Early Computing Education in Brazilian Public Schools: Insights from Teachers

Aline de Galés Silva[1], Maristela Holanda[2], Maria Emília Walter[2], Mirella M. Moro[3], Aleteia Araujo[2]

[1]Universidade de Brasília (UnB), Institute of Psychology, Brasília, Brazil
[2]Universidade de Brasília (UnB), Computer Science Department, Brasília, Brazil
[3]Universidade Federal de Minas Gerais (UFMG), Computer Science Department, Belo Horizonte, Brazil
gales.aline@aluno.unb.br, mholanda@unb.br, mariaemilia@unb.br, mirella@dcc.ufmg.br, aleteia@unb.br

Abstract

This article presents a mixed method study conducted with school teachers involved in a project that promotes interest in computing through computer science, robotics, and programming in Brazilian public schools. The study examines teachers' perceptions about the impact of the project on their professional development, student learning and participation, and surrounding school and community contexts. The results highlight the importance of early exposure to computing in fostering inclusion and social transformation. Teachers report positive outcomes, including the development of technical skills, increased motivation to teach, and significant improvements in the learning and participation of girls. Broader impacts at the school and community levels, such as increased parental participation, further underscore the role of teachers in initiatives aimed at broadening participation in Computing.

Keywords: Computing education, teacher training, pre-university education, gender, social impact.

1 Introduction

Gender inequality in Computing and the tech industry remains a well-known challenge. Researchers have examined this issue through various lenses, ranging from the broad spectrum of STEM (Science, Technology, Engineering, and Mathematics) to the nuances of intersectionality [1, 2, 3, 4, 5], and across different regions of the world [6, 7, 8, 9, 10, 11, 12, 13]. A common consensus is that there is no simple, straightforward explanation for the underrepresentation of women in tech. Consequently, there is no "one-size-fits-all" formula to increase these numbers.

Driven by the goal of fostering a more diverse tech industry [14, 15], studies delve into the complexities of reducing higher education dropout rates among female students and underrepresented minorities [12, 16, 17, 18, 19, 20], while also identifying strategies to help them thrive [21, 22]. Additionally, numerous outreach initiatives aim to encourage more girls to pursue Computing degrees [23, 24, 25, 26, 27]. These outreach efforts operate at the school level and focus on introducing computational concepts in creative, engaging ways, such as games [23], hackathons [24], and interactive programming workshops [25, 26, 27].

From a broader perspective, introducing Computing and computational thinking (e.g., problem decomposition, pattern recognition, abstraction, and algorithmic thinking) at the school level offers benefits that extend far beyond increasing diversity. In fact, the global movement to teach computational thinking in schools is built upon its numerous advantages for students, including acquiring problem-solving skills, improving digital literacy, enhancing learning in other academic subjects, and expanding analytical thinking [28, 29, 30, 31, 32, 33, 34, 35]. Nevertheless, both types of initiatives—those targeted at girls and those focused on teaching computational thinking—typically measure success through students' self-assessments and satisfaction (e.g., [23, 24, 25, 27]) or through their performance on quizzes and tests (e.g., [31, 33, 35]).

In this paper, we propose a complementary approach by shifting the focus to the perceptions of *teachers* involved in these outreach actions, recognizing their pivotal role in the success of the activities and in fostering collaboration among schools, communities, and universities. We do so by analyzing teachers' perceptions of the outreach project Meninas.comp (*Girls.comp*)—which, for over 15 years, has developed programming and robotics activities in public schools to reduce inequalities in access to computing education and to foster greater diversity and heterogeneity in the field [36, 37, 38]. By investigating teachers' perceptions, we are able to: (*i*) identify pedagogical strategies to stimulate girls' interest in computing, as well as the main challenges to ensuring a lasting impact; (*ii*) understand how students respond to the proposed activities, which methodologies are most effective, and what obstacles arise in maintaining engagement; and (*iii*) recognize the role of teachers as multipliers of successful practices, capable of influencing peers and driving transformations in curriculum and school culture.

This article is an extended version of the work originally published at the Congreso Latinoamericano de Estudios en Informática (CLEI) in 2025 [39]. It expands upon the previously reported results, provides a more in-depth data analysis, and proposes new research directions to strengthen and clarify the significance of the study. The remainder of this paper is organized as follows. We first go over related work in Section 2. Then, Section 3 contextualizes the study and outlines the history of the Meninas.comp project. Section 4 describes the methodological procedures adopted for data collection and analysis, and Section 5 presents our findings. Section 6 discusses these findings in light of the research question and relevant literature; and finally, Section 7 concludes the paper and outlines directions for future work.

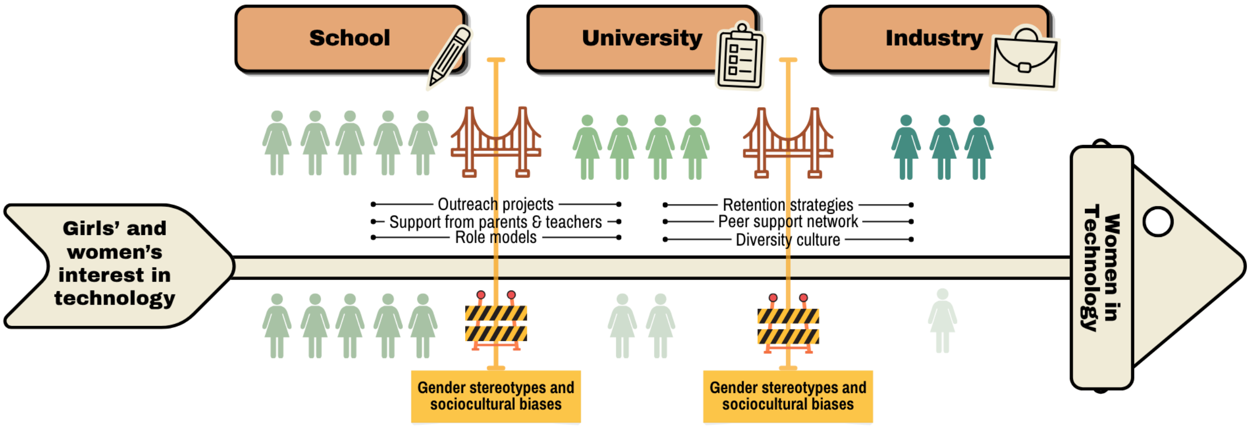

Figure 1: Women in technology status quo – today (bottom), girls and women loose interest in tech due to gender stereotypes and sociocultural biases (among other issues); the solution (top) involves building bridges among school, university and industry for a stronger, more diverse labor market.

2 Related Work

Gender inequality in Computing, across both academia and the private sector, remains a historically documented challenge. This disparity is particularly pronounced in the chronic underrepresentation of women in Computing programs and professional careers [3, 4, 8, 9, 11, 12]. Specifically, a multifaceted set of barriers restricts both the entry and retention of women in the field of Computing and its respective technology industry. These cumulative factors act as an institutional bottleneck, preventing young girls from pursuing technology careers upon completing basic education. Consequently, targeted interventions are required to dismantle these barriers and establish pathways that cultivate girls' interest and visibility in the field, as conceptually mapped in Figure 1. Indeed, numerous studies have emphasized the critical role of pre-university interventions to stimulate girls' interest in technology, dismantle persistent stereotypes, and foster equitable engagement from early school years onward [23, 24, 25, 26, 27].

All such initiatives are important and do indeed generate impact, which is hard to measure. Hence, most actions and interventions are evaluated from the participating students' perspective through self-assessments and satisfaction degree, largely overlooking the educators' viewpoints. Overall, teacher perceptions are vital to evaluating these interventions, but such a research domain remains significantly underexplored.

One existing teacher-related evaluation focuses on project coordination within higher education. Reznik and Massarani [40] interviewed five female project coordinators leading initiatives aimed at promoting gender equity in STEM fields. Although their study adopts a coordinator-centered approach, the participants' expertise spanned physics, chemistry, and mathematics, leaving Computing-focused initiatives unexamined. Addressing a broader scope, Lima [41] interviewed 12 Computing teachers of both genders to investigate their perceptions regarding female inclusion in the field. The author identified underlying patterns of gender segregation that varied based on the respondent's gender, reinforcing that implicit gender biases persist among educators. This finding aligns with Moss-Racusin *et al.* [42], which demonstrated a systemic tendency to perpetuate unconscious gender bias against female students in scientific disciplines.

Regarding educators operating at the school level, Bim and Berardi [43] detailed the strategy of the TIChers project, which trains K-12 teachers to act as facilitators of Computing initiatives within their schools [44]. Their findings revealed a marked increase in teachers' self-confidence when delivering computing content. However, this framework treats educators as the primary target audience of the training, rather than mediators of student-focused actions.

When studying general Computing instruction at pre-university levels—outside the scope of specialized outreach projects—a systematic review by Cavalcante and Raabe [45] uncovers a critical gap in professional development for Brazilian teachers. The authors argue that existing teacher training is largely deficient and insufficient to adequately prepare students for qualified entry into Computing higher education. This deficiency underscores the urgent need for robust teacher-education policies and highlights the value of supportive, scaffolded outreach initiatives.

While few studies investigate teacher perceptions within gender-focused computing initiatives, the impact of teachers in shaping students' life trajectories and career choices is undeniable [44, 46, 47]. These foundational studies demonstrate that teachers directly influence student decision-making, reinforcing the methodological necessity of capturing their insights when evaluating the systemic impact of diversity initiatives in Computing.

In this context, our work analyzes teachers' perspectives specifically regarding the actions carried out with K-12 students within a gender-focused outreach project. As discussed in Section 1, the vast majority of publications on such initiatives restrict their evaluation to student satisfaction and self-assessment, omitting teacher feedback. Our study addresses this limitation by identifying effective pedagogical strategies and systemic challenges to achieving sustained engagement for girls in Computing, drawing directly on the insights of the educators who operationalize the project. This analysis directly complements prior student-centric research conducted within this initiative [38].

3 Contextualization

To mitigate gender disparity in technology, the Meninas.comp project was established as a structured outreach initiative affiliated with the Department of Computer Science (CIC) at the Universidade de Brasília (UnB) – Brazil. The project operates in formal partnership with the Digital Girls Program (Programa Meninas Digitais - PMD),[1] a nationwide initiative of the Brazilian Computer Society (SBC) dedicated to fostering girls' interest in computing disciplines [48]. Since 2010, Meninas.comp has maintained continuous operations, developing a specialized methodology designed to bridge the gap between female public K-12 students across the Federal District and the state of Goiás and the IT sector [38, 49]. The initiative expands access to technological knowledge, deconstructs pervasive gender stereotypes, and empowers students to envision viable academic and professional trajectories in Computing and digital technologies.

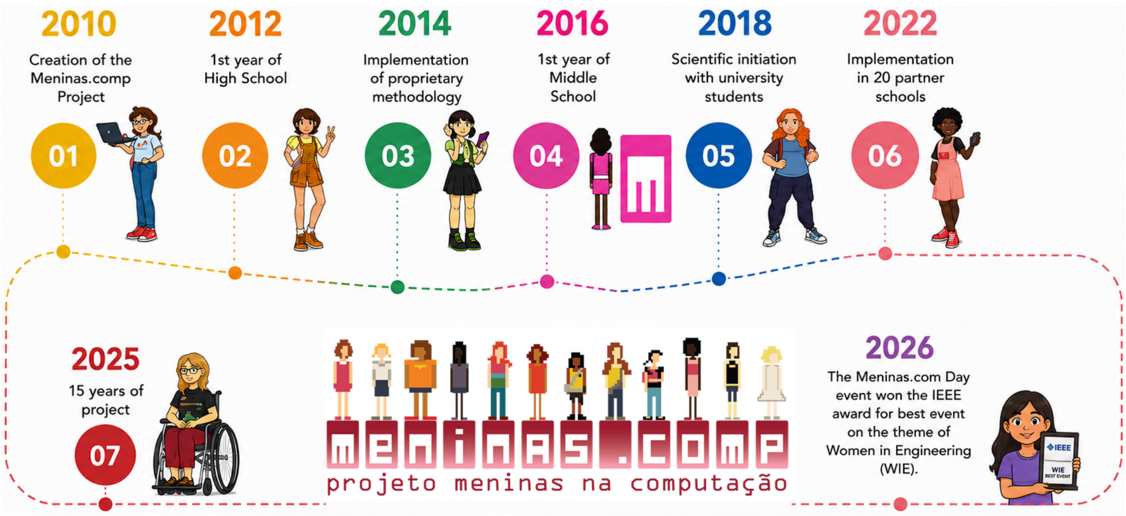

Figure 2: Timeline of the Meninas.comp project.

[1]SBC Digital Girls Program: `https://meninas.sbc.org.br`

Throughout its 15-year tenure, the project has progressively scaled its operational footprint, as illustrated in the historical timeline in Figure 2. What initially began as isolated school interventions has evolved into a comprehensive portfolio of activities. This diverse framework includes specialized technical workshops, guest lectures featuring industry professionals, creative programming sessions via Scratch and Arduino, events highlighting female leadership, and guided visits to university laboratories. These actions collaborate to cultivate an inclusive, inspiring, and gender-sensitive learning environment where young girls can confidently recognize themselves as active participants in scientific and technological domains.

Initially targeting high school cohorts, the project progressively expanded its scope to include middle school students, while concurrently introducing initiatives to support the retention of women already enrolled in undergraduate Computing degrees. This strategic expansion was driven by high female dropout rates observed within an undergraduate environment historically constrained by systemic gender asymmetries and structural biases. The relevance of initiatives like Meninas.comp aligns with international frameworks that advocate for an early, playful, and meaningful introduction to Computing within primary and secondary school environments [23, 32]. Empirical studies confirm that integrating fundamental computing concepts into K-12 curricula fosters early computational thinking and yields positive outcomes across diverse student demographics, nurturing a sense of belonging and driving broader social impact.

Project Implementation and Pedagogical Methodology. The operational methodology developed by Meninas.comp is structured to foster a symbiotic, long-term partnership between the university and public K-12 complexes, as delineated in Figure 3. The implementation process initiates when a public school expresses a formal interest in the project and designates a host educator to serve as the local coordinator [23, 38, 50]. These educators belong to the permanent staff of the regional public education network and teach various traditional subjects across elementary, middle, and high school levels. Many already possess an intrinsic interest in digital technology and volunteer to facilitate the project's activities, typically during after-school hours and in addition to their standard professional workloads. This voluntary dedication underscores the deep engagement of the participating educators, positioning them as vital mediators among the university, the local school structure, and the student cohorts.

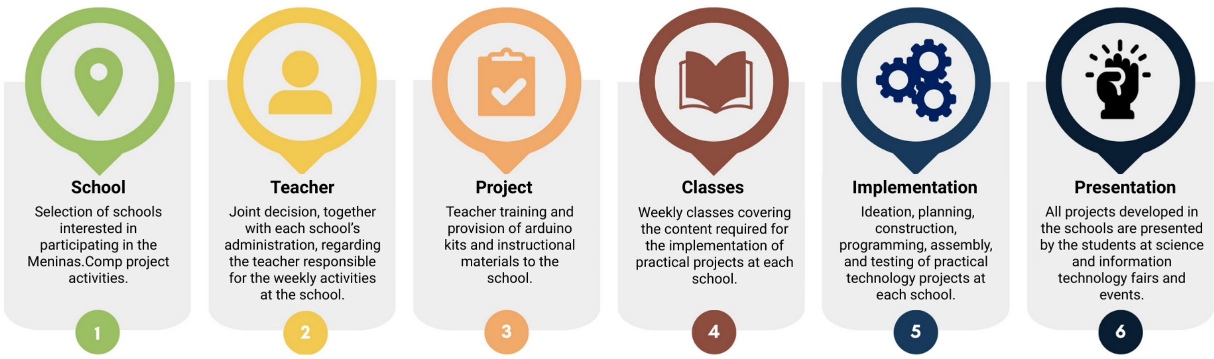

Figure 3: Implementation and execution phases of the Meninas.comp project.

Once the institutional partnership is formalized, the designated teachers undergo training led by the core Meninas.comp coordination team at UnB. Armed with this professional development, teachers return to their respective schools to deliver weekly, extracurricular, girls-only classes. These lessons cover a scaffolded curriculum encompassing computational thinking, logic, programming, basic electronics, Arduino hardware, and educational robotics. To ensure the operational feasibility of these activities, the university project supplies each partner school with complete Arduino hardware kits and all necessary instructional and pedagogical materials. In return, the school administration commits to maintaining at least one active, girls-only cohort and protecting the weekly instructional hours allocated for the project.

Applied Projects and Community Outcomes. After approximately six months of structured instruction, the pedagogical focus shifts to applied creation. Teachers and students collaboratively design and execute hands-on engineering projects aimed at solving practical, real-world problems identified within their own local communities. These projects represent the tangible synthesis of the technical skills acquired throughout the course and are routinely showcased at regional science fairs, school exhibitions, and academic symposiums organized by partner universities.

This phase enables the young students to not only master dry technological concepts but also to actively experience the dynamics of scientific inquiry, hardware development, and academic communication, mapping

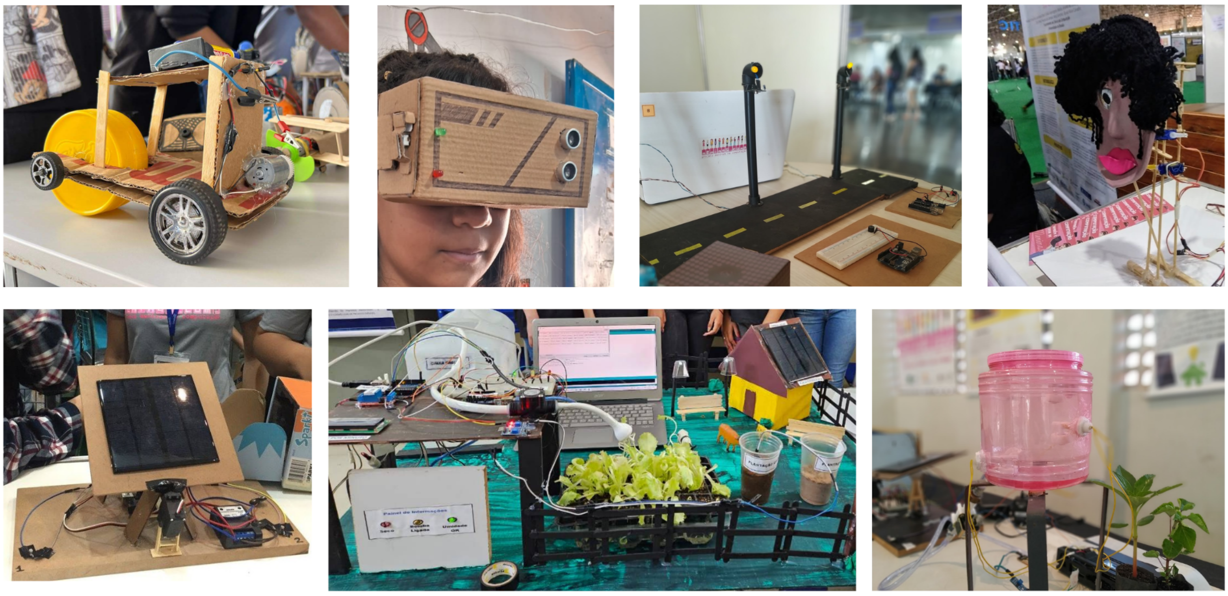

Figure 4: Practical projects developed with Arduino by Meninas.comp students: Recyclable Remote-Controlled Car, Virtual Glasses for the Visually Impaired (providing environmental feedback), Smart Street (reducing energy consumption in public lighting), Rita (an interactive humanoid face answering pre-programmed questions), Smart Solar Panel (sun-tracking system), Smart Garden (moisture-based automated irrigation), and Smart Water Tank (water level monitoring system).

closely to the professional realities of the tech industry. As illustrated in Figure 4, these student-led, Arduino-based solutions include sophisticated systems such as school humidification mechanisms, automated trash cans designed for visually impaired users [37], mobile sun-tracking solar panels to optimize energy efficiency on school grounds, and intelligent traffic light networks built to enhance pedestrian safety near school perimeters.

Over its trajectory, the initiative has yielded highly promising longitudinal outcomes. Beyond the immediate technical artifacts produced at the school level, preliminary tracking surveys indicate that several former participants successfully transitioned into higher education, enrolling in university Computing programs. Similarly, the project acts as a support network to reinforce the retention of women already facing the chilly climate of undergraduate STEM fields, although the exact magnitude of these long-term retention dynamics warrants further empirical investigation.

Ultimately, reinforcing the institutional ties between public schools and universities is essential to broadening the academic and professional horizons of K-12 students, particularly in fields historically characterized by unequal access. Bridge initiatives that offer pre-university experiences play a strategic role in exposing students to the language, methods, and cultures of higher education, thereby transforming technical career paths into something tangible and attainable. Within this framework, the methodology of Meninas.comp relies heavily on the agency of teachers as the central nodes connecting university research with the daily school environment. Consequently, in this article, we take the evaluation of this outreach ecosystem to the next level by shifting the analytical focus directly to the insights, challenges, and systemic impacts observed by the educators who make this transformation possible.

4 Methodology

This section details the methodology employed to investigate teachers' perception on running an outreach project towards more women in technology. It includes the following parts: research design and rationale (4.1); instrument development (4.2); and participation and sampling (4.3). The subsequent section (5) presents and discusses the empirical results.

4.1 Research Design and Rationale

As an exploratory study, the methodology was designed to provide initial insights of teachers' experiences within the Meninas.comp project. The primary goal is to understand how participating in the project influences the professional trajectories of its teachers, as well as the impacts they perceive in their school and community contexts. Consequently, this study complements previous student-centric investigations within the project [23, 36, 50], broadening the understanding of how pre-university Computing education is implemented in the partner schools and how this process shapes teaching practices.

Accordingly, priority was given to ensuring alignment with the research objectives and capturing a wide range of perspectives, rather than conducting formal psychometric validation procedures. This approach is consistent with exploratory research designs, which seek to generate insights and identify emerging patterns to inform subsequent, more rigorous investigations.

The choice to use a mixed-methods questionnaire allowed for a comprehensive, contextualized analysis of teachers' experiences by combining quantitative and qualitative data [51]. This approach facilitated the identification of shared trends among participants while maintaining the visibility of individual trajectories, thereby revealing unique facets of the educators' experiences. Furthermore, the instrument offered practical advantages, such as ease of administration, low cost, and rapid data systematization [52], which made data collection feasible despite the geographical dispersion of the participating schools.

4.2 Instrument Development

This study employed an original, self-administered electronic questionnaire as the primary data collection instrument.[2] Developed specifically to align with the study's research objectives, the instrument was informed by prior investigations conducted within the Meninas.comp project.

Structure and Content. The questionnaire includes both closed-ended (multiple-choice) and open-ended questions structured to address the central research question and capture teachers' perceptions of their experiences. It is consisted of 43 questions organized into five thematic blocks: sociodemographic profile; experience within the Meninas.comp project; prior experiences with Computing education; perceptions of the project's impacts; and open-ended questions capturing personal and professional qualitative insights. In addition to data on teachers' individual perceptions of the project's impacts, the instrument also included quantitative metrics to provide an overall view of the initiative. These indicators offer a contextual overview of participants' profiles and levels of engagement, contributing to a more comprehensive understanding of the effects generated by the Meninas.comp project. To improve readability, the questionnaire content is illustrated near the respective results (over the next section).

Analyses. Objective questions were analyzed using descriptive quantitative statistics to identify general trends and response patterns [53]. Open-ended questions were manually systematized and subjected to qualitative content analysis following Bardin's method [54] to identify recurring themes, emerging categories, and the core meanings attributed by teachers to their experiences.

Subsequently, the quantitative and qualitative data were integrated through methodological triangulation, enabling a deeper, more contextualized understanding of teachers' perceptions. This triangulation balanced the collective dimension of these experiences with the participants' individual specificities. The results were then interpreted in light of the existing literature to advance the debate on teacher experiences in pre-university Computing education.

Instrument Limitations. Finally, a primary limitation of this study concerns the sampling, which was restricted to teachers already affiliated with the Meninas.comp project. By analyzing only educators engaged in the initiative, selection bias may arise, and the generalizability of the results may be limited, given that these professionals already demonstrate an active interest in Computing education and sensitivity to gender-equity issues. Nevertheless, this study contributes to the literature on university outreach projects by highlighting the challenges, opportunities, and benefits perceived by participating teachers. Future research should expand this scope to incorporate new institutional contexts and broader educator perspectives.

4.3 Participants and Sampling

The target audience consisted exclusively of K-12 teachers currently or previously involved with the Meninas.comp project in partner schools. The questionnaire remained open for responses between January and February 2025 and was distributed directly via text messages to participants previously registered by the

[2] Research Questionnaire: `https://drive.google.com/file/d/1EXVPpr5D6jy7q9eyCMHvimfT-EpuRnu9/view?usp=sharing`, in Portuguese.

project coordination. In total, 20 valid responses were obtained, representing 91% of the teachers actively involved in the project at the time of the study.

Ethical Safeguards. To ensure compliance with research ethics principles, the instrument was preceded by an Informed Consent Form (ICF),[3] which explicitly described the study's objectives and guaranteed respondent anonymity and confidentiality. Participation was entirely voluntary, and data collection commenced only after respondents provided explicit consent.

5 Results

This section presents the quantitative and qualitative findings derived from the collected data, followed by their respective analyses. For clarity, the results are organized into the following thematic axes: teacher profiles and an overview of the project (Section 5.1); teachers' computing backgrounds prior to the project (Section 5.2); the institutional and professional impact experienced by teachers (Section 5.3); perceptions of the Meninas.comp project and its broader effects (Section 5.4); and concluding insights, including primary implementation challenges (Section 5.5).

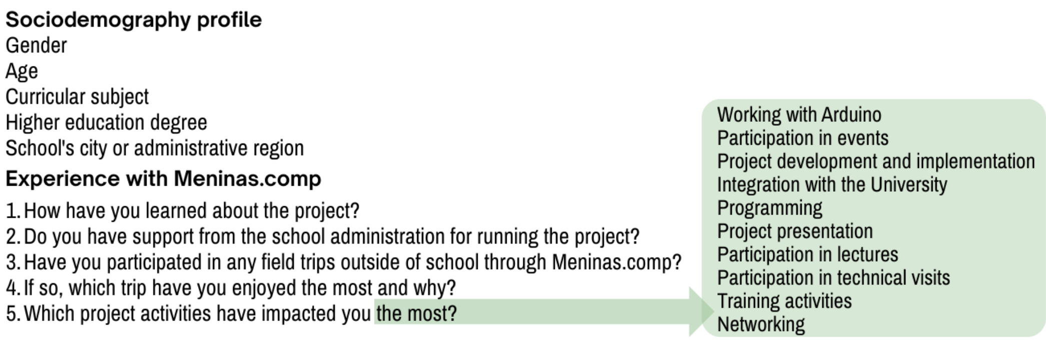

Figure 5: Questionnaire overview on profile and experience within Meninas.comp (parts 1 and 2).

5.1 Profile and Overview

The questionnaire first captures the participants' sociodemographic profiles and fundamental experiences with Meninas.comp, as illustrated in Figure 5. As previously noted, 20 public school teachers—either currently or formerly involved in the project—completed the instrument. This sample represents 91% of all educators associated with the project during the analyzed timeframe. This high response rate minimizes self-selection bias and ensures the representativeness and reliability of the data. Below, we present these baseline results in two parts: the respondents' demographic characteristics (gender, education, and regional reach) and an operational overview of their project experience (initial awareness, administrative support, external event participation, and high-impact activities).

Respondents' Sociodemographic Profile. The participating teachers exhibit diverse academic and professional backgrounds. Regarding gender distribution, eight respondents identified as female and 12 as male (i.e., 40% women). Participant ages range from 29 to 62 years, with a mean age of 42.15 (median: 43).

Figure 6 summarizes their educational profiles, displaying the primary undergraduate field on the left and the highest academic degree achieved on the right. Female respondents predominantly hold Ph.D. degrees or specialized certificates in Geography, Medicine, Physics, or Mathematics. In contrast, male respondents hold Bachelor's, Specialist, or Master's degrees across a broader spectrum of disciplines.

Although the sample is heterogeneous regarding gender and training, a key structural insight emerges: only male teachers hold higher education degrees in *informatics-related fields*, such as Computing and Information Systems. This finding reflects the persistent lack of gender diversity in Brazilian technology programs within higher education, a systemic issue widely documented in the literature [55].

To map the regional reach of the initiative, the questionnaire collected data on the specific cities or administrative regions where the partner schools operate. All respondents teach in public institutions across various regions of the Federal District and the state of Goiás, Brazil. The Federal District—which includes the capital city of Brasília—accounts for the highest concentration of participating schools. Notably, the project also serves peripheral areas surrounding the capital, as mapped in Figure 7. Students in these socioeconomic

[3]Informed Consent Form: `https://drive.google.com/file/d/1kNMmGuTbNAGdPTg16gOwi3CFrAwm6BPd/view?usp=sharing`, in Portuguese.

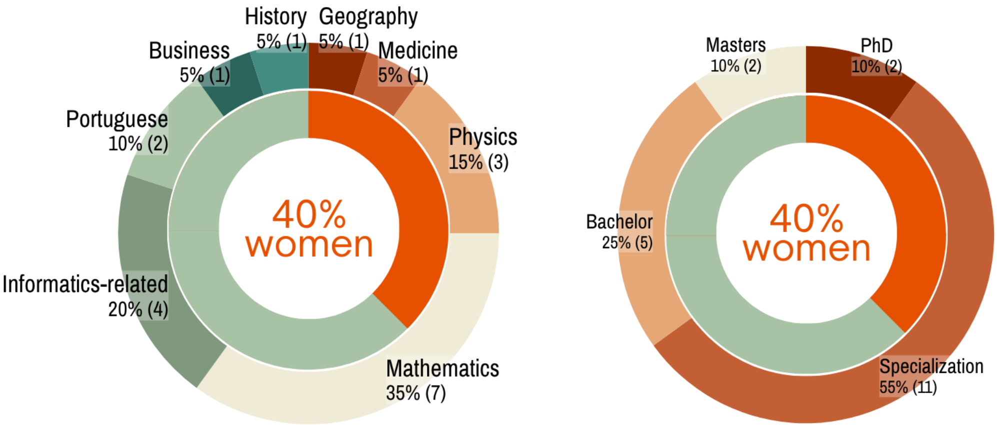

Figure 6: Education profile by gender with primary area of higher education (left) and highest education degree (right): 40% of respondents are women whose areas vary from Geography to Mathematics, and highest degree is either PhD or specialization.

Figure 7: Distribution of regions with partner schools in the Meninas.comp project.

margins historically face lower expectations regarding academic continuity and professional labor-market entry [50, 56]. Consequently, Meninas.comp serves as a critical mechanism to mitigate educational and regional inequalities within Brasília and its surrounding areas.

Experience Overview. The second phase of the instrument (Figure 5, bottom) investigates the educators' general experiences within Meninas.comp. We first examined how teachers became aware of the project, given that the majority do not specialize in technology-related fields. The responses indicate that:

- seven teachers discovered the initiative through a peer educator;
- six operated within schools that were already active project partners;
- five were introduced to the project by colleagues within the regional public education network; and
- two engaged with the initiative through public events organized by the project team.

These schools span diverse geographical zones in the Federal District and Goiás, each characterized by distinct infrastructural capabilities and regional challenges. Regarding institutional dynamics, all respondents reported receiving support and collaboration from school management, with 60% indicating strong administrative support and 40% reporting moderate support. This positive outcome is a direct consequence of the project's onboarding methodology: Meninas.comp is only implemented after the school administration signs a formal partnership agreement. This institutional commitment requires the school to designate at least one focal teacher to coordinate the project locally.

Regarding experiential engagement, we evaluated teacher participation in events outside the school environment, such as field trips, science fairs, and academic presentations. The vast majority (95%) had participated in such activities. The most impactful external experiences included University Week (Semana Universitária – SEMUNI) at UnB (47.37%), followed by campus laboratory visits and corporate excursions to IT companies and public institutions (21.50%). SEMUNI is an annual institution-wide symposium where UnB opens its academic departments, research labs, and centers to the public. During this event, students, teachers, and external visitors interact directly with research projects, outreach initiatives, and scientific dissemination activities across all undergraduate and graduate programs, thereby bridging the gap between higher education and the community.

Teachers were also invited to share the moments or activities they considered with most impact. In addition to such events, respondents highlighted subjective experiences that were equally transformative:

- *"Participation and interaction at regional science fairs. It was beautiful to see school's students teaching robotics to other children";*
- *"The girls' joy during the first hands-on class, when they realize they are capable of making a LED blink—there is a sparkle in their eyes that is truly gratifying".*

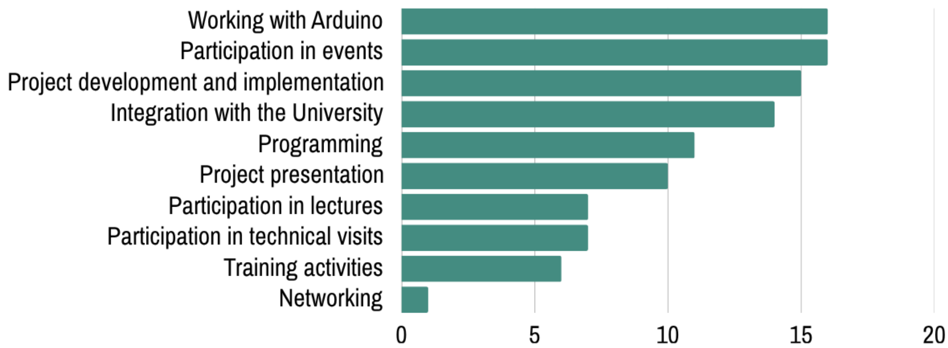

Figure 8: Meninas.comp project activities that most impact teachers.

Finally, teachers identified which project activities had the greatest impact on their professional experience from a predefined list. As shown in Figure 8, the highest-rated interventions were: hands-on physical computing with Arduino, participating in regional scientific events, collaborating on student-led applied projects, and being integrated into the core Meninas.comp digital network at UnB. Beyond these structural pillars, respondents highlighted subjective, transformative experiences that occurred as the project progressed.

These qualitative accounts reinforce that an educational outreach initiative of this nature transforms not only student trajectories but also reshapes the professional and personal lives of the educators, generating systemic changes across schools, families, and communities. The testimonials reveal multi-level impacts across five distinct dimensions: (*i*) on the students, who transition from passive learners to active peer instructors; (*ii*) on the teachers, who expand their pedagogical repertoire and witness student development; (*iii*) on young children, who build self-efficacy in technology; (*iv*) on the broader school community, which exhibits increased interest in collaborating with UnB; and (*v*) on families, as parents recognize the scientific capabilities of their daughters. Consequently, the project's decentralized methodology significantly scales the volume of stakeholders positively affected by computing education.

5.2 Computing Background

Following the initial demographic and experience baseline, the questionnaire investigates the participants' prior experience with Computing education, as summarized in Figure 9. This subsection begins with an evaluation of eight items using a 5-point Likert scale [57], ranging from 1–*None* to 5–*Very high*.

Prior Knowledge. The baseline knowledge assessment used a Likert scale across eight distinct topics within Computing and digital technology. The results indicate that nearly half of the respondents reported None or Low prior knowledge in Arduino, electronics, and robotics. Conversely, the majority of participants reported at least Moderate familiarity with technology careers, programming, Computer Science concepts, project

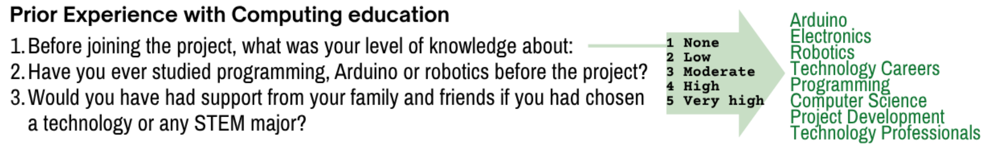

Figure 9: Questionnaire overview on computing background (part 3).

development, and the tech industry workforce. The explicit before-and-after distributions are discussed subsequently as part of the analysis of project impacts on teacher skills (illustrated in Figure 11).

Programming, Arduino and Robotics. These baseline results are complemented by a binary/categorical inquiry explicitly addressing prior knowledge in programming, Arduino, and robotics. Despite their diverse academic backgrounds, 65% of the teachers reported having some level of prior familiarity with these three topics. Notably, the project does not restrict participation to educators with formal technical training. On the contrary, an intrinsic motivation to acquire new technical competencies—such as educational robotics and fundamental computing concepts—serves as a primary driver for teacher engagement and long-term retention. Within this framework, Meninas.comp fulfills a critical professional development role by providing structured, scaffolded training in computational logic, programming, electronics, Arduino, and robotics.

Consequently, the operational structure of Meninas.comp effectively expands access to Computing education within public institutions across the Federal District. Enabling teachers from non-technical disciplines to join the project, combined with institutional incentives for engagement, facilitates the establishment of decentralized project hubs. This structure significantly broadens the initiative's operational footprint and cumulative impact. Furthermore, this dynamic directly supports the continuing education of participating teachers, who frequently face restricted access to professional development opportunities from official public institutions, such as the Ministry of Education [58]. Thus, the project serves not only as an intervention to bridge the gender gap for female students but also as a vital formative space for K–12 educators

Support for Tech/STEM Career. Finally, all respondents indicated that they would have received support from family and friends had they originally chosen to pursue a higher education degree in a technology or STEM-related field. This outcome underscores broader questions regarding the sociocultural factors that initially guided the career choices of the female respondents—a dimension that falls outside the scope of the present study.

5.3 Impacts Experienced by Teachers

In addition to influencing their students, participating teachers perceived themselves as significantly impacted by the initiative. Figure 10 summarizes the first half of the fourth phase of the questionnaire, which evaluates the project's direct effects on the educators (Items 1 to 5).

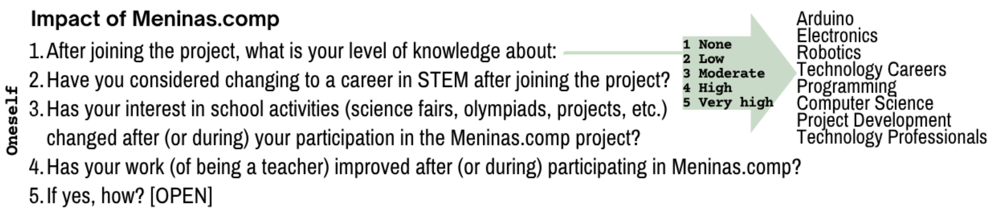

Figure 10: Questionnaire overview on impact (beginning of part 4).

Level of Knowledge Growth. To measure skill acquisition, respondents re-evaluated the baseline list of eight computing topics (previously introduced in Figure 9) to reflect their perceived proficiency after facilitating the project. Figure 11 illustrates the comparative results, tracking the evolution of teacher competencies before and after entering the initiative. According to the teachers' perceptions, the technical domains demonstrating the highest knowledge growth were Arduino, electronics, and robotics. Crucially, many educators who reported absolute zero baseline knowledge in these areas achieved high levels of self-reported proficiency after participating in the project.

It is important to emphasize that this technical skill acquisition extended beyond mere instrumental mastery. As Bim and Berardi [43] argue, equipping teachers with these competencies directly reinforces their sense of self-efficacy, a critical factor in ensuring they feel confident and comfortable delivering computing content to their students. Moreover, the technical knowledge acquired through Meninas.comp integrates with

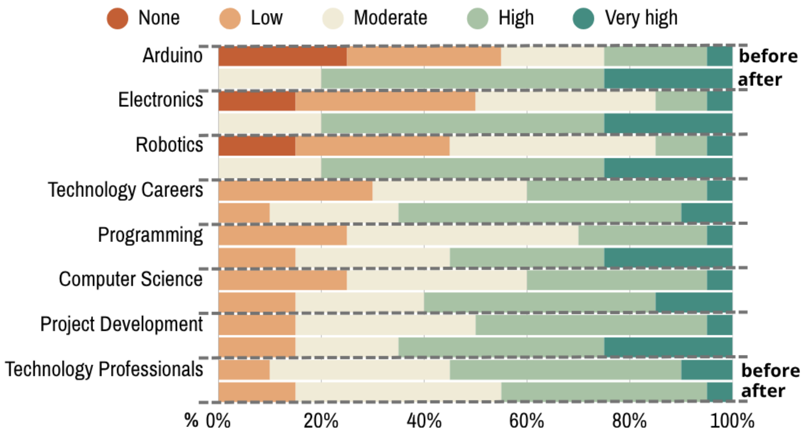

Figure 11: Evolution of teachers' perceived technical knowledge.

the teachers' original academic disciplines, enabling them to cross-pollinate computing concepts into different curricular areas and expand the use of these technologies beyond the project's standalone workshops.

Career Redirection Interests. The second item in this block assesses whether participating in the project influenced the teachers' interest in pivoting toward a professional career in STEM. A majority of respondents (65%) answered affirmatively, 5% indicated they would potentially consider such a career change, and 30% reported they had not considered it. This result aligns with established literature showing that prior contact and familiarity with a discipline lower barrier perceptions and frame it as a viable career pathway. Familiarization with the field and the subsequent recognition of one's own technical capabilities help dismantle the gender stereotypes and structural biases historically associated with STEM domains.

Engagement in School-Wide Activities. Within the institutional sphere, the instrument captured how the project impacted teacher engagement in extracurricular school-wide events, such as science fairs and regional academic competitions. The feedback was overwhelmingly positive: interest increased significantly for 60% of the respondents and slightly for 35%, remaining unchanged for only a single participant (5%).

Pedagogical and Professional Improvement. Items 4 and 5 allowed educators to report how project participation shifted their broader professional practice. The vast majority (90%) recognized that their relationship with teaching evolved during or after their involvement in the project, whereas 10% believed this pedagogical shift had occurred prior to the initiative. Qualitative descriptions of this impact revealed that the experience:

- fostered greater pedagogical creativity;
- increased intrinsic motivation;
- enhanced instructional interaction with students; and
- provided critical material and hardware support to execute classroom activities.

Reflecting the consensus among these accounts, one respondent noted: *"Participating in the project brought new perspectives and opportunities for my teaching practice, broadening my view of possible classroom methodologies and pushing me out of my comfort zone."*

Synthesized Remarks on Teacher Impact. Contrasting these findings with the broader literature on pre-university Computing education highlights the critical formative role played by initiatives like Meninas.comp. Recent systematic reviews [45] identify a severe gap in professional development for Brazilian teachers, noting that standard training pipelines fail to adequately prepare educators to guide students into technical fields. In line with this diagnostic, our empirical data indicate that participating educators perceive the acquisition of new technical skills—specifically programming, robotics, and computational logic—as one of the most profound outcomes of their involvement. These insights suggest that university outreach frameworks operate effectively on a dual axis: they promote diversity among K-12 students while simultaneously acting as a critical, decentralized space for continuing professional development, thereby mitigating the systemic infrastructure limitations documented in the literature.

5.4 Perceived Impacts on the School and the Community

Given their proximity to the student body, institutional culture, and classroom activities, participating teachers are uniquely positioned to assess both the progress and systemic challenges of the outreach initiative. As previously noted, Figure 10 delineates the initial items of the questionnaire's fourth phase, which focused on personal and professional teacher outcomes. Now, Figure 12 displays the remaining items of this block, which evaluate the broader impacts of the project across four distinct dimensions: participating students (Items 6–7), school administration (Items 8–10), the institutional environment (Items 11–12), and the local community (Items 13–14).

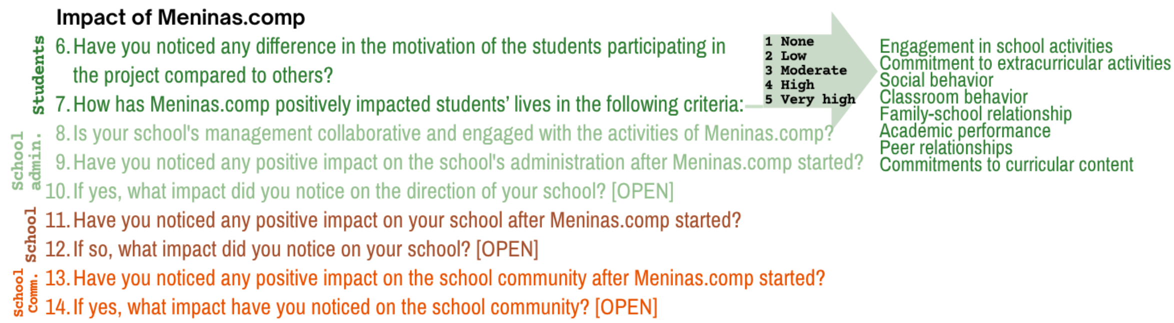

Figure 12: Questionnaire overview on further impact (part 4).

Impact on Students. Regarding student dynamics, educators reported a distinct contrast in motivation between project participants and the general student body: 90% of the teachers observed this motivational shift significantly, while 10% perceived it more subtly. Additionally, the instrument measured the intensity of the project's impact on specific areas of the students' lives using a 5-point Likert scale (*none*, *low*, *moderate*, *high*, and *very high*). As illustrated in Figure 13, the most pronounced impacts manifest in heightened engagement with school-promoted activities, positive shifts in social behavior, increased dedication to extracurricular topics, and proactive behavioral attitudes during regular classes.

Impact on School Administration. A substantial majority of respondents (90%) reported observing positive changes in school administrators following the project's implementation. Specifically, teachers highlighted that principals and administrative staff became significantly more supportive and collaborative, frequently expressing institutional pride in the Meninas.comp initiative. This sentiment is captured by one educator's account: "*It is a source of happiness and admiration to see the projects developed by our students*."

Impact on the School Environment. Reflecting the same metric observed in administrative support, 90% of the surveyed teachers reported positive transformations within the broader school environment. Qualitative descriptions of these institutional impacts centered primarily on structural shifts in student realities, including tangible curricular enhancements, the cultivation of new technical skills, and expanded opportunities for direct engagement with the university.

Impact on the School Community. Recognizing that educational institutions do not operate in isolation from their surrounding environments, the survey evaluated perceived impacts on the local community. According to 80% of the respondents, the implementation of the project catalyzed several positive communal developments. These external impacts manifested through increased parental and community participation in school-wide activities, as well as the dissemination of student achievements to the broader public during science fairs and exhibitions. Educators noted that parents express profound pride when witnessing their

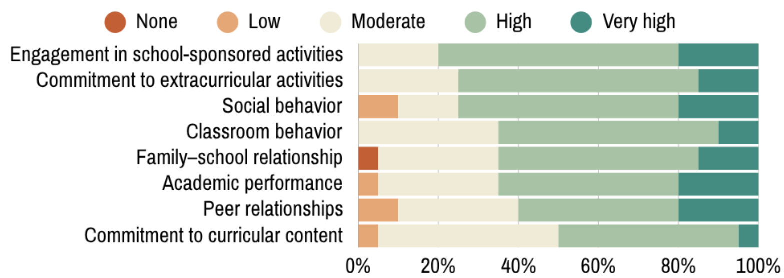

Figure 13: Perceived impacts on students' experiences.

daughters build technical artifacts, which is further amplified by the prestige of the school maintaining a formal partnership with UnB.

Synthesized Remarks on Systemic Impact. The empirical insights derived from the teachers' perspectives strongly converge with prior research evaluating this initiative from the standpoint of the student cohorts [50]. In this study, 90% of the educators identified substantial baseline differences in motivation among project participants compared to their peers; similarly, the prior student-centric evaluation indicated that the girls perceived positive changes in their own school engagement and relationship with learning. Notably, these reported impacts transcend the technical domain of Computing, encompassing holistic behavioral development, such as improved social dynamics, dedication to extracurricular research, and proactive classroom engagement. This alignment between educator observations and student lived experiences reinforces the evidence that Meninas.comp drives meaningful transformations in pre-university educational trajectories—suggesting that these pedagogical outcomes are both externally visible to mentors and subjectively internalized by the students.

5.5 Final Thoughts and Qualitative Insights

The final phase of the instrument invited educators to reflect on broader, systemic issues through open-ended questions. This qualitative space allowed participants to elaborate on personal impacts, implementation barriers, the systemic underrepresentation of women in STEM, and actionable recommendations for project optimization.

Personal and Professional Impact. When asked, "*How do you believe Meninas.comp has impacted your life*?", teachers openly discussed their personal and professional trajectories. The qualitative coding of their responses yielded four primary thematic categories: the acquisition of new technical skills (mentioned by 6 teachers), the opportunity to positively transform student lives (6), the emergence of new professional opportunities (5), and heightened instructional motivation (3). Representative testimonials illustrating these dimensions include:

- "*The primary impact I observe is pedagogical... researching materials and designing lesson plans for the project meetings was highly enriching, especially learning a entirely new domain—Arduino.*";
- "*The project provided the opportunity to support young girls who lacked clear professional prospects, opening doors to a new future.*";
- "*It introduced me to a completely different professional world. Participating in technological workshops and major events like Campus Party and Girls in ICT Day (organized in partnership with the ITU/UN) was profoundly rewarding.*"; and
- "*I already possessed an affinity for technology and programming; this project synthesized those interests, translating them into sustained professional motivation.*"

Primary Operational Challenges In response to the inquiry, "*What is your greatest difficulty regarding the project*?", the educators identified structural and institutional barriers that constrain the scalability and long-term sustainability of Meninas.comp. A prominent, recurring challenge is the need for more consistent, structured university presence within the partner schools. Although the initiative establishes a solid baseline connection between K-12 institutions and higher education, teachers indicated that a more frequent campus-led presence would solidify institutional ties, enhance continuous pedagogical support, and elevate the project's legitimacy within local school communities. This feedback aligns with contemporary frameworks that define university outreach as a bidirectional pillar of higher education—responsible not merely for knowledge transfer, but for actively listening to local demands and co-constructing educational solutions.

Institutional visibility also emerged as a critical vulnerability. Teachers emphasized the necessity of expanding the dissemination of Meninas.comp milestones across local and institutional media channels. Enhanced visibility is perceived as vital to attracting corporate or governmental partnerships, securing social recognition, and driving expansion into additional educational networks. This challenge resonates with literature indicating that successful diversity initiatives in Computing often remain isolated in scope when they lack systematic strategies for institutional communication and scalability.

Perceptions on the STEM Gender Gap. Furthermore, educators were asked, "*What do you believe distances women from STEM careers*?", to investigate why a significant gender gap persists despite targeted interventions. The respondents identified several sociocultural and institutional barriers that align with international literature on gender disparity in technology. Key factors include the pervasive stereotype that

STEM disciplines are inherently difficult, a male-dominated culture that can foster exclusionary or hostile environments, a systemic lack of early exposure or encouragement toward Computing, and deeply rooted cultural biases regarding gender roles.

The surveyed teachers were unanimous in contending that this paradigm can only be dismantled through early, direct interventions within K-12 schools, where young girls must build technical self-efficacy and confidence. This consensus underscores that school-level educators play an indispensable role in fostering gender equity in technology, offering a vital, systemic perspective that complements student-centric evaluations within the Meninas.comp framework.

Teacher Recommendations for Project Optimization. Finally, when invited to answer, "*What do you believe can be improved in the project?*", teachers repeatedly underscored the urgent need for expanded financial resources—specifically to scale the allocation of stipends and scholarships for both participating students and host educators. This critical demand directly reflects the broader socioeconomic context of public education, which is frequently marked by funding inequalities and a reliance on isolated outreach initiatives. This reality highlights the need for institutionalized, continuous public policies supporting Computing education. Additional recommendations for optimization included increasing direct university presence in the classrooms, maximizing mainstream and digital media visibility, and systematically expanding the project's methodology to other public educational complexes.

6 Discussion

The empirical findings derived from this study demonstrate that the Meninas.comp outreach framework produces a multidimensional impact, transcending simple technical skill acquisition to encompass motivational, pedagogical, and socio-educational transformations. By analyzing these outcomes through the lens of participating educators, this study bridges a critical gap in the literature, shifting the focal point from student self-assessments to the observations of the mentors who operationalize the initiative on the ground.

Teacher Competency Growth and Mitigating Educational Gaps. A salient insight from our analysis is the rapid technical progression observed among teachers in domains such as programming, electronics, and robotics. This evolutionary growth is particularly significant given that a substantial portion of the participants reported *none* or *low* baseline familiarity with these areas (Section 5.2). Rather than acting as an institutional barrier, this initial lack of expertise was effectively mitigated by the project's structured onboarding framework, which provides scaffolded training and continuous university support.

This outcome directly contextualizes the systemic challenges identified by Cavalcante and Raabe [45], who highlight chronic deficiencies in formal teacher-education pipelines for Computing in Brazil. Our results suggest that university outreach initiatives like Meninas.comp can actively function as vital, decentralized spaces for continuing professional development. By equipping non-specialist public school teachers with physical computing skills, the project partially fills these structural institutional gaps, reinforcing the viability of alternative models for scaling computing literacy in public school systems.

Pedagogical Reconfiguration and Self-Efficacy. Beyond individual technical learning, the results indicate deep changes in pedagogical practices and professional attitudes (Section 5.3). The marked increases in teacher motivation, instructional creativity during lesson planning, and enhanced classroom interaction suggest that project participation triggers a reconfiguration of teaching methodologies. This alignment supports established frameworks emphasizing teachers as active agents capable of shaping learning environments and altering student career trajectories [44, 47]. Within this dynamic, Meninas.comp contributes to strengthening the educators' sense of professional self-efficacy. As teachers master complex tools like Arduino, they build the requisite pedagogical confidence to incorporate novel tech methodologies into their broader curricular practices, extending the project's benefits beyond the standalone outreach hours.

The Teacher as an Active Mediator for Student Transformation. The study underscores the critical role of teachers as vital mediators rather than passive facilitators of a predetermined curriculum. Educators actively adapt technical contents to local school constraints, provide scaffolded learning support, and sustain student engagement over long periods. This high agency is paramount in socioeconomically vulnerable contexts where access to computing resources and specialized hardware is constrained.

From the perspective of school dynamics, the substantial positive impacts noted by teachers regarding student motivation and classroom behavior strongly converge with prior student-centric evaluations within this initiative [50]. This empirical consensus validates that the behavioral and attitudinal changes—such as elevated technical confidence, collaboration, and academic drive—are both subjectively internalized by the young girls and externally observable to their mentors, indicating a holistic educational outcome.

Institutional Integration, Community Scaling, and Gender Barriers. At the institutional and community levels, the findings demonstrate that Meninas.comp catalyzes social engagement that extends far past the classroom walls (Section 5.4). The high rates of administrative backing (90%) and parental involvement (80%) indicate that the project builds a symbiotic bridge between public schools, families, and the university. In marginalized communities, showcasing tangible scientific artifacts (e.g., student-built Arduino projects at science fairs) elevates collective pride and dramatically expands the students' perceived horizons regarding higher education and technology careers.

Nevertheless, the data also provide sobering insights into the persistence of structural gender inequalities in tech. The educators identified deep-seated cultural barriers, including the pervasive stereotype that STEM subjects are inherently exclusionary, the lack of early domestic encouragement for girls, and a male-dominated tech culture that remains hostile to female participation. These observations align with modern literature [44] and emphasize that isolated interventions are insufficient. They reinforce the strategic necessity of early, sustained, and safe spaces—such as the girls-only cohorts designed by Meninas.comp—to safely cultivate technical self-efficacy before structural gender biases fully dictate career choices.

Limitations and Future Horizons. While this study offers valuable insights into the mechanisms driving outreach success, a primary methodological limitation must be acknowledged. The sample consists entirely of teachers already self-selected and actively engaged in the initiative, which introduces an inherent positive bias toward valuing diversity and computing education.

To build upon the contributions of this work, future research will adopt longitudinal methodologies to track student career trajectories long after project completion. Additionally, we aim to incorporate the explicit perspectives of secondary stakeholders, such as school administrators and family members, while systematically documenting our best practices to allow other global outreach initiatives to replicate and scale gender equity in Computing.

7 Conclusion

This study investigated how K-12 educators perceive the impacts of their participation in the Meninas.comp outreach project on their professional trajectories and broader educational contexts. Our findings demonstrate that the initiative drives critical advancements on dual axes: it fosters the development of specialized technical competencies in Computing while simultaneously triggering profound transformations in pedagogical practices, teacher motivation, and student classroom engagement.

By prioritizing the often-overlooked perspectives of teachers, this research complements existing student-centric literature and underscores the indispensable role that educators play in the operational viability, local adaptation, and long-term sustainability of university outreach frameworks. The empirical results confirm that providing structured technical training, baseline institutional support, and continuous university collaboration empowers teachers from non-technical backgrounds to effectively and confidently incorporate hardware and computational logic into their standard teaching repertoires.

Beyond its immediate pedagogical contributions, Meninas.comp demonstrates a significant capacity for socio-educational impact. By decentralizing access to Computing education within public schools, the project actively challenges systemic barriers and cultivates technical self-efficacy among young girls in fields historically marked by severe gender disparities. These outcomes underscore the strategic importance of educational policies and diversity frameworks that deliberately couple teacher professional development with targeted interventions designed to reduce gender inequalities in STEM.

While this study offers valuable insights, certain limitations must be acknowledged. The analysis relies on self-reported data from a bounded sample of educators already engaged in the initiative, a factor that may introduce selection bias. To build upon the foundations established here, future work will expand this investigation through longitudinal tracking of student career paths and integrate the systemic perspectives of secondary stakeholders, including school administrators, parents, and the broader community.

In conclusion, despite these scope limitations, this work advances the state of the art in Computing education by illustrating how structured university-school partnerships can simultaneously elevate teacher capabilities and champion equity. Ultimately, the Meninas.comp methodology offers a scalable, replicable model for fostering inclusive technological literacy and dismantling gender asymmetries within historically underrepresented and underserved educational landscapes.

Acknowledgment

The authors thank everyone who has been (and continues to be) part of the history of the Meninas.comp project, especially the teachers who agreed to participate in this research. Aline de Galés Silva acknowledges

CNPq (National Council for Scientific and Technological Development) for the Scientific Initiation scholarship received. Aleteia Araujo and Mirella Moro thank CNPq - Funding Code 001.

References

[1] S. N. Alegria and E. H. Branch, "Causes and Consequences of Inequality in the STEM: Diversity and its Discontents," *International Journal of Gender, Science and Technology*, vol. 7, no. 3, pp. 322–342, 2015.

[2] S. N. Alegria, "What do we mean by broadening participation? race, inequality, and diversity in tech work," *Sociology Compass*, vol. 14, no. 6, p. e12793, 2020.

[3] L. Alfrey and F. W. Twine, "Gender-Fluid Geek Girls: Negotiating Inequality Regimes in the Tech Industry," *International Journal of Gender, Science and Technology*, vol. 31, no. 1, 2016.

[4] E. L. Mickey, "The Organization of Networking and Gender Inequality in the New Economy: Evidence from the Tech Industry," *Work and Occupations*, vol. 49, no. 4, 2022.

[5] S. Rangarajan. (2018) Here's the clearest picture of Silicon Valley's diversity yet: It's bad. But some companies are doing less bad. [Online]. Available: https://revealnews.org/article/heres-the-clearest-picture-of-silicon-valleys-diversity-yet

[6] C. Bezerra, M. Macedo, and K. Lopes, "Fatores e Dificuldades que Influenciam na Entrada e Permanência das Mulheres na Área de TI," in *Anais do XVII Women in Information Technology.* Porto Alegre, RS, Brasil: SBC, 2023, pp. 148–158.

[7] S. Clegg and D. Trayhurn, "Gender and computing: Not the same old problem," *British Educational Research Journal*, vol. 26, no. 1, pp. 75–89, 2000.

[8] D. Gürer and T. Camp, "An ACM-W literature review on women in computing," *SIGCSE Bull.*, vol. 34, no. 2, p. 121–127, 2002.

[9] M. Holanda and D. D. Silva, "Latin american women and computer science: A systematic literature mapping," *IEEE Transactions on Education*, vol. 65, no. 3, pp. 356–372, 2022.

[10] I. Miliszewska, G. Barker, F. Henderson, and E. Sztendur, "The issue of gender equity in computer science – what students say," *Journal of Information Technology Education: Research*, vol. 5, no. 1, pp. 107–120, January 2006.

[11] I. Villegas Molina, A. Montalvo, and A. G. Soosai Raj, "U.S. Latines in Computing: A Review of the Literature," in *Proceedings of the 55th ACM Technical Symposium on Computer Science Education V. 1*, ser. SIGCSE 2024. New York, NY, USA: ACM, 2024, p. 1381–1387.

[12] M. Moro, "Lack of Diversity: Are you part of the problem or its solution?" in *Anais do II Simpósio Brasileiro de Educação em Computação.* Porto Alegre, RS, Brasil: SBC, 2022, pp. 261–271.

[13] N. Rodriguez-Rodriguez, K. Ponce1, and I. R. Guzman, "Occupational inheritance and the decision for a university career: a study on women IT professionals in Peru," in *Proceedings XVI Congress of Latin American Women in Computing*, 2024, pp. 50–61.

[14] Women in Tech, "5 benefits of more women working in tech," 2023. [Online]. Available: https://www.womenintech.co.uk/5-benefits-of-more-women-working-in-tech/

[15] M. M. Moro, A. Araujo, C. Cappelli, F. Nakamura, L. B. Frigo, L. Salgado, R. Braga, and R. Viegas, "7 Motivos (7PS) de Gênero em TIC," in *TIC, Governância da Internet, Gênero, Raça e Diversidade - Tendências e Desafio*, B. Barbosa, L. Tresca, and T. Lauschner, Eds. Brasília, Brazil: CGI Br, 2023, p. 369–402. [Online]. Available: https://cgi.br/publicacao/3-coletanea-de-artigos-tic-governanca-da-internet-genero-raca-e-diversidade-tendencias-e-desafios

[16] A. Araujo, M. M. Moro, L. Salgado, C. Cappelli, I. Gasparini, and R. Viegas, "Diversidade de Gênero na Educação em Computação: Um Desafio Persistente em um Mundo em Evolução," in *I Seminário dos Grandes Desafios da Educação em Computação no Brasil: Trabalhos Apresentados*, L. Ribeiro and R. Duran, Eds. SBC, 2024, pp. 64–72. [Online]. Available: https://books-sol.sbc.org.br/index.php/sbc/catalog/book/186

[17] M. Proebster and N. Marsden, "Retention of women in tech – a systematic literature review," *Journal of Computer Information Systems*, pp. 1–15, 2026.

[18] R. Rocha, M. Teles, M. Souza, M. Nascimento, A. Nascimento, and A. Marques, "Mentoria acadêmica gamificada: Explorando o legado das mulheres na computação," in *Anais do XVIII Women in Information Technology*. Porto Alegre, RS, Brasil: SBC, 2024, pp. 172–182.

[19] N. Rodriguez, M. Lima, A. Moura, and R. Szenberg, "Twist: Programa de capacitação de desenvolvedoras de software," in *Anais do XVIII Women in Information Technology*. Porto Alegre, RS, Brasil: SBC, 2024, pp. 263–273.

[20] E. L. M. Xavier, F. Coscia, and C. von Lücken, "University student dropout prediction for female students in the Computer Engineering career," in *Proceedings XVI Congress of Latin American Women in Computing*, 2024, pp. 62–73. [Online]. Available: https://ceur-ws.org/Vol-3872/paper6.pdf

[21] D. M. Branson, *The Future of Tech Is Female – How to Achieve Gender Diversity*. New York, USA: New York University Press, 2018.

[22] C. Corbett and C. Hill, "Solving the Equation: The Variables for Women's Success in Engineering and Computing," AAUW, Tech. Rep., 2015. [Online]. Available: https://www.aauw.org/app/uploads/2020/03/Solving-the-Equation-report-nsa.pdf

[23] A. Araujo, A. J. L. Briceño, A. S. S. Silvestre, B. P. Castro, C. D. Castanho, C. Koike, F. S. Marcilio, H. E. F. Soares, M. Holanda, M. M. Sarmet, R. B. Oliveira, T. A. Oliveira, and T. P. Silva, "Mundo Bit Byte - A digital mobile game to disseminate female personalities that made history in Computing," *Journal on Interactive Systems*, vol. 13, no. 1, p. 419–429, Dec. 2022.

[24] G. Costa, A. García-Holgado, and P. P. Alvarez, "Hack4women: In search of a framework," in *Proceedings XVI Congress of Latin American Women in Computing*, 2024, pp. 38–49. [Online]. Available: https://ceur-ws.org/Vol-3872/paper4.pdf

[25] F. dos Santos Coutinho, I. de Souza, L. da S Dias, J. Lindebeck, P. H. D. Valle, and A. M. de Oliveira, "A Scratch Programming Workshop for High School Girls: Engagement, Learning, and Inclusion in Computing," in *Anais do Women in Information Technology*, 2026.

[26] R. Fernández, E. Kremer, and A. Delgado, "ProgramADAmente: educational and social platform to bring programming closer to girls and teenage girls," in *Proceedings XV Congress of Latin American Women in Computing*, 2023, pp. 159–170. [Online]. Available: https://ceur-ws.org/Vol-3607/paper15.pdf

[27] S. Ferreira, G. Santos, V. Cavalcante, A. Oliveira, and C. Costa, "Iniciativas de ensino de programação para mulheres: Um mapeamento sistemático," in *Anais do XIX Women in Information Technology*. Porto Alegre, RS, Brasil: SBC, 2025, pp. 151–160.

[28] V. Barr and C. Stephenson, "Bringing computational thinking to k-12: what is involved and what is the role of the computer science education community?" *ACM Inroads*, vol. 2, no. 1, p. 48–54, 2011.

[29] M. Carvalho, L. Chaimowicz, and M. Moro, "Pensamento computacional no ensino médio mineiro," in *Anais do XXI Workshop sobre Educação em Computação*. Porto Alegre, RS, Brasil: SBC, 2013, pp. 641–650.

[30] B. Palop, I. Díaz, L. J. Rodríguez-Muñiz, and J. J. Santaengracia, "Redefining computational thinking: A holistic framework and its implications for K-12 education," *Education and Information Technologies*, vol. 30, no. 51, 2025.

[31] B. Quintela, M. Guimarães, L. Dias, A. Verly, and A. Oliveira, "Teaching Computational Thinking main concepts with a marble-powered computer," in *Anais do V Simpósio Brasileiro de Educação em Computação*. Porto Alegre, RS, Brasil: SBC, 2025, pp. 413–422.

[32] J. P. Rodríguez and L. A. Cecchi, "Logic Programming in Primary School: Facing Computer Science at an Early Age," in *2024 L Latin American Computer Conference (CLEI)*, 2024, pp. 1–9.

[33] M. Román-González, J.-C. Pérez-González, and C. Jiménez-Fernández, "Which cognitive abilities underlie computational thinking? Criterion validity of the Computational Thinking Test," *Computers in Human Behavior*, vol. 72, pp. 678–691, 2017.

[34] V. J. Shute, C. Sun, and J. Asbell-Clarke, "Demystifying computational thinking," *Educational Research Review*, vol. 22, pp. 142–158, 2017.

[35] S. Yeni, J. Nijenhuis-Voogt, M. Saeli, E. Barendsen, and F. Hermans, "Computational thinking integrated in school subjects – a cross-case analysis of students' experiences," *International Journal of Child-Computer Interaction*, vol. 42, p. 100696, 2024.

[36] M. Holanda, A. P. Araujo, and M. E. Walter, "Meninas. comp project: Programming for girls in high school in Brazil," in *2020 Research on Equity and Sustained Participation in Engineering, Computing, and Technology (RESPECT)*. IEEE, 2020, pp. 1–2.

[37] M. Holanda and A. Araujo, "Meninas.comp: transformando realidades de meninas e mulheres na computação," *REVISTA PARTICIPAÇÃO - Extensão UnB*, vol. 42, pp. 57–78, 2024. [Online]. Available: https://periodicos.unb.br/index.php/participacao/article/view/55188

[38] A. Silva, N. Oliveira, M. Holanda, and A. Araujo, "No Passado Meninas, no Presente Mulheres, no Futuro Profissionais de TI com o apoio do Projeto Meninas.comp," in *Anais do XVIII Women in Information Technology*. Porto Alegre, RS, Brasil: SBC, 2024, pp. 251–262.

[39] A. d. G. Silva, R. M. Prado, M. Holanda, M. E. M. Telles Walter, M. M. Moro, and A. Araujo, "Introducing Computing in Brazilian Basic Education: Insights from Teachers' Perspectives," in *2025 LI Latin American Computer Conference (CLEI)*, 2025.

[40] G. Reznik and L. Massarani, "Mapeamento e importância de projetos para equidade de gênero na educação em STEM," *Cadernos de Pesquisa*, vol. 52, p. ee09179, jun. 2022. [Online]. Available: https://publicacoes.fcc.org.br/cp/article/view/9179

[41] M. P. Lima, "As mulheres na ciência da computação," *Revista Estudos Feministas*, vol. 21, no. 3, p. 793–816, Sep 2013.

[42] C. A. Moss-Racusin, J. F. Dovidio, V. L. Brescoll, M. J. Graham, and J. Handelsman, "Science faculty's subtle gender biases favor male students," *Proceedings of the National Academy of Sciences*, vol. 109, no. 41, pp. 16 474–16 479, 2012.

[43] S. Bim and R. Berardi, "TIChers - conscientização e formação de docentes da Educação Básica por mais mulheres na Computação," in *Anais do XIV Women in Information Technology*. Porto Alegre, RS, Brasil: SBC, 2020, pp. 269–273.

[44] B. Amador, P. Turato, M. Hoger, L. Santos, S. A. Bim, and R. C. Berardi, "O papel das professoras no incentivo à carreira de computação para meninas no ensino fundamental," in *Anais do XV Women in Information Technology*. Porto Alegre, RS, Brasil: SBC, 2021, pp. 131–140.

[45] E. d. A. Cavalcante and A. Raabe, "Revisão sistemática sobre a formação professores da educação básica para ensinar Computação," *Informática na Educação: Teoria & Prática*, vol. 27, no. 2, dez. 2024. [Online]. Available: http://doi.org/10.22491/1982-1654.140269

[46] A. Balyer and K. Özcan, "Choosing teaching profession as a career: Students' reasons," *International Education Studies*, 2013.

[47] G. M. Faitar and S. L. Faitar, "Teachers' Influence on Students' Science Career Choices," *American International Journal of Social Science*, vol. 2, no. 5, 2013.

[48] C. Maciel, S. A. Bim, and K. da Silva Figueiredo, "Digital girls program: disseminating computer science to girls in Brazil," in *Proceedings of the 1st International Workshop on Gender Equality in Software Engineering*. New York, NY, USA: ACM, 2018, p. 29–32.

[49] A. P. F. Araujo, M. T. Holanda, V. Souza, and C. Koike, "An educational intervention for inclusion of deaf students in computing," in *Proceedings XV Congress of Latin American Women in Computing 2023*, vol. 1, 2023, pp. 1–10.

[50] A. Silva, R. Prado, M. Moro, and A. Araujo, "Autopercepção de Meninas do Ensino Básico em Relação às Carreiras de STEM," in *Anais do XVII Women in Information Technology*. Porto Alegre, RS, Brasil: SBC, 2023, pp. 91–102.

[51] G. Chaer, R. R. P. Diniz, and E. A. Ribeiro, "A técnica do questionário na pesquisa educacional," *Evidência*, vol. 7, no. 7, pp. 251–266, 2011.

[52] F. Faleiros, C. Käppler, F. A. R. Pontes, S. S. d. C. Silva, F. d. S. N. d. Goes, and C. D. Cucick, "Uso de Questionário Online e Divulgação Virtual como Estratégia de Coleta de Dados em Estudos Científicos," *Texto & Contexto - Enfermagem*, vol. 25, no. 4, p. e3880014, 2016.

[53] R. C. A. Caregnato and R. Mutti, "Pesquisa qualitativa: Análise de discurso versus análise de conteúdo," *Texto & Contexto - Enfermagem*, pp. 679–684, 2006.

[54] L. Bardin, *Análise de Conteúdo – Edição Revista e Actualizada.* Edições 70, 2015.

[55] S. K. d. O. Menezes and M. D. F. d. Santos, "Gênero na educação em computação no brasil e o ingresso de meninas na Área - uma revisão sistemática da literatura," *Revista Brasileira de Informática na Educação*, vol. 29, p. 456–484, maio 2021.

[56] R. Lopes, B. Maciel, D. Soares, L. Figueiredo, and M. Carvalho, "Análise e reflexões sobre a diferença de gênero na computação: podemos fazer mais?" in *Anais do XVII Women in Information Technology.* Porto Alegre, RS, Brasil: SBC, 2023, pp. 68–79.

[57] L. South, D. Saffo, O. Vitek, C. Dunne, and M. A. Borkin, "Effective use of likert scales in visualization evaluations: A systematic review," *Comput. Graph. Forum*, vol. 41, no. 3, pp. 43–55, 2022. [Online]. Available: https://doi.org/10.1111/cgf.14521

[58] E. Ishikawa, M. Brandão, and J. Fernandes, "Semana do Professor de Computação da Educação Básica: Um Relato de Experiências dos Desafios de se Formar um Professor," in *Anais do IV Simpósio Brasileiro de Educação em Computação.* Porto Alegre, RS, Brasil: SBC, 2024, pp. 123–131.