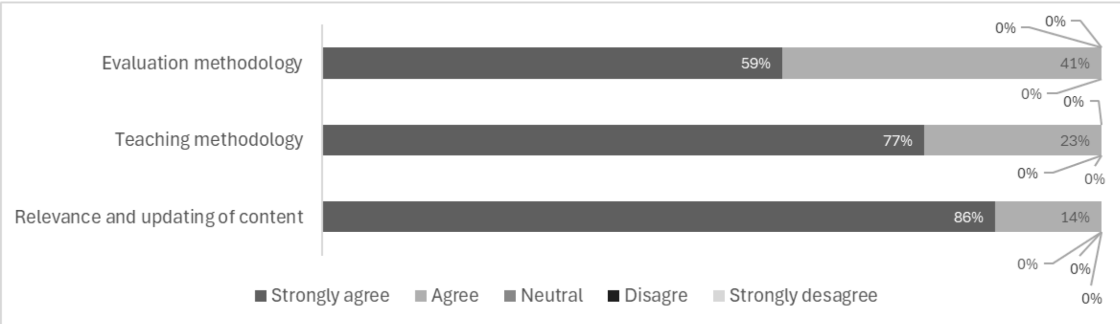

Figure 1: Participants' perception of training quality elements in the Youth in STEM program.

Research on STEM education quality emphasizes the importance of content relevance and structured methodologies [3] [12]. The perception results in Figure 2 align with these findings, showing highly positive assessment in relevance and updating of content (86 % strongly agree) and teaching methodology (77 % strongly agree). The lower but significant approval for methodological evaluation (59 % strongly agree) suggests the need for evaluation strategies that combine measurable indicators with comprehensive experiential analysis [17].

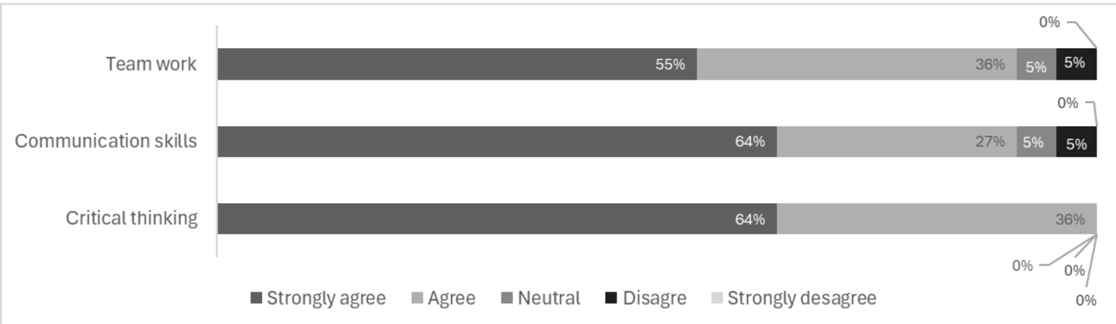

Figure 2: Participants' perception of soft skills development in the Youth in STEM program.

The results shown in Figure 3 reveal positive perceptions. Communication skills and critical thinking scored highest, each receiving 64 % strongly agree responses. Studies in Costa Rican technical universities [13] have demonstrated that students particularly value these competencies as essential for their academic-to-professional transition. Teamwork, although lower at 55 %, still shows a positive assessment, supporting research on collaborative STEM projects [16] where problem-solving abilities prove crucial for women's persistence in technical fields [6].

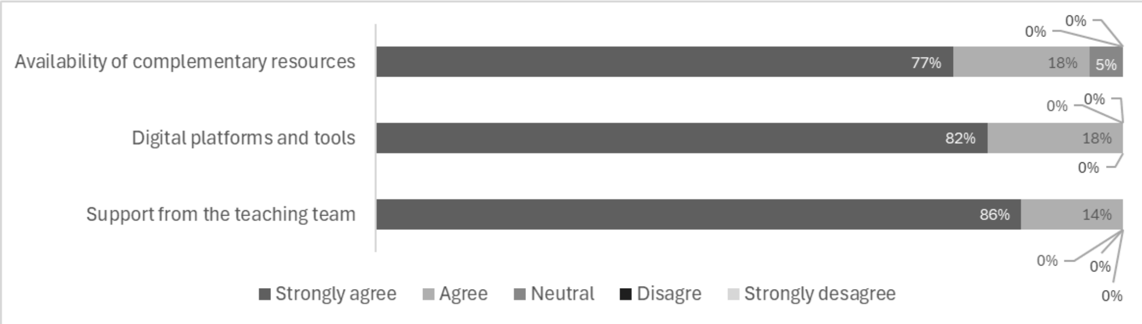

Figure 3: Participants' perception of the support received in the Youth in STEM program.

The support dimension in Figure 4 demonstrates consistently high approval: teaching team support (86 %), digital platforms and tools (82 %), and complementary resources (77 %). This comprehensive support pattern reflects what literature identifies as pedagogical mediation that facilitates professional identity construction while addressing specific barriers women encounter in STEM environments [5] [11] [14].

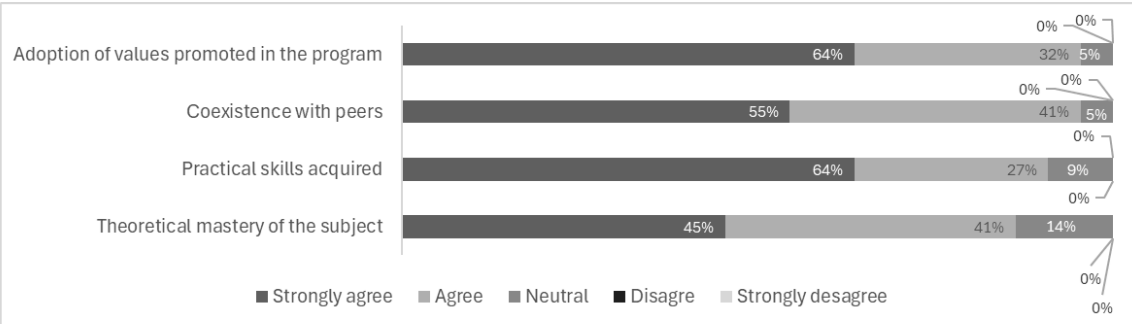

Figure 4: Participants' perception of learning components in the Youth in STEM program.

The learning dimension results in Figure 5 reveal a clear preference pattern: practical skills (64 %) and values adoption (64 %) received higher approval than peer interaction (55 %) and theoretical mastery (45 %). This outcome aligns with situated learning principles [18], which emphasizes contextualized knowledge construction, while supporting research on diverse learning approaches [4] [15] that strengthen self-efficacy through concrete application rather than purely theoretical frameworks [19].

4.2. Qualitative Analysis

The analysis involved reading the script repeatedly using thematic analysis, generating codes, merging them into themes, and revising to ensure coherence and consistency. There were four key recurrent themes across participants: Gender Inclusivity, Self-Discovery through Practice, Mentorship and Belonging, and Desire for Deeper Engagement.

The Youth in STEM program highlights how situated learning [18] and self-efficacy theory [19] collectively reshape young Salvadoran youth's perceptions of STEM careers. By cultivating an inclusive, hands-on learning environment, the program enabled participants to reimagine their roles in technical fields. This analysis explores these outcomes through the interplay of experiential learning and confidence-building frameworks.

Gender and Inclusivity as Situated Practice: Participants' narratives revealed a collective shift in gendered perceptions of STEM, echoing Sagástegui's assertion that learning is inseparable from its social context [18]. The program's emphasis on collaborative projects (e.g., 3D modeling, web development) disrupts traditional hierarchies, positioning STEM as a shared endeavor rather than a male-dominated space. As Karen noted, "*she [the instructor] helped both me and him, regardless of me being a woman",* highlighting how situated activities normalized gender equity. "*I really liked interacting with her [the instructor]... that made me feel included*" (Noah). To this point, Sophia added, "*They never addressed us in a bad way... they always explained in the best way possible so we could understand*". This aligns with Tam et al.'s findings that inclusive pedagogies disrupt stereotypes by embedding equity into daily practice [6]. Mentorship further reinforced this shift: Emely said, "*The engineer welcomed us with a hug... that made us love the program*", and modeled emotional accessibility, fostering a community where participants could authentically engage without conforming to rigid gendered expectations.

4.2.1. Self-Discovery Through Legitimate Participation

Hands-on modules like Arduino and web design functioned as legitimate peripheral participation [18], allowing students to experiment with technical roles while gradually integrating into STEM communities. For instance, Logan's realization that "*Arduino wasn't for me, but web development was*" illustrates Bandura's concept of mastery experiences [27], where trial and error clarify personal competencies. Visual elicitation (image included in appendix B) deepened this process: participants Emely, Sophia, and Viktor identified themselves with Image 3 (3D modeling), which revealed career interests, showing that visuals help clarify hidden aspects of identity. These findings resonate with Atkins et al.'s work on mentorship, where situated tasks help marginalized groups envision themselves as STEM professionals [11].

4.2.2. Mentorship: Bridging Affective and Cognitive Domains

The program's mentors exceeded traditional instruction, exemplifying what Puerta Gil terms pedagogical mediation [14]. By explaining concepts "*equally to everyone*" (Sophia), instructors mitigated the fear of failure, a critical barrier to self-efficacy [19]. Creative tasks, such as transforming a periodic table into a dress design, "*I realized it was for us [referring to women]*" (Hannah). Merged technical skill with cultural relevance, affirming participants' identities while building confidence. This dual focus on affective and cognitive growth mirrors Escobar et al's framework, where mentorship bridges individual agency and communal belonging [19].

4.2.3. Longing for Immersion: A Call for Sustained Communities

Requests for longer modules, "*The morning went by too fast*," Sophia said, reflecting a desire to deepen engagement within the program's community of practice. This comment was echoed by Logan, stating "*allowing more time to familiarize ourselves [with the content of the course*]".
Situated learning thrives on sustained interaction [18], and participants, like Hannah, wished for extended architectural modeling "*like blueprints or models*", which signals a craving for immersive, discipline-specific contexts. These insights align with Delors' "learning to do" pillar [15], emphasizing that competency develops through prolonged, meaningful practice.

The Youth in STEM's success lies in its fusion of situated learning and self-efficacy principles. Collaborative projects and mentorship forged a community where technical competence and gender-inclusive identities co-evolved. Participants' journeys from self-doubt ("*fear of not being capable*") to vocational clarity ("*web development was for me*") mirror Bandura's assertion that self-efficacy emerges through mastery, vicarious experiences, and social persuasion [27].

5. Triangulation

This study employed a methodological triangulation strategy consistent with the explanatory sequential design proposed by Creswell and Plano Clark [21]. The integration of quantitative survey data, qualitative focus group findings (including visual elicitation), and a robust theoretical framework enabled a deeper understanding of the Youth in STEM program's impact.

Relevance and Pedagogical Structure of the Youth in STEM Program: Quantitative data revealed that 86% of participants strongly agreed that the content was relevant and up to date (Figure 2). Qualitative insights supported this, as participants emphasized how modules such as web development, Arduino, and 3D modeling helped them identify academic interests. These perceptions align with Guzmán [12], who highlights clarity and relevance as critical factors in higher education, and with Stoet and Geary [3], who advocate for structured programs that build on students' academic strengths. Statements such as "I realized Arduino wasn't for me, but web development was" reflect the role of content in fostering self-discovery, consistent with Bandura's theory of self-efficacy [27].

Soft Skills Development: A total of 64% of respondents indicated significant growth in communication and critical thinking skills (Figure 3). These results were echoed in qualitative accounts that emphasized teamwork, peer collaboration, and reflective problem-solving. According to Toruño Arguedas [13], such skills are essential for academic-to-professional transitions. These findings also support Sagástegui's situated learning theory [18] and Delors' "learning to do" pillar [15], which frame competence development as contextually and socially embedded.

Mentorship and Emotional Safety: The teaching staff received 86% approval in the category of instructional support (Figure 4). Focus group testimonies affirmed this, with students stating, "*They explained equally to everyone*" and "*The instructor would greet us with a hug*." These gestures reflect what Puerta Gil [14] defines as pedagogical mediation—guidance that extends beyond knowledge transmission. Mentorship played a key role in fostering motivation and emotional resilience, aligning with [11] and constructs of vicarious experience and social persuasion [19].

Applied Learning and Skill Transfer: Sixty-four percent of participants valued the practical skills acquired (Figure 5), while only 45% expressed high confidence in theoretical mastery. This discrepancy was explained in the focus group through reflections such as "*I wish we had done more hands-on work, like blueprints or models*." These insights underscore the value of experiential learning and are supported by Espinosa Cevallos [17], who emphasizes the importance of combining measurable indicators with experiential data. Moreover, Escobar et al. [19] assert that self-efficacy strengthens when learners are able to apply knowledge in concrete settings.

Gender Inclusivity as Situated Practice: Participants described a shift in perceptions regarding gender roles in STEM, supported by both survey responses and qualitative data.

Comments such as "*They helped both me and him equally*" and "*I felt included*" highlight how gender-sensitive instruction reshaped expectations. These findings support Tam et al. [6], who argue that inclusive pedagogies transform gender norms by embedding equity into everyday learning. They also align with González-Pérez et al. [10] and Blackburn [4], who emphasize that inclusive environments and female representation foster greater persistence among women in STEM. Future studies should conduct a longitudinal resesach with a control group to assess the program's sustained effects.

6. Limitations

The study has several limitations that should be considered when interpreting the results. There were 32 completed the surveys, resulting in a small sample that limits the generalizability of findings. In addition, the program was created and is executed exclusively at Universidad Gerardo Barrios, which makes this a single institution study and may not represent other educational contexts.

7. Conclusions

The Youth in STEM program shows that combining situated learning and self-efficacy theory creates a transformative environment for young Salvadoran participants. Embedding gender inclusivity into hands-on practices has a disruptive effect in traditional gender hierarchies and helps normalize equity as a social practice. This approach not only fostered technical competence but also enabled participants to reimagine their identities within STEM, as stated in the narratives of self-discovery and affirmations of belonging. When equity is woven into both pedagogy and community dynamics.

While the program successfully ignited and clarified vocational pathways, participants expressed a desire for deeper engagement in the form of longer sessions or modules with more practice, which signals a gap between initial inspiration and sustained development. This longing aligns with situated learning and communities of practice. Addressing this need is essential for translating short-term confidence into enduring career aspirations and expertise.

Future research should extend this program's technical modules, continuous mentorship systems, and longitudinal tracking of participants' trajectories. Additional efforts should focus on expanding gender equity interventions based on international research and adapting the methodology for rural areas through hybrid models to maximize impact across El Salvador.

Declaration on Generative AI

During the preparation of this work, the authors used ChatGPT, Claude, and Grammarly in order to: Grammar and spelling check, improve writing style, Text translation, Paraphrase, and reword. After using these tools/services, the authors reviewed and edited the content as needed and take full responsibility for the publication’s content.

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A. Survey questionnaire

The complete version of the questionnaire used in the study can be accessed at: link

B. Semi-structured interview guide

The complete version of the interview guide can be accessed at: link