Journal on Interactive Systems, 2026, 17:1
ISSN: 2763-7719 • doi: 10.5753/jis.2026.7538

Research Paper

Designing Situated Computing Experiences for Girls: Intersectionality, CTScale, and HCI Artifacts in Hackathon 360

Tainá G. Souza [Fluminense Federal University | *tainags@id.uff.br*]
Elaine F. Rangel Seixas [Fluminense Federal University | *elaine.seixas@midiacom.uff.br*]
Marcelo Rocha [Fluminense Federal University | *marcelo_rocha@midiacom.uff.br*]
Anna Beatriz Marques [Fluminense Federal University | *annabeatrizmarques@id.uff.br*]
Estéfani N. P. Eller [Fluminense Federal University | *estefanie@id.uff.br*]
Sandy F. Cabral [Fluminense Federal University | *sandycabral@id.uff.br*]
Isabel Reis G. Lacerda [Fluminense Federal University | *isgaleno@id.uff.br*]
Aline de Paula Nascimento [Fluminense Federal University | *aline@ic.uff.br*]
Débora C. Muchaluat-Saade [Fluminense Federal University | *debora@midiacom.uff.br*]
Luciana Cardoso de Castro Salgado [Fluminense Federal University | *luciana@ic.uff.br*]

Institute of Computing, Universidade Federal Fluminense, Av. Gal. Milton Tavares de Souza, s/n, São Domingos, Niterói, RJ, 24210-590, Brazil.

Abstract. Girls from socially vulnerable contexts often face educational and symbolic barriers that restrict their access to Computing. This study examines how Hackathon 360 constitutes a situated formative Computing experience for these girls, extending the investigation conducted in its First Edition by broadening both the empirical basis and analytical scope. The research adopted a comparative mixed-methods design involving distinct cohorts from the 2024 and 2025 editions, both organized as multi-day formative processes, with a short-term longitudinal analysis conducted in the Second Edition. To address the research objective, the analysis articulated evidence from questionnaires, CTScale data collected before each Hackathon, the intersectional characterization of participants, the pedagogical redesign, and HCI artifacts. The findings indicate that the experiential categories identified in the First Edition also recurred in the Second Edition, characterizing the Hackathon as meaningful, collaborative, and socially relevant. The intersectional analysis situated this experience within racial and socioeconomic inequalities, restricted access to computing devices, and limited prior technical experience. Participant feedback informed pedagogical adaptations that expanded hands-on programming opportunities, while the CTScale characterized the Computational Thinking dispositions. The HCI artifacts showed how identities, experiences, and educational and psychosocial barriers were translated into personas, scenarios, interaction flows, and prototypes. Taken together, these findings characterize Hackathon 360 as a collaborative and situated formative Computing experience grounded in access, participation, pedagogical responsiveness, representation, and technical authorship.

Keywords: Computing Education, Social Robotics, Hackathon, Intersectionality, Computational Thinking, HCI

Edited by: Claudia Cappelli | **Received:** 31 January 2026 • **Accepted:** 13 August 2026 • **Published:** 21 August 2026

1 Introduction

Intersectionality, originally formulated by Crenshaw, has become a foundational analytical lens for understanding how multiple social markers, such as gender, race, class, territory, and conditions of access, intersect and produce differentiated experiences of participation, persistence, and recognition across domains, including Computing [Crenshaw, 2015]. In Computing Education, this perspective challenges approaches that treat "women" as a homogeneous group and rely on binary gender framings, often overlooking the asymmetries experienced by distinct groups [Rankin and Thomas, 2020]. Within Brazilian research, the literature indicates that inclusion initiatives in Computing frequently under-specify [Amaral and Oliveira, 2024] or insufficiently operationalize intersectionality, which can inadvertently reproduce patterns in which opportunities fail to reach groups positioned at greater institutional and infrastructural disadvantage [Ashcraft *et al.*, 2017].

Computing has been establishing itself as a central field in contemporary education, expanding its presence in both school and organizational contexts [Moreira Oliveira and Pereira, 2023]. Within this context, the *Grand Challenges of Computing Education in Brazil 2025–2035* emphasize that consolidating the field in Basic Education requires more than introducing content and tools: it demands contextualized pedagogical materials, teaching strategies that integrate technical and socio-emotional competencies, and explicit commitments to inclusion, diversity, equity, and accessibility [Sociedade Brasileira de Computação, 2025]. Additionally, the *Grand Challenges of HCI Research in Brazil 2025–2035* highlight the need for a situated and critical stance, particularly the third challenge (GC3 - Plurality and Decoloniality), which advocates examining HCI theories, methods, and practices through intersectional markers and avoiding the uncritical reproduction of Global North frameworks [Oliveira *et al.*, 2024].

Within this landscape, Hackathon 360 provides the empirical setting for investigating a formative Computing experience for girls mediated by Social Robotics and shaped by institutional and infrastructural conditions.

The investigation began with the 2024 edition of Hackathon 360. The study adopted a qualitative and exploratory approach, based on the coding of participants' responses, to investigate how participation in innovation projects involving Social Robotics stimulated girls in Computing. In that study, stimulation was understood as an increase in participants' interest in learning about Computing, as illustrated by the following excerpt reproduced from the article reporting the 2024 edition: *"I feel that I learned more about Computing, and this made me want to learn more about this field" (A0)*. The analysis identified seven categories describing the means through which this stimulation occurred: perception of work utility and social impact, self-efficacy and confidence, appropriation in activities, satisfaction in task completion, overcoming challenges, sense of belonging, and collaborative work [Souza *et al.*, 2025].

Building on the initial investigation, the present article incorporates data from the 2025 edition and broadens its analytical scope to examine Hackathon 360 as a situated formative Computing experience for girls, guided by the following research question: *How does Hackathon 360 constitute a situated formative Computing experience for girls?* To answer this question, the analysis integrates five dimensions: (i) the examination of the extent to which the seven experiential categories identified in the First Edition are evidenced in the Second Edition; (ii) the intersectional characterization of the 2025 participants; (iii) the pedagogical redesign of the Second Edition, informed by findings and feedback from the previous edition; (iv) a cross-cohort comparison of baseline Computational Thinking dispositions between the 2024 and 2025 participants; and (v) the examination of student-produced outputs as HCI artifacts. Through this integrated analytical structure, the study connects the agenda of plurality, decoloniality, and inclusion in HCI with the need for contextualized and adapted pedagogical strategies in Computing Education [Sociedade Brasileira de Computação, 2025; Oliveira *et al.*, 2024], while addressing the limited operationalization of intersectionality in empirical studies [Rankin and Thomas, 2020; Amaral and Oliveira, 2024; Ashcraft *et al.*, 2017].

Methodologically, the study adopts an empirical, comparative, mixed-methods design organized across two consecutive Hackathon editions involving distinct cohorts (2024 and 2025). Both editions were structured as multi-day formative processes in which the same participants engaged in consecutive activities within their respective cohorts. Within this temporal structure, the explicit short-term longitudinal analysis reported in this article concerns the Second Edition and is based on repeated perception questionnaires administered on Days 3, 4, and 5. Data were collected primarily through online questionnaires and materials produced by the teams during the Hackathons. The CTScale, administered before each Hackathon, was used to characterize and compare participants' baseline Computational Thinking dispositions across the 2024 and 2025 cohorts, focusing on creativity, cooperativity, critical thinking, and problem solving. Cross-edition comparisons were based on post-Hackathon questionnaires containing Likert-scale items and open-ended responses. The open-ended responses were analyzed comparatively across editions and grouped according to recurring themes, with representative excerpts selected to contextualize and clarify patterns observed in the quantitative results. Quantitative and qualitative evidence were integrated through methodological triangulation. Quantitative analyses included descriptive and nonparametric statistical procedures, such as means, standard deviations, and Mann–Whitney U tests, as well as an analysis of participants' progression during the Second Edition. Perceptions associated with the analytical categories were examined using means and standard deviations, whereas intersectional profile data were processed and analyzed through statistical routines implemented in Python. Finally, the HCI artifacts produced by the teams were analyzed according to the intersectional markers proposed by Marques *et al.* [2026].

The remainder of this article is organized as follows: Section 2 presents the theoretical foundation; Section 3 reviews related work; Section 4 details the methodology; Section 5 reports the results; Section 6 discusses the findings in light of the literature; Section 7 presents the study limitations; and Section 8 concludes the manuscript and outlines future work.

2 Theoretical Background

In this section, we address themes and theoretical concepts that highlight the relevance of the work carried out and support the interpretation of the results.

2.1 Women's Participation in Hackathons

Hackathons typically consist of short-term events in which programmers and other software development professionals collaborate intensively over a limited period of time. In addition to achieving their specific objectives, this format also promotes networking opportunities among participants [Briscoe, 2014]. Their primary focus is collaborative problem solving, bringing together participants to develop solutions with the potential to drive digital innovation [Cowan, 2013]. In educational settings, however, hackathons do not necessarily require the development of fully functional software prototypes [Briscoe, 2014].

Due to their less restrictive organizational structure, hackathons foster innovation by encouraging experimentation and learning through failure [Briscoe, 2014]. They can be employed to creatively explore challenges and opportunities across different organizational contexts, representing an effective strategy for developing innovative products and services from both internal and external perspectives [Valença and Santos, 2022]. Nevertheless, as observed in other areas of Computing, women's participation in hackathons remains limited, accounting for approximately 11% of participants, indicating that the traditional hackathon format alone has not been sufficient to reduce gender disparities [Briscoe, 2014].

In response to this scenario, recent studies have investigated how structural characteristics of hackathons influence the participation of women and other historically underrepresented groups. Kovaleva *et al.* [2022] argue that the low participation of women in hackathons is associated with gender stereotypes that foster impostor syndrome. As a result, the authors advocate reducing the competitive nature of hackathons and promoting more collaborative, safe, and welcoming environments as strategies to increase female participation. Similarly, Kos [2019] found, in an exploratory study conducted during the inclusive T9Hacks event, that women, non-binary participants, and other historically excluded groups exhibit lower competitive orientation and prefer flexible and collaborative forms of participation. Based on these findings, the author recommends diversifying participation opportunities, adopting more flexible team formation processes, and incorporating low-pressure activities into hackathon design. Corroborating these findings, Tisha *et al.* [2026] observed that female-focused hackathons emphasize learning, collaboration, mentorship, and community building. In this format, team formation prioritizes comfort, affinity, and psychological safety, fostering greater belonging, confidence, and appropriation, particularly among first-time participants.

Based on this evidence, the hackathon developed in this work preserved the core structural characteristics of a traditional hackathon, including collaborative problem solving under time constraints, team-based work, mentorship, and the presentation of developed solutions. The primary distinction was the reduced emphasis on competition among teams. This design decision was grounded in recent literature, which suggests that more collaborative, welcoming, and less competitive environments are better suited to promoting women's participation in hackathons.

2.2 Gender and Intersectionality in Computing Education

Research on gender in computing education has consistently documented the underrepresentation of women and girls in Computer Science (CS) and related fields. However, a growing body of scholarship argues that gender alone is insufficient to explain persistent inequities in access, participation, and retention. Intersectionality, originally articulated by Crenshaw, offers a critical analytical lens to understand how multiple, overlapping social identities interact to shape distinct educational experiences [Crenshaw, 2015]. In computing education, this perspective has become increasingly relevant to challenge one-dimensional approaches to diversity and inclusion.

Empirical studies demonstrate that gender-focused interventions often fail to adequately address the lived realities of women from historically marginalized groups. Black women in computing experience forms of gendered racism that cannot be understood by examining gender or race in isolation [Rankin and Thomas, 2020]. Although awareness of intersectionality in CS has increased in recent years, most studies focus predominantly on binary gender differences, while fewer explicitly examine how gender intersects with race, class, disability, or nationality [Szlavi *et al.*, 2023]. Computing education can foster girls' engagement and agency when it recognizes intersectional identities and connects technical learning to social justice and community-relevant issues [Ashcraft *et al.*, 2017].

In the Brazilian context, structural inequalities, such as limited access to educational resources, social networks, and institutional support, disproportionately affect Black and low-income women [Rodrigues *et al.*, 2025]. Computing education initiatives in Brazil must explicitly consider these intersecting dimensions, recognizing that intersectionality is not merely an analytical add-on but a necessary foundation for designing, implementing, and evaluating them. This perspective is particularly relevant for initiatives that aim to engage girls in collaborative, socially meaningful computing activities, such as robotics and hackathons, where learning, identity, and participation are deeply intertwined, particularly in contexts such as Hackathon 360, in which many of the girls were experiencing this type of event for the first time.

2.3 Computational Thinking in Basic Education

Due to the technological era in which we live, Computing has become one of the leading disciplines in education in our century [Moreira Oliveira and Pereira, 2023]. In 2018, the BNCC defined the general competencies that should be promoted among students, one of which refers to "understanding, using, and creating digital information and communication technologies" [Brasil, 2018]. Expanding on this competency, a complementary document entitled "Computing – BNCC Supplement" was created, through which Computing becomes a mandatory element in Basic Education in Brazilian schools one year after the approval of Resolution No. 1/2022. This supplement defines the skills and knowledge required in this field, organizing them into three axes: (i) CT; (ii) Digital World; and (iii) Digital Culture [Brasil, 2022].

Computational Thinking is, in theoretical terms, a way of solving problems by mobilizing concepts from Computing; that is, a mode of reasoning that structures problem formulation, information representation, and the construction of solutions in a systematic manner, even when the final outcome is not necessarily an executable program. This understanding has become particularly relevant in education because it supports the view that CT can be developed as a transversal human competence, with the potential to support learning across different domains, while also providing a conceptual basis for teaching computational content and practices in Basic Education. Within the CT axis, a recurring operationalization in the literature highlights four fundamental competencies (or pillars): decomposition, pattern recognition, abstraction, and algorithmic thinking [Ferreira *et al.*, 2023].

Beyond the tradition that describes CT in terms of widely disseminated operational pillars, the literature has increasingly emphasized CT as an integrated constellation of cognitive, social, and dispositional competencies, closely aligned with twenty-first-century skills and with situated conditions of learning. The International Society for Technology in Education (ISTE) frames CT as an extension of problem solving and as an integrated set of capacities that includes creativity, algorithmic thinking, critical thinking, problem solving, and cooperation [Korkmaz *et al.*, 2017]. This framing shifts the focus from a strictly procedural conception to an approach in which agency, self-regulation, and collaboration are constitutive components of performance in complex tasks, particularly in technology-mediated educational environments.

It is within this horizon that the Computational Thinking Scale (CTScale), proposed by Korkmaz *et al.* [2017], becomes relevant, as it operationalizes CT through five skills: creativity, algorithmic thinking, cooperativity, critical thinking, and problem solving. The instrument's modeling broadens the analytical reach of empirical studies by providing evidence beyond binary right/wrong metrics, incorporating indicators of perceived competence, reasoning patterns, and collaborative dynamics, thereby supporting interpretations of computational thinking as a situated practice. In the CTScale, creativity refers to the ability to generate novel relations and perspectives; algorithmic thinking involves formulating and evaluating goal-oriented sequences of steps, anticipating alternatives and refinements; cooperativity becomes central when problem complexity requires coordination, communication, and negotiation; critical thinking justifies inferences and regulates the quality of decisions; and problem solving constitutes the articulating core, mobilizing strategies to overcome obstacles and transform an initially unattainable goal into a solved state [Doleck *et al.*, 2017].

Given this multidimensional and dispositional conception of CT, the CTScale was administered before each edition of Hackathon 360 to characterize participants' pre-existing self-perceived Computational Thinking dispositions and establish a baseline profile prior to their engagement in the activities.

2.4 Human–Computer Interaction Artifacts

HCI is a multidisciplinary field of research and practice whose purpose is to study the design, evaluation, and implementation of interactive computing systems for human use [Preece *et al.*, 1994]. The field emerges from the convergence of areas such as CS, Cognitive Psychology, Design, and Ergonomics, which makes it essential for understanding how people interact with technology across different contexts. HCI seeks to ensure usability and high-quality user experience (UX) by investigating how technology can be designed to be accessible, efficient, and safe, while also promoting user satisfaction and engagement during use [Nielsen, 1994]. Thus, the focus of HCI extends beyond the mere functionality of a system, encompassing perceptual, emotional, and social aspects of interaction between people and digital devices.

Within this field, and as part of the process of implementing a system, concepts such as personas, problem scenarios, and prototypes serve as fundamental instruments in user-centered design. Personas are detailed fictional characters that represent different user profiles who interact with a system. They are constructed from the analysis of real user data—such as behaviors, goals, experiences, and frustrations—transforming abstract information into concrete and empathic representations [Cooper, 2004]. By designing for a specific persona rather than for a generic user, development teams can focus their efforts more precisely, building solutions that align with the actual needs of the target audience. This practice also supports alignment among team members by fostering a shared understanding of who the users are and what they expect from the system [Nielsen, 2013].

Information about personas is then incorporated into a detailed narrative, the problem scenario, which describes the persona's context prior to the technological intervention. Such scenarios help visualize the user's current situation, difficulties, and goals, enabling a deeper understanding of the environment in which the system will be used. They serve as a starting point for design, guiding the identification of opportunities for improvement and innovation [Rosson and Carroll, 2002]. In addition, scenarios support anticipating the potential impact of proposed solutions by foregrounding use-related challenges or constraints that could compromise the user experience.

To address the problem articulated in the scenario, the process moves into the prototyping phase, in which solution ideas are materialized prior to final implementation. This stage is essential for transforming abstract concepts into tangible representations, allowing both the team and prospective users to visualize and test what is being designed. Prototyping functions both as an experimental model for testing design hypotheses and as a communication instrument between users and developers, fostering dialogue and mutual understanding regarding system expectations. As Rogers *et al.* [2013] argue, "the activity of building prototypes encourages reflection on design," insofar as it promotes exploration of alternatives, learning through error, and continuous improvement in the quality of the intended interaction [Rogers *et al.*, 2013].

Accordingly, the HCI artifacts produced during Hackathon 360 were structured around these three concepts—personas, problem scenarios, and prototypes—which guided the teams from the representation of situated user needs and challenges to the materialization of interactive solutions.

3 Related Work

Within the Brazilian context, Desidério *et al.* [2024] investigated whether and how HCI-related soft skills are developed in initiatives affiliated with the Meninas Digitais Program. Through qualitative documentary research covering experience reports published at WIT between 2011 and 2021, the authors identified the recurrent presence of empathy, communication, collaboration, and creativity, with empathy emerging as the most prominent competency. The study indicates that outreach projects promote these skills by exposing participants to real-world challenges, particularly when they conduct activities with children who have limited familiarity with technology.

Amaral et al. examined how feminist, gender, and intersectional perspectives have been addressed in Brazilian Computing publications indexed in the SBC Digital Library. Their systematic mapping articulated categories such as intersectionality, activism, politicization, horizontality, and situated knowledge. The results revealed a gap between indexing and content: although intersectional perspectives appeared in the interpretation of some studies, the term itself appeared only once as a descriptor. The authors therefore advocate greater visibility for intersectionality and an agenda that incorporates plurality, interdisciplinarity, and the integration of teaching, research, and outreach in Computing Education [Amaral and Oliveira, 2024].

Menezes et al. reported the *Escola de Games* outreach project, which teaches programming logic to children and adolescents from public schools through game development with Scratch. The practical and author-centered workshops were associated with engagement, motivation, creative and technical skills, and interest in technology careers. The study argues that learning programming through game creation fostered engagement, contributed to the development of technical and creative skills, and positively affected participants' motivation, with indications of increased interest in pursuing technology careers. Particularly relevant to the present study, the project was continuously redesigned across editions using student and teacher feedback, instructors' observational records, and internal evaluations. This iterative process supported adjustments to content and teaching strategies according to participants' needs [Menezes *et al.*, 2025].

Ferreira et al. described the translation and cultural adaptation of the CTScale into Portuguese and its exploratory administration to 70 Computing undergraduates. The authors adopted methodological guidelines for translation and cultural adaptation and organized the procedure into stages, emphasizing that linguistic translation alone is insufficient without careful attention to semantic and cultural equivalence, particularly when the goal is to preserve content validity and enable future use in larger-scale studies. The exploratory application revealed a distinct pattern across the five skills. Creativity was the most frequently endorsed skill, with responses predominantly concentrated in "always" and "usually." Algorithmic thinking tended to concentrate in "sometimes," while cooperativity was generally reported as "always" or "usually." Critical thinking occurred more frequently between "usually" and "sometimes." Problem-solving received the highest number of responses in "rarely," followed by "sometimes," making it the least frequently endorsed dimension in the analyzed set [Ferreira *et al.*, 2023].

International studies complement these contributions by examining practical interventions aimed at girls and their effects on self-perception. Allaire-Duquette et al. evaluated a two-hour introductory robotics-programming workshop with 172 students aged 10 to 14. Before the intervention, girls reported lower self-perceived programming ability than boys; after the workshop, this difference was no longer statistically significant. The authors also noted that girls frequently chose female-only teams, which increased their opportunities to control the programming interface and may have reduced barriers associated with gender stereotypes [Allaire-Duquette *et al.*, 2022].

Benavent et al. presented Girls4STEM, an outreach initiative developed at the University of Valencia to increase girls' interest and confidence in STEM through family talks, professional role models, and teacher-training activities. Their findings highlighted the influence of self-image and external expectations on girls' academic decisions. Only 35% of the girls perceived themselves as highly competent in Mathematics, compared with 50% of the boys. Moreover, 43% of the girls believed that their teachers regarded them as competent, indicating that their self-perception was less positive than the recognition they perceived from others. This contrast suggests that lower confidence may persist even when girls receive or perceive external validation of their abilities [Benavent *et al.*, 2020].

From an intersectional perspective, Szlavi *et al.* [2023] reviewed studies addressing overlapping identities in Computer Science education and professional contexts. Although gender, ethnicity, education, and socioeconomic status appeared in the literature, most studies examined only two variables, commonly gender and ethnicity. The authors call for analyses that consider multiple intersecting factors and broader geographical and sociocultural contexts, particularly in regions such as Latin America [Szlavi *et al.*, 2023].

Regarding CT, Korkmaz and Bai adapted and validated the CTScale with 1,015 Chinese secondary-school students. Participants presented predominantly high Computational Thinking scores, particularly in creativity, cooperativity, and critical thinking, whereas problem-solving and algorithmic thinking received comparatively lower scores. Although male students obtained higher scores in overall Computational Thinking and most of its dimensions, girls and boys presented similar problem-solving scores, with no statistically significant gender difference in this dimension [Korkmaz and Bai, 2019].

Taken together, these studies provide complementary foundations for the present research, although they examine its dimensions separately. Brazilian and international research points to the limited operationalization of intersectionality in Computing studies [Amaral and Oliveira, 2024; Szlavi *et al.*, 2023], while studies on the CTScale provide both the methodological basis for its Portuguese adaptation and evidence of its applicability in secondary education [Ferreira *et al.*, 2023; Korkmaz and Bai, 2019]. Prior work also highlights HCI-related socioemotional competencies [Desidério *et al.*, 2024], the relevance of feedback-informed pedagogical redesign [Menezes *et al.*, 2025], and the effects of supportive interventions on girls' self-perception and confidence [Allaire-Duquette *et al.*, 2022; Benavent *et al.*, 2020].

Building on these contributions, Hackathon 360 integrates these dimensions within a single empirical investigation. The study considers participants' intersectional conditions, characterizes their self-perceived Computational Thinking dispositions, incorporates evidence-informed pedagogical redesign across editions, and analyzes HCI artifacts as situated representations of participants' experiences, challenges, and proposed solutions.

4 Methodology

This study extends the previous investigation of how participation in Hackathon 360 stimulated girls in Computing. The seven categories identified in that study establish the analytical continuity between the two investigations. By incorporating data from the 2025 edition, the present research broadens both its empirical basis and analytical scope to examine Hackathon 360 as a situated formative Computing experience for girls. To this end, it adopts an empirical, applied, comparative, mixed-methods design in which the seven experiential categories identified in the First Edition constitute one of five complementary analytical dimensions.

Within the first analytical dimension, the study revisits and analyzes perceptions of the following categories: (a) perception of work utility and social impact; (b) self-efficacy and confidence; (c) appropriation in activities; (d) satisfaction in task completion; (e) overcoming challenges; (f) sense of belonging; and (g) collaborative work. Methodologically, this strategy strengthens the evidence by enabling the identification of regularities and contrasts across Hackathons, thereby contributing to the analysis of participants' experiences as one dimension through which Hackathon 360 is examined as a situated formative Computing experience for girls.

The remaining four analytical dimensions broaden this examination. First, an intersectional characterization of the 2025 participants is introduced to contextualize the analysis and qualify the interpretation of experiences through articulated markers. Second, the study examines the Second Edition Hackathon redesign implemented in 2025. Third, a CT measure is added for both editions (2024 and 2025) via the CTScale, providing a standardized instrumental component that complements interpretive evidence and supports triangulation on competencies associated with CT. Fourth, the artifacts produced in 2024 and 2025, personas, and implemented interaction scripts are presented, analyzed and treated as empirical evidence of the design and prototyping process.

The study encompasses two consecutive Hackathon editions involving distinct cohorts in 2024 and 2025. Both editions followed a short-term longitudinal structure, as the same participants engaged in consecutive activities within their respective Hackathon. In this extended article, however, the explicit short-term longitudinal analysis is operationalized through repeated perception questionnaires administered on Days 3, 4, and 5 of the Second Edition.

4.1 Context of Research

The First Edition of the event was carried out within the context of the Include Meninas outreach project, whose goal is to increase girls' and women's interest in, and retention in, Computing. Include Meninas is a local initiative of the Institute of Computing at Fluminense Federal University (UFF) and is affiliated with the Meninas Digitais Program of the Brazilian Computer Society (SBC) [Universidade Federal Fluminense (UFF), Pró-Reitoria de Extensão, 2016].

The Second Edition of the Hackathon, in turn, was implemented within the framework of RENACEE_MD (Rede Nacional de Educação e Extensão Meninas Digitais), a large-scale Brazilian initiative that explicitly incorporates an intersectional perspective in Computing Education, while maintaining the formative commitment originally pursued by Include Meninas, which participates in the network as one of its member projects [Programa Meninas Digitais, 2025]. RENACEE_MD brings together higher education institutions, public schools, and local communities across multiple regions of Brazil, many of which are marked by socioeconomic vulnerability, racial inequality, and limited access to technological infrastructure.

By engaging girls from public schools, predominantly Black and mixed-race, and from low-income backgrounds, the network addresses not only gender disparities in Computing, but also the combined effects of race, social class, and territory on educational trajectories. Its activities integrate technical training, mentorship, and community-oriented projects, fostering early contact with Computing while valuing students' lived experiences and sociocultural contexts [Programa Meninas Digitais, 2025].

Within this framing, the Second Edition of the Hackathon can be interpreted not only as an initiative to encourage girls' participation in Computing, but also as an intervention situated in an ecosystem that makes the study's intersectional dimension analytically visible, thereby broadening the interpretive scope of the research in comparison to the first year.

4.2 Analysis of Intersectional Data

Data about participants' profiles were processed in Google Colab using Python libraries (*pandas*, *numpy*, *matplotlib*, and *seaborn*). Descriptive statistics were applied to summarize participants' demographic profiles.

4.3 Pedagogical Redesign of the Second Edition

The 2025 redesign was guided by evidence from the 2024 Hackathon, especially the barriers and needs reported by participants in the post-Hackathon surveys. The changes were conceived as deliberate adaptations aligned with the theoretical framework, and their rationale can be verified in the findings presented in Section 5.3.

In the Second Edition of Hackathon 360, the pedagogical structure was reorganized into five in-person meetings, each lasting three hours, totaling fifteen hours of formative activities. The pedagogical proposal was redesigned based on principles of active learning, design thinking, and social constructivism to increase participant engagement, autonomy, and meaningful learning [Prince, 2004].

The first session involved an expanded participation of students from the participating schools. It aimed to provide initial familiarity, including a demonstration of the EVA social robot, to stimulate students' interest in computing by presenting practical outcomes enabled by robotics.

The second session was dedicated to the initial stages of the design thinking process [Brown, 2008], comprising: (i) an initial brainstorming activity to identify challenges related to the educational context; (ii) an immersion phase, including the definition of the problem to be addressed by each group, the construction of personas and tand the development of the problem scenario; and (iii) the ideation phase, focused on planning the scripts and dialogues to be subsequently implemented in the robot. These stages reinforce a student-centered approach, in which knowledge is collectively constructed through problematization, experimentation, and reflection, which are core principles of active learning [Prince, 2004]. Compared to the First Edition of the Hackathon, a relevant change was observed in this session: due to the impossibility of holding an in-person meeting at one of the schools, the organizers conducted the activity remotely and synchronously via the Google Meet platform. All planned stages were carried out without compromising the methodology, and the results obtained were equivalent to those from the in-person session held at the other institution, demonstrating the feasibility of the remote format for this type of collaborative activity.

In the third session, each group presented its proposed solution, followed by an introductory mini-course on the EvaML language, a Domain-Specific Language (DSL) based on XML developed for the EVA social robotics platform to facilitate the creation of interaction scripts for the robot [Rocha *et al.*, 2025]. In the fourth session, the groups began implementing their code based on the content presented, with continuous support from monitors throughout the process. The monitoring team consisted of one technical secondary school student and undergraduate students, promoting more accessible and horizontal communication. This arrangement enabled participants to feel more comfortable expressing doubts and requesting support, thereby reducing the hierarchical barriers often observed in technical education environments [Porter *et al.*, 2016]. The implementation of the interaction scripts constituted the prototyping stage of the design thinking process [Brown, 2008]. In the fifth and final session, the groups delivered pitch presentations, during which each team presented the final solution developed using the EVA robot.

A fundamental pedagogical difference compared to the First Edition was the alignment of the mini-course content with the specific needs of the projects proposed by the groups. Based on a prior analysis of the scripts developed during the second session, the programming content was directed exclusively toward the functionalities required to implement the proposed solutions, avoiding cognitive overload associated with the presentation of excessive or contextually irrelevant concepts, in line with the principles of meaningful learning [Sweller, 1988]. In addition, the instructor was advised on the need to adapt the language for a predominantly non-technical audience. In this edition, reinforcement exercises were also incorporated at the end of each module, allowing groups to immediately begin implementing their scripts and promoting a gradual and integrated transition between theory and practice. This approach is a fundamental characteristic of learning-by-doing and experiential learning, in which knowledge is consolidated through reflective action on practice [Kolb, 1984].

Finally, the physical learning environment was also reconfigured, acknowledging the role of space in pedagogical mediation. In the First Edition, activities took place in a computer laboratory with a traditional row-based layout oriented toward the instructor, which hindered participants seated at the back of the room from visualizing projected content and contributed to reduced engagement. In the Second Edition, we adopted a room with computers arranged in a "U" shape, ensuring that all students had adequate visibility of both the projection and the instructor. This configuration reduced the physical distance between instructor and participants, encouraging interaction, dialogue, and collaboration, and reinforcing constructivist and active learning principles. The entire environment was designed to make students feel more comfortable, promote greater integration within the group, and contribute to a more inclusive, participatory, and student-centered learning process [Prince, 2004].

4.4 Data Collection Instruments

All questionnaires and instruments used in this study are available in the study repository.

4.4.1 Hackathon Questionnaires

At the end of the Hackathon, a structured questionnaire was administered to assess participants' perceptions of the training experience, with an emphasis on cognitive, socio-emotional, and collaborative aspects related to the activities developed, especially the programming of the social robot EVA. The questionnaire was made available in digital format and completed individually by participants immediately after each Hackathon. Two versions were administered, one in 2024 and another in 2025. Both questionnaires consisted of closed-ended items on a five-point Likert scale (rating from 1 (strongly disagree) to 5 (strongly agree)) and open-ended questions, organized into three main blocks: (i) overall evaluation of the Hackathon, (ii) perception of learning and skills development, (iii) qualitative evaluation of the experience. In the second hackathon edition, questions were introduced to assess socio-emotional engagement and teamwork.

The first block investigated participants' overall satisfaction with the Hackathon, including an item assessing whether the edition met initial expectations, along with an optional open-ended question for comments in cases of negative or partial evaluations. This block allowed for capturing a global view of the experience and identifying possible gaps perceived by the participants. The second block focused on perceived learning and skills development, including items related to increasing problem-solving abilities, learning CS concepts, and the difficulties encountered in programming the EVA robot. These items sought to assess the educational impact of the Hackathon from participants' perspectives, considering both the gains and the challenges encountered during the practical activity.

The third block consisted of open-ended questions in which participants could describe their overall experience at the Hackathon, point out positive aspects of this edition, suggest improvements for future editions, and report significant feelings, thoughts, or experiences that occurred during the activity. These qualitative responses complement the quantitative data, providing a deeper understanding of the perceptions, emotions, and meanings associated with the formative experience.

Finally, in the second hackathon edition, the questionnaire was expanded to address socioemotional and collaborative dimensions through Likert-scale statements derived from the categories identified in the first study. These categories are further elaborated in the subsection below, and the second hackathon edition instrument also enabled the confirmation of the categories observed in the first hackathon edition.

The open-ended responses from the 2024 and 2025 post-Hackathon questionnaires were also analyzed qualitatively and comparatively. The responses were examined as a whole and organized according to recurring themes related to participants' perceptions of the activities, instructional support, hands-on programming, available time, and suggested improvements. Representative excerpts were then selected to illustrate these thematic patterns and to contextualize aspects of the experience that could not be fully captured by the Likert-scale comparisons. The excerpts were therefore treated as complementary qualitative evidence within the mixed-methods analysis.

Operationalization of the Analytical Categories The following operationalization translates the seven categories identified in the First Edition as means through which Hackathon 360 stimulates girls in Computing into measurable questionnaire statements. To examine participants' perceptions of the analytical categories, a standardized section was added to all post-session questionnaires starting at the end of the third day of the Hackathon. Participants rated, on a 5-point Likert scale, the extent to which each affirmative statement represented their experience in the activity, using the following anchors: (1) it did not happen to me, (2) it happened a little, (3) it happened somewhat, (4) it happened a lot, and (5) it happened a lot to me. The categories were operationalized through one statement per category, except for Category 1, which was administered via two single-clause statements to reduce syntactic complexity and facilitate interpretation by the girls. These two Category 1 statements were analyzed separately in the descriptive and inferential analyses; however, in the interpretive synthesis, their results were recombined and discussed under Category 1 to preserve conceptual comparability with the analytical framework adopted in the previous edition.

- **Category 1a — Perception of work utility:** "I thought the activity was useful and important."
- **Category 1b — Social impact:** "I cared about what the activity could do for other people."
- **Self-efficacy and confidence:** "I believed I could do the tasks on my own."
- **Appropriation of the activity:** "I took initiative and did my part in the activity."
- **Satisfaction in task completion:** "I enjoyed participating and felt happy with what I did."
- **Overcoming challenges:** "I kept trying even when something was difficult."
- **Sense of belonging:** "I felt part of the group and comfortable with my peers."
- **Collaborative work:** "I talked, shared tasks, and helped my peers."

Responses on the 5-point Likert scale (1–5) were summarized by day and by group using the mean (M) and the sample standard deviation (σ). For each item, we computed $M = \sum x_i/n$ and $\sigma = \sqrt{\sum(x_i - M)^2/(n-1)}$. When reported, the composite index was defined as each participant's mean across the items in the block, followed by computation of M and σ for these participant-level composite scores within each group. In the cross-edition discussion, results for Category 1a and Category 1b were interpreted jointly as Category 1.

4.5 Analysis Procedures for Questionnaire Data

This subsection summarizes how questionnaire responses were handled analytically, including variations in valid respondent counts across instruments and the descriptive and inferential procedures adopted for Likert-scale items.

The values of N reported throughout the manuscript correspond to the number of valid participants for each instrument and, therefore, may vary across sections and data-collection points. This variation occurs because questionnaires were administered on different days of the event and targeted distinct dimensions (e.g., participant characterization, post-event evaluation, daily follow-up, and CTScale), so responding to one instrument does not necessarily imply responding to the others. In addition, the same participant may have responded on one day but not on another. Accordingly, each analysis was conducted using the available set of valid responses for the corresponding questionnaire and administration day, and N values are reported locally to ensure methodological transparency and to interpret differences in N strictly as nonresponse across instruments and days.

Because several post-Hackathon questionnaire items already showed very high central tendency in the First Edition (with medians close to the upper bound of the scale), the edition-to-edition comparison is subject to a ceiling effect, which reduces sensitivity to detect additional improvements; under this scenario, small shifts should be treated as descriptive differences in the observed response distributions and interpreted only in conjunction with the qualitative evidence and the broader pattern of indicators. They should not be taken as evidence of incremental gains or intervention effects. This ceiling effect also motivates the joint reporting of complementary descriptive statistics: when responses cluster near the maximum, distributions can become truncated and less informative under a single summary measure, making it important to characterize both central tendency and dispersion in more than one way to support careful interpretation in the discussion of results.

Given that questionnaire items were measured on Likert scales, the inferential analysis was conducted using the nonparametric Mann–Whitney U test, and descriptive statistics are presented using both median (IQR) and mean (standard deviation). The median and IQR are reported to ensure consistency with the ordinal nature of Likert-scale data and the assumptions of the nonparametric test, particularly in small samples and in the presence of skewness or concentration at the top of the scale. The mean and standard deviation are also reported to facilitate comparison with related studies in the literature and to provide an intuitive interpretation of central tendency and dispersion; this is especially relevant under ceiling effects, where medians may remain at the upper bound across editions and thus obscure subtle changes that can still emerge as shifts in the distribution's spread or in the relative balance of near-maximum responses. Reporting both sets of descriptors therefore supports methodological adequacy while enabling a more nuanced reading of stability versus incremental change, which is critical when the analysis is constrained by limited headroom for improvement.

4.6 Measures for Assessing Computational Thinking (CTScale)

The analysis was conducted at two data-collection points corresponding to the consecutive 2024 and 2025 Hackathon editions, with samples of $N = 10$ participants in the First Edition and $N = 13$ in the Second Edition. The CTScale comprises 29 Likert-type items distributed across five skill domains: creativity (8 items), algorithmic thinking (6 items), cooperativity (4 items), critical thinking (5 items), and problem solving (6 items), answered on a five-point frequency scale ranging from "Never" to "Always". Because the instrument was administered prior to any formal programming instruction and participants reported little or no prior programming experience, the algorithmic thinking subscale was not analyzed in this study; accordingly, the analyses focused on the remaining domains, which are more directly aligned with dispositional and collaborative competencies (soft skills) targeted in the intervention.

For each domain retained in the analysis, item-level responses were aggregated by computing the mean of the corresponding items. When relevant for reporting purposes, these mean scores were interpreted using ordinal categories. For the problem-solving domain, whose items are phrased in terms of perceived difficulty, responses were recoded so that higher values consistently indicated better perceived performance. In addition, negatively worded items were reverse-scored to ensure a uniform interpretive direction across the instrument. For a 1–5 Likert scale, reverse scoring follows the general rule $\mathrm{reverse}(x) = \max(x) + 1 - x$; thus, with $\max(x) = 5$, the recoded value is $6 - x$, which preserves the 1–5 range while reversing item polarity [Altermatt, 2007].

4.7 Artifact Analysis Procedure

The developed artifacts were analyzed in four sequential steps. First, the personas and scenarios were examined using the intersectional markers proposed by Marques *et al.* [2026] as the initial analytical framework. During this process, additional intersectional factors, contextual characteristics, and educational and psychosocial barriers that were not represented in the original framework were identified from the artifacts. Next, the corresponding EvaML prototypes were analyzed to identify the interaction design features implemented by each team to address the barriers represented in the personas and scenarios.

4.8 Data Confidentiality and Anonymization

Research data are stored in a password-protected repository with restricted access to ensure data confidentiality. During the qualitative analysis and reporting of the results, participants are identified only through anonymous alphanumeric codes. The prefix "S" is used to identify students, whereas the prefix "T" is used to identify teachers, followed by a sequential number (e.g., S0, S1, T0, T1), preventing individual identification.

5 Results

This section presents the findings of the empirical, applied, comparative, mixed-methods investigation conducted across two consecutive editions of Hackathon 360 involving distinct cohorts in 2024 and 2025. The results are organized into five complementary analytical dimensions: (i) the examination of the extent to which the seven experiential categories identified in the First Edition—perception of work utility and social impact, self-efficacy and confidence, appropriation in activities, satisfaction in task completion, overcoming challenges, sense of belonging, and collaborative work—are evidenced in the Second Edition, including their progression across repeated questionnaire administrations; (ii) the intersectional characterization of the 2025 participants, used to contextualize their experiences and conditions of participation; (iii) the analysis of the pedagogical redesign implemented in the Second Edition based on barriers, findings, and participant feedback identified in the previous edition; (iv) the cross-cohort comparison of baseline Computational Thinking dispositions between the 2024 and 2025 participants; and (v and vi) the presentation and analysis of the HCI artifacts produced in both editions, including personas, problem scenarios, interaction scripts, and EvaML prototypes, treated as empirical evidence of situated representation, design, and prototyping processes. These dimensions are subsequently integrated to address the following research question: *How does Hackathon 360 constitute a situated formative Computing experience for girls?*

5.1 Perception of Categories

In this step, we performed a nominal cross-check between the Day 3, Day 4, and Day 5 datasets, including spelling normalization, to track participants from 2025 over time. Post-Hackathon participants ($N = 16$) were organized into three groups: (i) a *complete longitudinal* group (completed the questionnaires on Days 3, 4, and 5; $n = 6$), (ii) a *post-Hackathon only* group (completed only the Day 5 questionnaire; $n = 4$), and (iii) a *partial questionnaire-completion* group (completed the Day 5 questionnaire and only one of the intermediate questionnaires—Day 3 or Day 4; $n = 6$). Importantly, this third category refers *exclusively* to the pattern of questionnaire completion (i.e., a missing record on one intermediate day) and should not be interpreted as partial participation in the Hackathon. This stratification is substantively relevant because participants in the "post-Hackathon only" group did not join late: they had a team and a project, attended Days 1 and 2, and contributed to the development of HCI artifacts (e.g., personas and an interaction scenario), but did not attend Days 3 and 4 due to school-related institutional constraints. Differences observed on Day 5 are therefore interpreted as reflecting distinct trajectories of exposure to intermediate stages of the process and, additionally, different levels of completeness in the records collected across days.

Within the complete longitudinal group ($n = 6$), Day 5 means were high across all categories, with maximal scores for perception of work utility ($M = 5.00; \sigma = 0.00$), social impact ($M = 5.00; \sigma = 0.00$), appropriation in activities ($M = 5.00; \sigma = 0.00$), satisfaction in task completion ($M = 5.00; \sigma = 0.00$), sense of belonging ($M = 5.00; \sigma = 0.00$), and collaborative work ($M = 5.00; \sigma = 0.00$), as well as a very high level of challenge perseverance ($M = 4.83; \sigma = 0.41$). Self-efficacy and confidence remained high but more variable ($M = 3.50; \sigma = 1.38$), suggesting that the perception of "being able to complete tasks on one's own" functions as a particularly sensitive indicator of individual differences even among participants with complete records across the three measurement points.

Maximal evaluations were also preserved in the post-Hackathon only group ($n = 4$) for dimensions related to the perceived purpose and social meaning of Hackathon 360: perception of work utility ($M = 5.00; \sigma = 0.00$), social impact ($M = 5.00; \sigma = 0.00$), and satisfaction in task completion ($M = 5.00; \sigma = 0.00$). Lower means emerged in dimensions more directly associated with agency in the process and sustained practical engagement: self-efficacy and confidence ($M = 2.00; \sigma = 1.15$), appropriation in activities ($M = 2.75; \sigma = 1.26$), and collaborative work ($M = 3.50; \sigma = 1.00$). Relational and persistence-related dimensions remained high, yet below the complete longitudinal group: belonging ($M = 4.25; \sigma = 0.50$) and challenge perseverance ($M = 4.25; \sigma = 0.50$). This profile is consistent with the fact that these participants contributed during the initial stages (Days 1–2) and returned for the closing session, but did not experience the intermediate stages (Days 3–4), which tend to consolidate opportunities for execution, task division, and perceived protagonism.

Intermediate Day 5 results characterized the partial questionnaire-completion group ($n = 6$): perception of work utility remained maximal ($M = 5.00; \sigma = 0.00$) and social impact remained high ($M = 4.83; \sigma = 0.41$). Compared to the post-Hackathon only group, higher means were observed in agency and team-interaction dimensions: self-efficacy and confidence ($M = 3.67; \sigma = 0.82$), appropriation in activities ($M = 4.50; \sigma = 0.84$), sense of belonging ($M = 4.67; \sigma =$

0.82), and collaborative work ($M = 4.50; \sigma = 0.84$), as well as challenge perseverance ($M = 4.50; \sigma = 0.84$) and satisfaction ($M = 4.50; \sigma = 0.84$). Because this group is defined by the incompleteness of records on one intermediate day, these values should be interpreted as descriptive of a subset with fewer repeated measurements, even though its members may have experienced the Hackathon more broadly than what is captured by the systematic completion of the questionnaires.

This pattern reinforces that, although participants' overall appreciation of Hackathon 360 and its perceived social significance remained high across groups, some dimensions related to self-assessment within the process—particularly self-efficacy and confidence, appropriation in activities, and collaborative work varied systematically. These differences were especially evident when comparing the group that did not attend Days 3 and 4 with participants whose records indicated greater exposure to the intermediate stages of the Hackathon.

The comparatively lower and more variable self-efficacy scores deserve particular attention. The item asked whether participants believed they could perform the tasks on their own; therefore, lower ratings do not necessarily indicate an unfavorable formative experience or a lack of learning, but may reflect a distinction between successfully participating with peer and mentor support and feeling able to act independently. In this cohort, limited prior exposure to Computing, restricted access to computers, and unequal continuity in the intermediate programming sessions may have intensified uncertainty about individual technical competence. Gendered stereotypes, fear of error, and reduced prior opportunities to build mastery experiences may also be relevant psychosocial explanations, especially for girls situated at the intersection of socioeconomic and racial inequalities. This interpretation is consistent with previous studies showing that girls may report lower self-efficacy and less favorable perceptions of their own technical or academic competence, even when they receive external recognition or successfully participate in supportive educational interventions [Allaire-Duquette *et al.*, 2022; Benavent *et al.*, 2020]. These interpretations are plausible but were not directly tested in the present study and should be examined through interviews, observation, and validated self-efficacy measures in future work.

A second pattern concerns the progressive perception of categories, examined with greater consistency in the complete longitudinal group ($n = 6$) because it includes repeated measures across all three time points. Perception of work utility increased across the three days (Day 3: $M = 4.33; \sigma = 1.21$; Day 4: $M = 4.50; \sigma = 0.84$; Day 5: $M = 5.00; \sigma = 0.00$), as did social impact (Day 3: $M = 4.50; \sigma = 0.84$; Day 4: $M = 4.67; \sigma = 0.52$; Day 5: $M = 5.00; \sigma = 0.00$). Appropriation in activities showed a particularly clear progression (Day 3: $M = 4.33; \sigma = 0.82$; Day 4: $M = 4.83; \sigma = 0.41$; Day 5: $M = 5.00; \sigma = 0.00$), suggesting a gradual strengthening of initiative and responsibility throughout project development. Collaborative work also increased over time (Day 3: $M = 4.67; \sigma = 0.52$; Day 4: $M = 4.83; \sigma = 0.41$; Day 5: $M = 5.00; \sigma = 0.00$), consistent with intensified task coordination as deliverables approached. Self-efficacy and confidence evolved more moderately (Day 3: $M = 3.00; \sigma = 1.10$; Day 4: $M = 3.33; \sigma = 1.51$; Day 5: $M = 3.50; \sigma = 1.38$). Sense of belonging remained high from the outset (Day 3: $M = 4.83; \sigma = 0.41$; Day 4: $M = 4.83; \sigma = 0.41$; Day 5: $M = 5.00; \sigma = 0.00$), while perseverance in overcoming challenges remained high and relatively stable (Day 3: $M = 4.83; \sigma = 0.41$; Day 4: $M = 4.67; \sigma = 0.52$; Day 5: $M = 4.83; \sigma = 0.41$) and satisfaction in task completion remained maximal across the series ($M = 5.00; \sigma = 0.00$ in Days 3, 4, and 5).

Taken together, these results provide initial evidence that the categories are operationally adequate in the hackathon context and strengthen their link to the previous qualitative study. In terms of content validity and interpretive adequacy, the adopted operationalization preserves an explicit correspondence between construct and indicator. The categories also showed sensitivity to a process-relevant variable in the design self-assessment: continuity of participation in intermediate stages, inferred both from attendance/non-attendance on Days 3–4 and from the pattern of questionnaire completion across days. On Day 5, meaning- and valuation-related dimensions (perception of work utility, social impact, and satisfaction) remained at the maximum level across all profiles, whereas dimensions related to self-assessment and practical team-based experience consistently distinguished trajectories—for instance, self-efficacy and confidence, appropriation in activities, and collaborative work. Although the block is intentionally concise and oriented toward intra-Hackathon monitoring, the results support that the categories derived from qualitative coding are suitable for tracking key dimensions of participants' experiences.

5.2 Context and Participants

In the 2025 edition, participants were students enrolled in the Junior Scientific Initiation (ICj) program, integrated into the RENACEE_MD project. The group consisted of adolescents from public schools. Their profile reflects a context marked by socioeconomic vulnerability, limited prior access to computing education, and diverse educational trajectories.

Regarding socioeconomic conditions, a significant portion of the participants reported receiving social benefits. As shown in Figure 1, most students indicated that their families were beneficiaries of public income transfer programs, such as Bolsa Família, while others reported receiving educational assistance programs or no social benefits. Consistently, family income levels (Figure 2) indicate that the majority of participants lived in households earning up to one minimum wage, with a smaller subset reporting an income between one and three minimum wages.

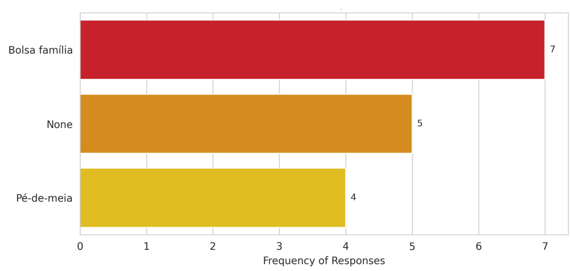

Figure 1. Social benefits received by the participants, indicating reliance on public income transfer and educational support programs.

In terms of educational background, participants were

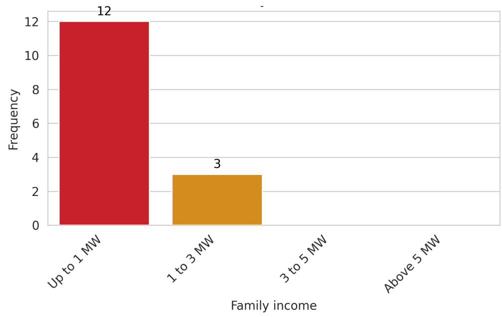

Figure 2. Distribution of family income levels, evidencing socioeconomic vulnerability among participants' households.

distributed across different school years, with the majority in the final years of elementary school (7th and 8th grades), followed by students in the first years of high school, as illustrated in Figure 3.

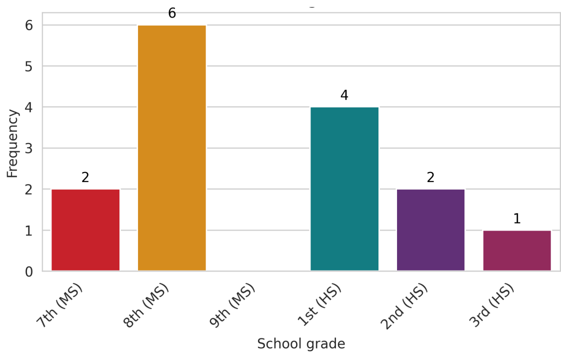

Figure 3. Educational stage of participants at the time of the study.

The racial and ethnic composition of the group further underscores its intersectional nature. As presented in Figure 4, most participants self-identified as Black or Brown, with a smaller proportion identifying as White.

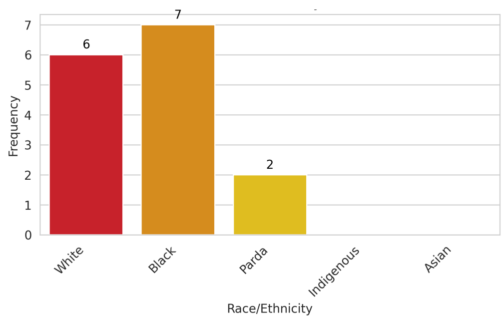

Figure 4. Racial and ethnic self-identification of participants, reflecting the intersection of gender and race in access to computing education.

Regarding technological infrastructure, most participants reported accessing the internet primarily via broadband connections (Figure 5). However, a considerable number relied on mobile networks or reported limited or unstable connectivity, indicating potential constraints on sustained engagement with online learning activities. Regarding personal devices, smartphones were the most commonly available technology, while access to computers or notebooks was significantly more restricted, as shown in Figure 6. Tablets were reported by only a few participants. These findings reveal a context in which mobile technologies play a central role in digital access, while traditional computing devices remain scarce.

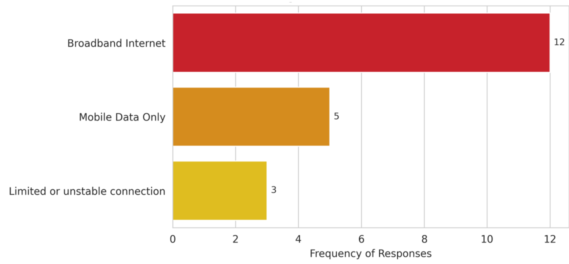

Figure 5. Forms of internet access reported by participants, revealing heterogeneity in connectivity conditions.

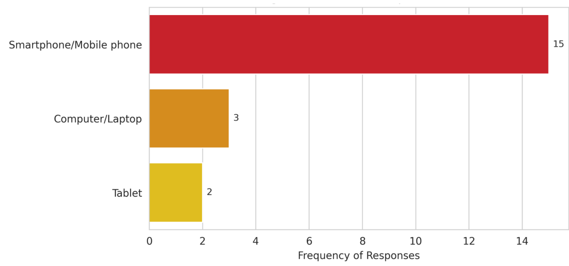

Figure 6. Availability of personal digital devices, underscoring the predominance of mobile access over traditional computing resources.

Prior to participating in the project, the majority reported low levels of prior knowledge in computing. Figure 7 shows that most participants indicated having little or no previous experience with computing concepts, programming, or related activities. Similarly, prior interest in computing was predominantly low or none (Figure 8), with fewer participants reporting moderate levels. These results suggest that the experience reached students with limited prior exposure to computing, rather than those already engaged in the area.

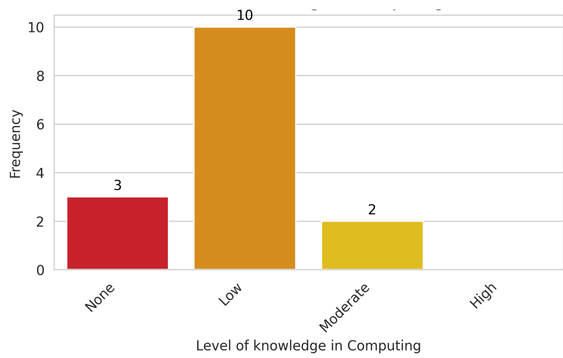

Figure 7. Self-reported level of prior computing knowledge before the project, characterizing participants as novices in the domain.

Consistent with this profile, most participants reported no prior experience with programming languages. As shown in Figure 9, only a small number indicated previous contact with languages such as Python or Java, reinforcing the introductory nature of the activities proposed in the project.

When asked about their expectations and interests in learning, participants expressed a strong interest in a diverse set of topics. Figure 10 shows that the most frequently selected themes included programming, interface design, computer networks and internet, games and gamification, and public speaking and presentation skills. Interest was also observed in topics such as robotics and Arduino, artificial intelligence, higher education and career guidance, academic writing, and information security. This diversity of interests highlights the importance of multidisciplinary and socially contextualized

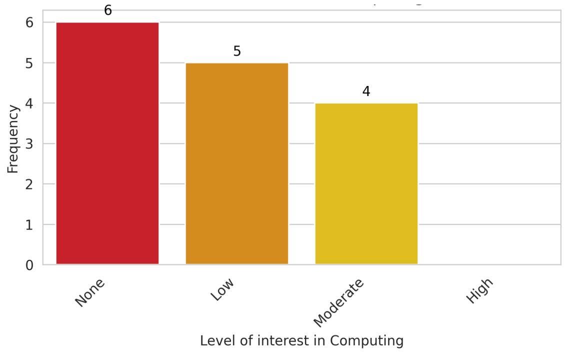

Figure 8. Participants' initial interest in computing prior to the intervention, indicating limited prior engagement with the field.

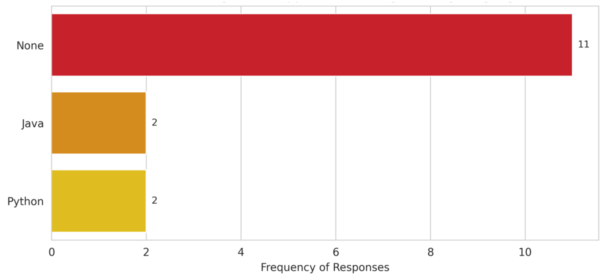

Figure 9. Reported prior exposure to programming languages, reinforcing the introductory nature of the educational intervention.

computing activities that go beyond technical skills alone.

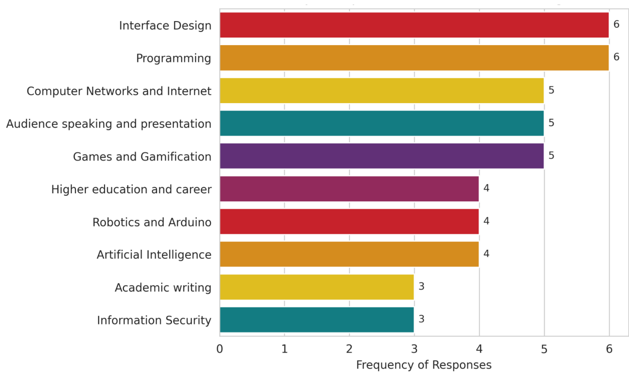

Figure 10. Learning interests expressed by participants, illustrating the breadth of technical and socio-communicative topics valued.

Overall, the participants' profile reveals a group characterized by socioeconomic vulnerability, racial diversity, limited prior access to computing education, and broad learning interests. This context reinforces the relevance of adopting an intersectional perspective when conducting interventions in computing education.

5.3 Effects of Pedagogical Modifications in the Second Edition

A comparative analysis between the two editions of the Hackathons, corresponding to two Hackathons, was conducted. Questionnaires administered at the end of the editions, covering participants from the last day when the developed projects were presented, were analyzed. The First Edition took place in 2024, with N = 9 participants, corresponding to First Edition. The Second Edition took place in 2025, with N = 16 participants, corresponding to Second Edition. It is worth highlighting that 25% of students in Second Edition did not directly participate in the EvaML and EVASIM programming training.

Both editions were based on practical activities, problem-based learning, and direct use of the EVA social robot as a central element of the training process. However, the Second Edition of Hackathon 360 incorporated relevant pedagogical changes compared to the previous edition, mainly regarding the environment, and with a greater focus on practical activities and greater instructor preparation.

In general, both editions showed high levels of satisfaction, indicating that the Hackathon has consolidated as a positive experience. In the First Edition (2024), the item "The Hackathon completely met my expectations" had a mean of 4.78 (σ = 0.42), while in the Second Edition (2025) it remained equally high (mean = 4.50, σ = 0.79). Although a slight reduction is observed, the values remain close to the upper limit of the scale, suggesting that the pedagogical changes did not compromise overall satisfaction and may have increased the perceived level of challenge among participants.

Regarding perceived learning, both editions showed high self-reported scores. In 2024, participants reported high ratings for learning in Computing (mean = 4.33, σ = 0.67) and problem-solving ability (mean = 4.11, σ = 0.57). In 2025, the corresponding ratings were also high (learning in Computing: mean = 4.56 (σ = 0.70); problem solving: mean = 4.06, (σ = 0.75)). Given the small samples, overlapping distributions, ceiling effects, and non-significant Mann–Whitney comparisons, these values are interpreted as descriptive evidence of consistently positive perceptions rather than as evidence of gains between editions. A descriptive difference was observed for engagement with the core practical activity. In 2024, the item "I enjoyed programming the EVA robot" already received a very high rating (mean = 4.89, σ = 0.31), and in 2025, all respondents selected the maximum score (mean = 5.0, σ = 0.00). Because both distributions are concentrated at the upper limit and the between-edition comparison was not statistically significant, this pattern indicates sustained high enjoyment and a ceiling response in 2025.

Table 1 presents the descriptive statistics of the responses to the common items of the questionnaire, expressed as median and interquartile range (IQR), along with the results of the Mann–Whitney U test for comparison between the First and Second Editions. No statistically significant differences were observed ($p > 0.05$), although a marginal trend was identified for the item related to the ease of the programming language. The medians remain high in both editions, indicating globally positive evaluations. At the same time, the IQRs tend to be wider in the Second Edition for some items, suggesting greater heterogeneity in participants' perceptions. This heterogeneity may reflect the fact that, in the Second Edition, some students did not participate in the practical robot programming training, a central activity of the pedagogical proposal, which should be considered when interpreting these results.

The analysis of the open-ended responses from the 2024 and 2025 editions reveals qualitative changes in how participants described their learning experiences following the implementation of the pedagogical modifications in the Second Edition. In response to the question, "What do you think could be improved in a future Hackathon 360 with other female students?", the First Edition revealed a demand for more

Table 1. Descriptive statistics (median and IQR) and results of the Mann-Whitney U test for the comparison between the First and Second Editions.

Item	First Edition Median [IQR]	Second Edition Median [IQR]	U	p-value
The Hackathon completely met my expectations.	5.0 [5.0–5.0]	5.0 [4.0–5.0]	81.5	0.5182
I enjoyed participating in Hackathon 360.	5.0 [5.0–5.0]	5.0 [5.0–5.0]	74.0	0.8804
I enjoyed programming the EVA Robot.	5.0 [5.0–5.0]	5.0 [5.0–5.0]	64.0	0.2113
The programming language for the robot was easy to learn.	5.0 [4.0–5.0]	4.0 [3.75–4.0]	101.5	0.0730
I feel that I increased my problem-solving skills with the Hackathon.	4.0 [4.0–4.0]	4.0 [3.75–5.0]	74.0	0.9258
I feel that I learned about Computer Science at Hackathon 360.	4.0 [4.0–5.0]	5.0 [4.0–5.0]	57.0	0.3469

hands-on programming activities, as expressed in the suggestions "More time to practice" (S1) and "more tasks or examples during the programming activity" (S2). In the Second Edition, the responses indicate that more time was allocated to the activities, as illustrated by the statement "The number of meetings was sufficient" (T1), although some participants still suggested "Having more time to develop the programming" (S3). Regarding the question, "What do you think went well in this edition of the Hackathon?", the responses from the First Edition were broader and generally positive, also emphasizing the role of the instructors, as illustrated by "The support provided by the project coordinators during the activities" (S4), "The organization was excellent, and the mentors provided a great deal of support" (S5), and "The explanations provided by Professor Débora and the undergraduate students" (S6). In the Second Edition, the responses focused more directly on the hands-on activities and the instructors' teaching practices, as evidenced by "The programming was interesting" (S7), "The group development and programming EVA went well" (S8), "The programming was wonderful" (S9), "The support provided by the teachers and interns" (S10), and "I believe that teamwork while programming EVA went well" (S11). This perception was also reflected in a teacher's account: "I had the impression that the girls picked up programming quickly" (T2). This pattern is consistent with participants and instructors perceiving greater emphasis on hands-on programming in the Second Edition.

5.4 Computational Thinking

Figures 11 (2024; N=10) and 12 (2025; N=13) show how participants were distributed among the CTScale response options for creativity, cooperation, critical thinking, and problem-solving. The comparison between the two editions highlights the dominant response categories. In the 2025 edition (Second Edition), we observe shifts toward higher or lower endorsements and changes in dispersion within each skill.

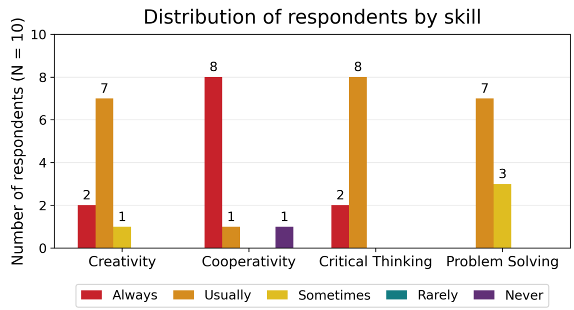

Figure 11. CTScale 2024.

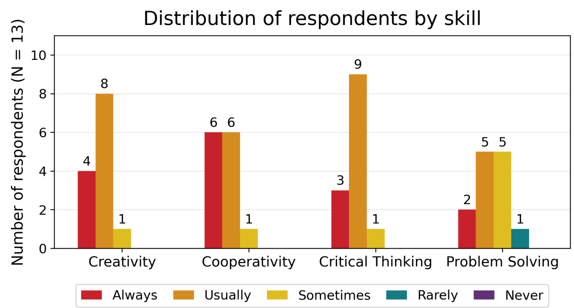

Figure 12. CTScale 2025.

Creativity Creativity in 2024 clustered around "Usually" (70.0%; $n = 7$), with fewer responses in "Always" (20.0%; $n = 2$) and "Sometimes" (10.0%; $n = 1$); none appeared in "Rarely" or "Never" (0.0%; $n = 0$). A comparable configuration appears in 2025: "Usually" remains most frequent (61.5%; $n = 8$), while "Always" rises to 30.8% ($n = 4$) and "Sometimes" accounts for 7.7% ($n = 1$); "Rarely" and "Never" again do not occur (0.0%; $n = 0$). The main contrast lies in a modest reallocation toward the top category in 2025.

Cooperativity Cooperativity in 2024 exhibits a strong ceiling tendency, with "Always" representing 80.0% ($n = 8$) and "Usually" 10.0% ($n = 1$), alongside a single endorsement of "Never" (10.0%; $n = 1$); "Sometimes" and "Rarely" are absent (0.0%; $n = 0$). In 2025, endorsements distribute evenly across the two highest options: "Always" accounts for 46.2% ($n = 6$) and "Usually" for 46.2% ($n = 6$), with 7.7% ($n = 1$) in "Sometimes" and no responses in "Rarely" or "Never" (0.0%; $n = 0$). This comparison suggests that 2024 combined a pronounced ceiling effect with an isolated negative case, whereas 2025 removes the lower extreme while preserving a highly positive overall profile (12 of 13 participants in "Always" or "Usually").

Critical Thinking Critical thinking remains consistently high across both editions. In 2024, responses concentrate in "Usually" (80.0%; $n = 8$) and "Always" (20.0%; $n = 2$), with no endorsements of "Sometimes", "Rarely", or "Never" (0.0%; $n = 0$). In 2025, "Usually" continues to dominate (69.2%; $n = 9$), "Always" remains substantial (23.1%; $n = 3$), and a small fraction appears in "Sometimes" (7.7%; $n = 1$); "Rarely" and "Never" remain absent (0.0%; $n = 0$). The edition-to-edition profile therefore indicates stability, with only a slight increase in spread in 2025.

Problem Solving (recoded competence) Problem solving in 2024 stays within an intermediate-high range, with 70.0% ($n = 7$) in "Usually" and 30.0% ($n = 3$) in "Sometimes"; "Always", "Rarely", and "Never" do not occur (0.0%; $n = 0$). In 2025, the distribution broadens: "Usually" falls to 38.5% ($n = 5$) and "Sometimes" rises to 38.5% ($n = 5$), while "Always" appears (15.4%; $n = 2$) and "Rarely" emerges (7.7%; $n = 1$); "Never" remains absent (0.0%; $n = 0$). Compared with 2024, the Second Edition therefore combines both higher-end endorsements and a low-end case, producing visibly greater dispersion.

Summary Across both editions, CTScale responses remain concentrated in the upper portion of the scale, particularly for creativity, cooperativity, and critical thinking. Differences across editions are better characterized as redistributions than as uniform improvements. Cooperativity shifts from a stronger ceiling profile in 2024, coupled with a single negative outlier, to a uniformly positive pattern in 2025 distributed across "Always" and "Usually". Problem solving shows the clearest increase in variability in 2025, spanning from "Always" to "Rarely", whereas 2024 remains confined to "Usually" and "Sometimes".

5.5 Human–Computer Interaction Artifacts Produced by the Girls' Teams

In both editions (2024 and 2025), the Hackathons invited students to create scenarios based on problems they had personally experienced, formulating situations in which the social robot EVA could contribute to a plausible solution. Each team created a Persona and a Problem Scenario to guide ideation and prototyping; the resulting interaction concepts were then implemented in EvaML. These artifacts make explicit the design choices, translating the identified needs into concrete conversation flows with the robot. Overall, only two Personas were translated into illustrative images, as can be seen in the text. For this article, only two dialogue representations are presented in full. The 2024 edition is illustrated by a paper-based storyboard, whereas the 2025 edition is represented by a digital dialogue flowchart developed for the synchronous online format (Figs. 13–14). Additionally, only two prototypes are presented in full (BIS and Galáxya), while the remaining teams are reported through excerpts.

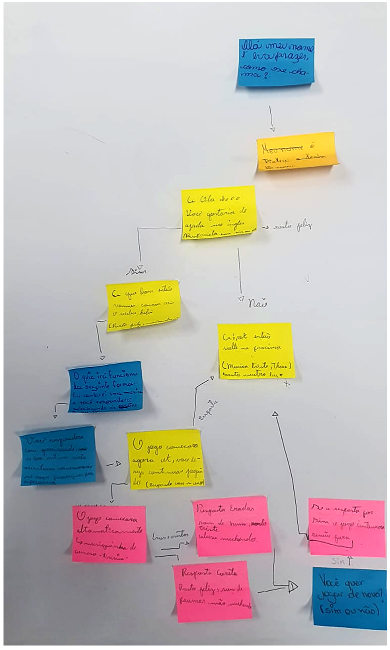

Figure 13. Dialogue storyboard developed during the in-person edition (paper-based flow).

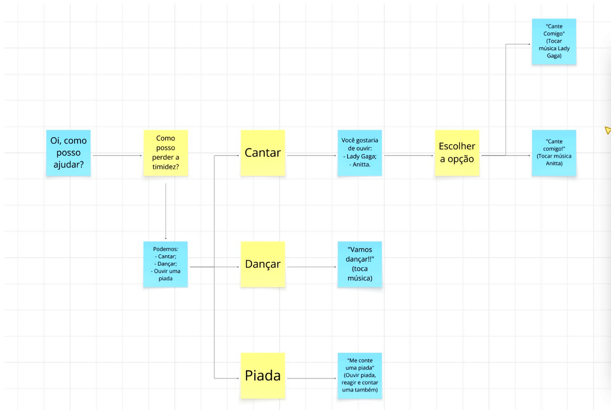

Figure 14. Dialogue flow represented in a digital diagram, adopted in the online (synchronous) edition.

Three teams participated in the 2024 edition—BIS, Galáxya, and E-nova—each composed of three students.

BIS BIS developed the persona "Brita," a 14-year-old Black girl with curly hair who attends the 9th grade of lower secondary education (Fig. 15). Her scenario combines long commuting distance, strict family rules, and recurrent bullying, which undermines emotional safety and makes help-seeking difficult. The goal defined for the persona is to build confidence and courage to report aggressions. The prototype responds by positioning EVA as an initial socioemotional support agent: the robot asks how the student is feeling, adapts the interaction based on the answer, and offers coping strategies through recommendations and positive encouragement (e.g., suggestions of music and films). The dialogue also incorporates expressive cues (emotions) and lighting as feedback throughout the conversation. *Prototype:* Fig. 16.

Galáxya Galáxya designed the persona "Pietra," a 15-year-old student transitioning from lower secondary to upper sec-

Figure 15. Brita (BIS).

```
<script>
  <!-- Interação do usuário com a EVA-->
  <listen />
  <evaEmotion emotion="HAPPY" />
  <talk>Olá, que bom que você veio.</talk>
  <wait duration="2000" />
  <motion left-arm="POSITION 0" right-arm="POSITION 3"/>
  <motion right-arm="DOWN"/>
  <wait duration="2000" />
  <evaEmotion emotion="NEUTRAL" />
  <talk>Como você está se sentindo? Escolha um dos QR Côudes.</talk>
  <!-- De acordo com a resposta da Brita,
  a Eva vai reagir com um rostinho de acordo com os
  sentimentos da Brita-->
  <qrRead var="sentimento"/>
  <switch var="sentimento">
    <case op="exact" value="alegria">
      <audio source="song-samba-loop" block="TRUE" />
      <talk>Que bom que você está feliz.</talk>
    </case>
    <default>
      <evaEmotion emotion="SAD" />
      <light state="ON" color="BLUE"/>
      <talk>Eu posso te ajudar com isso. Aqui estão algumas
            recomendações de filmes e músicas</talk>
      <random min="1" max="1" />
      <switch var="$">
        <case op="eq" value="1">
          <talk>Então escute just the whay you are</talk>
          <audio source="efx-crowdapplause1" block="TRUE" />
        </case>
      </switch>
    </default>
  </switch>
</script>
```

Figure 16. BIS prototype implemented in EvaML.

ondary education. Her scenario centers on difficulties in finding effective study methods, since traditional instruction fails to motivate her and her family, while supportive, lacks the academic knowledge and routines needed to assist. Pietra's goal is to adjust her learning process by using music to support concentration and memorization. The prototype operationalizes this goal through a micro-learning activity mediated by Eva, combining the study of English (e.g., the verb *to be*) with music as a strategy for focus and retention. During the interaction, the robot provides immediate performance feedback (correct/incorrect) and sustains engagement through multimodal stimuli, including audio and variations in emotional expression. *Prototype:* Fig. 17.

E-nova E-nova created the persona "Lucas," a 16-year-old student with special educational needs who attends a class marked by uneven learning levels (Fig. 18). The scenario highlights teachers' limited preparation to support him and the accelerated pace of lessons, which produces frustration and exclusion. The central goal is to foster his integration in the class and ensure appropriate pedagogical attention. The prototype takes the form of a revision tutor: EVA allows the learner to select a subject area (e.g., Chemistry or Physics), presents objective questions, and provides corrections and immediate feedback, combining positive reinforcement for correct answers with explicit error indication when necessary. The intended effect is to support content follow-up while reducing recurrent experiences of frustration. *Prototype:* Fig. 19.

Three teams also participated in 2025: Divas Altivas, Âmina, and Star sem Par.

```
<script>
  <evaEmotion emotion="HAPPY"/>
  <talk>Olá! Meu nome é Eva.</talk>
  <talk>Qual é o seu nome?</talk>
  <listen var="nome"/>
  <talk>#nome , você gostaria de ajuda para estudar Inglês?
        para aprender o verbo to be</talk>
  <listen />
  <switch var='$'>
    <case op='exact' value='sim'>
      <evaEmotion emotion="INLOVE" />
      <talk>"legal vamos la"</talk>
      <audio source="efx-mario-game-intro" block="TRUE"/>
      <talk> preste atenção na musica </talk>
      <audio source="Bruno Mars.wav" block="TRUE"/>
      <talk> indique com o cartao qual verbo to be está na musica </talk>
      <qrRead id="voltar"/>
      <switch var='$'>
        <case op='exact' value='are'>
          <evaEmotion emotion="HAPPY" />
          <talk>"parabéns!!! você acertou!"</talk>
          <audio source='efx-aplausos-bom' block="TRUE"/>
        </case>
        <default>
          <talk>
            você errou tente novamente
          </talk>
          <goto target="voltar" />
        </default>
      </switch>
  </case>
  <case op="exact" value="não">
      <evaEmotion emotion='SAD' />
      <talk>"ai que pena, até a próxima."</talk>
      <audio source="song-sad-violin" block="TRUE"/>
  </case>
  </switch>
</script>
```

Figure 17. Galáxya prototype implemented in EvaML.

Figure 18. Lucas (E-nova).

Divas Altivas Divas Altivas developed the persona "Carolina," a 15-year-old 9th-grade student described as brown-skinned, tall, and with curly hair. Her scenario foregrounds shyness and insecurity, which constrain social interaction and inhibit asking questions in class, especially in Portuguese Language. The stated goal is to overcome this communicative barrier and enter upper secondary education with greater confidence and autonomy. The prototype proposes playful interventions mediated by EVA to reduce communication blockages, such as invitations to sing and/or tell a joke. Participation is structured through successive choices, while engagement is reinforced through sound effects and lighting variations, culminating in a warm farewell. *Prototype:* Fig. 20.

Âmina Âmina proposed the persona "Maitê," a 16-year-old brown-skinned student in the 2nd year of upper secondary education. The scenario reflects post-pandemic demotivation and difficulties adapting to the state school system after completing lower secondary education in a private school, combined with perceived incapacity to succeed in the entrance examination for Biomedicine. The goal is to rekindle interest in studying through more dynamic methods and to support admission to university. In the prototype, EVA structures practice through questions and introduces a pedagogical decision point after errors (ending the attempt or repeating it). Correct answers trigger multimodal motivational reinforcement that combines praise, music, and bodily/lighting cues, followed by an encouraging closing message oriented toward persistence

```xml
<macros>
  <macro id="Apresentação">
    <talk>Olá, meu nome é Eva! O que voce deseja revisar?</talk>
    <talk>Química, física ou matemática</talk>
    <listen var = "resposta"/>
    <switch var = "resposta">
      <case op="contain" value="química">
        <talk>Como calculamos a densidade de uma substância</talk>
        <talk>opção A = MASSA SOBRE VOLUME</talk>
        <talk>opção B = VOLUME SOBRE MASSA</talk>
        <listen var = "respostaQuimica1" />
        <switch var = "respostaQuimica1">
          <case op="exact" value="a">th
            <evaEmotion emotion="HAPPY" />
            <talk>parabéns, você acertou</talk>
            <evaEmotion emotion="NEUTRAL" />
          </case>
          <case op="exact" value="b">
            <evaEmotion emotion="SAD" />
            <talk>Opa, você errou</talk>
            <evaEmotion emotion="NEUTRAL" />
          </case>
        </switch>
      </case>
    <case op="contain" value="física">
      <talk>qual é a primeira lei de newton?</talk>
      <talk>opção A = toda ação tem uma reação</talk>
      <talk>opção B = lei da inércia</talk>
      <listen var = "respostaFisica1" />
      <switch var = "respostaFisica1">
        <case op="exact" value="a">
          <evaEmotion emotion="SAD" />
          <talk>Opa, você errou!</talk>
          <evaEmotion emotion="NEUTRAL" />
        </case>
        <case op="exact" value="b">
          <evaEmotion emotion="HAPPY" />
          <talk>Parabéns, você acertou!</talk>
          <evaEmotion emotion="NEUTRAL" />
        </case>
```

Figure 19. E-nova prototype implemented in EvaML (excerpt).

and academic performance. *Prototype:* Fig. 21.

Star sem Par Star sem Par created the persona "Heloísa," a 16-year-old student in the 1st year of upper secondary education, described as brown-skinned with tightly curled hair. Her scenario is marked by social vulnerability, including distance between home and school, lack of adequate transportation, and limited family academic support, as her parents did not have access to formal schooling. The goal is to overcome shyness and difficulties in Mathematics in order to build a promising academic and professional trajectory. In the available prototype excerpt, EVA uses a sequence of lighting as feedback and as a dialogue-closing signal, ending with a brief message of support and farewell. This excerpt suggests an intention of ongoing encouragement, even though the full interaction flow is only partially represented in this version. *Prototype:* Fig. 22.

The EvaML´s codes indicate that teams were able to convert scenarios into structured conversational flows. Most solutions follow a question–answer–feedback logic supported by conditional decisions. Recurrent use of input mechanisms (e.g., `listen var="..."` and `qrRead`) and path selection via `switch`/`case` blocks suggests a functional understanding of interaction as a sequence of states and branches. Dialogue continuation is frequently adapted to user responses, distinguishing correctness/incorrectness or affective states, with explicit cues provided by `evaEmotion` (e.g., `HAPPY` for reinforcement and `SAD` to signal error or provide supportive responses). Multimodal resources also appear as strategies to sustain engagement and improve interaction legibility: lighting (`light state="ON" color="..."`), including sequences and animations such as `RAINBOW`; audio (music and effects such as applause); and movements (`motion`) are used as reinforcements, transitions, and closures. Personalization and didactic organization are also evident (e.g., the `#nome`

```xml
        <motion leftArm="SHAKE1"/>
        <motion rightArm="SHAKE2"/>
        <wait duration="8000" />
        <led animation="RAINBOW" />
      </case>
      <case op="exact" value="cantar">
        <talk>Vamos cantar juntos?</talk>
        <light state="ON" color="PINK"/>
        <audio source="song-happy" block="FALSE" />
        <evaEmotion emotion="SURPRISE" />
        <wait duration="6000" />
        <light state="OFF" />
        <evaEmotion emotion="HAPPY" />
      </case>
      <case op="exact" value="piada">
        <talk>vou contar uma piada</talk>
        <talk> Por que a velhinha não usa relógio? </talk>
        <audio source="efx-tic-toc" block="TRUE" />
        <talk>Porque ela é sem hora.</talk>
        <evaEmotion emotion="HAPPY" />
        <motion head="2YES"/>
        <audio source="efx-trombone-triste" block="TRUE" />
      </case>
    </switch>
    <!-- Esta parte foi adicionada na segunda versão. -->
    <talk>você deseja escolher mais um cartão?</talk>
    <listen var="Resposta"/>
    <switch var="Resposta">
      <case op="contain" value="Sim">
        <goto target="volta" />
      </case>
      <default>
        <talk>tudo bem!</talk>
      </default>
    </switch>
    <!-- A parte adicionada na segunda versão termina aqui. -->
    <talk>Espero que eu tenha te ajudado, #nome!</talk>
    <talk>até a próxima!</talk>
    <audio source="efx-aplausos-bom" block="FALSE" />
    <led animation="RAINBOW" />
  </script>
</evaml>
```

Figure 20. Divas Altivas prototype implemented in EvaML (excerpt).

marker and topic-based structuring), as are basic concerns with error tolerance when the flow offers remediation options (e.g., asking whether the user wishes to "end or repeat" and redirecting with `goto target="REPETE"`).

5.6 Analysis of Human–Computer Interaction Artifacts

The analysis began with the four intersectional factors proposed by Marques *et al.* [2026] as an *a priori* analytical framework: gender, race/ethnicity, socioeconomic condition, and territory. The personas and problem scenarios were initially examined according to these four factors, after which additional intersectional and contextual elements emerging from the artifacts were identified.

The analysis identified gender and race/ethnicity as the most recurrent *a priori* intersectional factors (Table 2). Socioeconomic condition appeared implicitly in only one scenario, whereas the territorial factor was not identified because all artifacts were produced during a local Hackathon involving participants from the same geographical region.

Beyond the markers previously described by Marques *et al.* [2026], the analysis revealed additional intersectional factors that were not included in the original framework. These factors are presented in Table 3.

In addition to the intersectional factors, the analysis also revealed contextual factors related to the educational trajectories of the personas. All teams explicitly identified the students' educational stage (e.g., 9th grade or upper secondary education), while two teams represented educational transition processes, particularly the transition from lower secondary to upper secondary education.

As shown in Table 3, the artifacts developed by the participants expanded the intersectional markers originally pro-

Table 2. A priori intersectional markers identified in the personas and scenarios.

Intersectional Marker	Frequency	Teams	Evidence
Gender	6	BIS, Galáxya, Divas Altivas, Âmina, Star sem Par, E-nova	girl; Brita; Pietra; Carolina; Maitê; Heloísa; Lucas
Race/Ethnicity	5	BIS, Divas Altivas, Âmina, Star sem Par, E-nova	Black girl; brown-skinned; curly hair
Socioeconomic Condition	1	Star sem Par	Parents without formal schooling
Territory	0	—	—

Table 3. Emerging intersectional factors identified in the personas and scenarios.

Emerging Intersectional Factor	Frequency	Teams	Evidence
Age	6	BIS, Galáxya, Divas Altivas, Âmina, Star sem Par, E-nova	14-, 15-, and 16-year-old students
Family Support for Learning	3	Galáxya, Star sem Par, BIS	Lack of academic support; strict family rules
Mobility and School Access	2	BIS, Star sem Par	Long commuting distance
Special Educational Needs (SEN)	1	E-nova	Student with SEN

posed by Marques *et al*. [2026]. Among the emerging factors, age, family support for learning, mobility and school access, and Special Educational Needs (SEN) stood out, indicating that the experiences represented by the participants extend beyond the dimensions currently discussed in the RENACEE_MD literature. Likewise, contextual aspects related to the educational trajectory, such as school stage and educational transitions, contributed to characterizing the scenarios and understanding the challenges faced by the personas. The SEN factor emerged exclusively in the scenario developed by Team E-nova and, because it was associated with the only male persona, it should be interpreted as a specific characteristic of that scenario. Therefore, it is not possible to establish relationships with the remaining intersectional markers based on the present corpus, especially considering that the original analytical framework focuses primarily on female students.

The scenarios also revealed a set of educational and psychosocial barriers that, although not constituting intersectional factors themselves, represent recurrent challenges experienced by the students. These included bullying, shyness, insecurity, lack of emotional safety, low motivation toward traditional teaching and the post-pandemic context, and limited teacher preparedness to address diversity. The prototype analysis showed that these barriers directly guided the HCI solutions developed by the teams, as summarized in Table 4.

As summarized in Table 4, the teams addressed the identified barriers through three main approaches: socio-emotional support, interactive learning, and content review. Although some solutions shared common HCI mechanisms, such as age-appropriate language, structured dialogues, quizzes, and immediate feedback, they were designed for different purposes and complemented by distinct interaction resources, including robot emotions, music, lighting, sound effects, and positive reinforcement. These findings demonstrate that the participants were able to translate educational and psychosocial barriers into concrete HCI mechanisms implemented in EvaML.

5.7 Response to the Research Question

The objective of this study was to examine how Hackathon 360 constitutes a situated formative Computing experience for girls. The findings indicate that this experience is constituted through five interconnected dimensions.

First, (i) the recurrence in the Second Edition of the seven experiential categories identified in the First Edition, perception of work utility and social impact, self-efficacy and confidence, appropriation in activities, satisfaction in task completion, overcoming challenges, sense of belonging, and collaborative work, shows that participants experienced the Hackathon as meaningful, collaborative, and socially relevant. Second, (ii) the intersectional characterization situates this experience within the trajectories of girls marked by limited prior technical experience, restricted access to conventional computing devices, and intersecting socioeconomic and racial conditions, for whom the Hackathon provided access to Computing practices and environments. Third, (iii) the pedagogical redesign of the Second Edition was informed by systematic listening to participants' interests, experiences, and feedback, enabling the initiative to respond to needs identified in the First Edition and provide greater space for hands-on programming activities. Fourth, (iv) the CTScale characterized the self-perceived Computational Thinking dispositions with which participants entered the Hackathon, while the collaborative design and programming activities presented demands and opportunities related to creativity, cooperativity, critical thinking, and problem solving. These relationships concern the demands and affordances of the activities. Finally, (v) the HCI artifacts show how participants translated socially situated experiences into design decisions by representing identities, experiences, and barriers in personas and scenarios and transforming them into interaction flows and EvaML

Table 4. Translation of educational and psychosocial barriers into HCI solutions.

Barrier	Prototype Purpose	HCI Strategies
Bullying, shyness, insecurity, and lack of emotional safety	Socio-emotional support	Age-appropriate language; branching dialogue; socio-emotional support; robot emotions; music; lighting; sound effects
Low motivation for learning	Interactive learning with motivational support	Age-appropriate language; quizzes; immediate feedback; multimodal interaction; motivational feedback; music; lighting
Limited teacher preparedness to address diversity	Content review with immediate feedback	Age-appropriate language; content selection; quizzes; immediate feedback; positive reinforcement

```xml
      </case>
    <case op="contain" value="3">
      <evaEmotion emotion="SAD" />
      <talk>Você errou, deseja encerrar ou repetir?</talk>
      <motion type="2NO"/>
      <listen var="repouence"/>
      <switch var="repouence">
        <case op="contain" value="repetir">
          <talk>vamos lá</talk>
          <goto target="REPETE" />
        </case>
        <case op="contain" value="encerrar">
          <talk>vamos para a proxima pergunta!</talk>
        </case>
    </switch>
    </case>
    <case op="contain" value="4">
      <evaEmotion emotion="HAPPY" />
      <talk>Você acertou, Parabéns!</talk>
      <audio source="song-beyonce" block="FALSE" />
    <motion type="2YES"/>
    <motion leftArm="SHAKE2" rightArm="SHAKE2"/>
    <motion type="2YES"/>
    <motion leftArm="SHAKE2" rightArm="SHAKE2"/>
      <light state="ON" color="GREEN"></light>
      <wait duration="1000" ></wait>
      <light state="ON" color="PINK"></light>
      <wait duration="1000" ></wait>
    </case>
    <default>
      <talk>resposta inválida</talk>
      <goto target="REPETE" />
    </default>
      </switch>
    </case>
    <default>
      <talk>resposta inválida</talk>
      <goto target="VOLTAR" />
    </default>
  </switch>
  <talk>Foi um prazer estudar com você, boa prova!</talk>
  <stop />
  </script>
</evaml>
```

Figure 21. Âmina prototype implemented in EvaML (excerpt).

prototypes. Together, these dimensions show that Hackathon 360 constitutes a situated formative Computing experience grounded in access, meaningful participation, pedagogical responsiveness, collaboration, representation, and technical authorship.

6 Discussion

This section interprets the findings through a twofold discussion. It first situates Hackathon 360 within the theoretical framework established in Section 2 and then positions its contributions in relation to the related work reviewed in Section 3.

6.1 Discussion with the Literature

The results presented here engage with the gaps identified in the theoretical foundations articulated in Section 2 and directly operationalize the issues outlined in the introduction. The study addresses a diagnosis recognized in both international and national contexts: although Computing inclusion initiatives often mobilize "gender" as an explanatory category,

```xml
              <wait duration="1000" />
              <light state="ON" color="RED"/>
              <wait duration="1000" />
              <light state="ON" color="BLUE"/>
              <wait duration="1000" />
              <light state="ON" color="PINK"/>
              <wait duration="1000" />
              <light state="ON" color="YELLOW"/>
              <wait duration="1000" />
              <talk>Espero que tenha gostado. Até breve.</talk>
              <stop />
            </case>
          </switch>
        </case>
      </switch>
      <talk>Espero ter ajudado. Até breve.</talk>
      <evaEmotion emotion="INLOVE" />
      <goto target="voltar" />
    </script>
</evaml>
```

Figure 22. Star sem Par prototype implemented in EvaML (excerpt).

many still rely on binary framings [Szlavi *et al.*, 2023; Amaral and Oliveira, 2024] and remain insufficiently sensitive to structural overlaps. This limits their capacity to explain and, more importantly, to mitigate persistent inequalities, as noted by Rodrigues *et al.* [2025]. Within this scenario, the article confronts this gap by presenting an intersectional characterization of the 2025 participants as concrete evidence of intersectional barriers, grounded in the foundational framework of Crenshaw [2015]. This approach aligns with scholarship that conceptualizes learning and identity in Computing as phenomena shaped by expectations, belonging, and sociotechnical stereotypes [Ashcraft *et al.*, 2017], which makes it inadequate to reduce inequality to a single marker.

Consistent with RENACEE_MD's mission [Programa Meninas Digitais, 2025], the hackathon reaches the national network's target population, girls who are predominantly Black/brown, low-income, and enrolled in public schools. This materializes the introduction's claim about the need for initiatives that articulate education, outreach, and social engagement to confront structural barriers.

The 2025 pedagogical refinements, a more compact schedule, curricular alignment with team projects, a U-shaped spatial reconfiguration, linguistic adaptation for a non-technical audience, and synchronous hybrid delivery, respond concretely to the *Grand Challenges of Computing Education in Brazil 2025–2035* [Sociedade Brasileira de Computação, 2025], which call for contextualized pedagogical materials and adapted strategies. At the same time, the redesign advances the integration of technical and socioemotional competencies. The shift from generic training instructions to project-specific guidance reduced cognitive load [Sweller, 1988] and strengthened content appropriation, in line with the principles of the BNCC Computing Supplement [Brasil, 2022] for fostering CT transversally through meaningful practice.

The format of Hackathon 360 was also informed by research on women's participation in hackathons. While preserving collaborative problem solving, teamwork, mentorship, and project presentation, the event placed less emphasis on competition among teams, following recommendations that more collaborative, safe, and welcoming structures can reduce barriers associated with gender stereotypes [Kovaleva *et al.*, 2022]. It also emphasized flexible, collaborative, and lower-pressure participation, consistent with evidence concerning the preferences of women [Kos, 2019]. Finally, the all-girl environment and the emphasis on shared learning, mentorship, affinity, and community building align with findings from female-focused hackathons, particularly regarding first-time participants [Tisha *et al.*, 2026].

Applied as a pre-Hackathon baseline, the CTScale suggests a counterpoint to deficit narratives about girls from marginalized contexts, offering empirical support for Korkmaz *et al.* [2017] in conceptualizing CT as a sociocognitive constellation rather than a set of isolated procedural pillars. Creativity, cooperativity, and critical thinking, consistently high across both editions, including among participants who self-declared "low/none" programming knowledge, indicate pre-existing potential that is systematically neglected in traditional curricula [Doleck *et al.*, 2017].

The HCI artifacts make two additional points explicit. First, personas and problem scenarios were structured from the girls' situated knowledge of their own realities, consistent with HCI scholarship that understands these artifacts as devices for externalizing users' needs, values, and constraints. Thus, the personas (83% girls, with recurrent Black/brown representations and natural hair textures) and the scenarios (bullying, academic difficulties, socioemotional vulnerability, and educational gaps within the family context) directly operationalize Cooper's [2004] perspective on user-centered design decisions and Nielsen's [2013] understanding of personas as user-focused design artifacts through intersectionally grounded empathy. Second, these artifacts make visible the decolonial imperative of GC3 [Oliveira *et al.*, 2024]: rather than importing HCI methods uncritically, participants adapted personas and prototypes to their lived realities, evidencing plurality in design practices.

Taken together, these findings show that Hackathon 360 translates the theoretical commitments discussed in Section 2 into a situated intervention that combines intersectional attention, a more collaborative and less competitive format, pedagogical adaptation, and the production of HCI artifacts grounded in participants' realities.

6.2 Discussion with Related Work

The results of Hackathon 360 complement and extend the related work presented in Section 3. This study contributes an empirical exploration that engages with prior mappings and advances them through the production of primary evidence, combining qualitative and quantitative elements.

Building on the contributions of Desidério *et al.* [2024], we begin from the premise that socioemotional competencies associated with HCI, identified in the authors' qualitative mapping, can be empirically observed throughout the development of our intervention. In Hackathon 360, *empathy* becomes visible in the construction of Personas, Scenarios, and Prototypes, since these artifacts require eliciting users' needs and expectations and translating lived experiences into concrete design decisions [Cooper, 2004; Rosson and Carroll, 2002; Nielsen, 2013]. *Communication* is particularly evident during the *pitch* stage, when teams publicly articulate the problem, the proposed solution, and their rationale. *Creativity* can be observed both in the proposal of solutions and interaction flows and in dimensions of CT. *Collaboration* appears as a recurring experiential category across both editions and aligns with the literature on active and collaborative learning arrangements [Prince, 2004; Porter *et al.*, 2016]. Additionally, the findings reaffirm Hackathon 360's and RENACEE_MD's commitment to the SBC agenda of equity in Computing, insofar as the Hackathon is grounded in real-world challenges, welcomes participants with limited technological familiarity, and structures the experience to reduce entry barriers, consistent with the definition emphasized in the review by Desidério *et al.* [2024].

In dialogue with Amaral and Oliveira [2024], the present study adopts the term *intersectionality* explicitly and mobilizes it as an organizing principle for analysis and action, rather than treating it as an implicit descriptor. This operationalization is expressed, first, in the detailed characterization of participants through articulated social markers, shifting the analysis toward the material conditions of participation. Second, it appears in the symbolic and representational dimension of the HCI artifacts themselves, as when personas explicitly encode racial markers (e.g., curly/coily hair), reinforcing that the modeled "user" is not generic but situated. By foregrounding the term and its analytical use, the study contributes to reducing the traceability gap identified by Amaral and Oliveira [2024] in indexing and search processes, while aligning with calls for plurality and decolonial orientations in HCI and Computing education. Moreover, by articulating more than two intersectional markers—including gender, race/ethnicity, socioeconomic condition, and territory—the study responds to the limitation identified by Szlavi *et al.* [2023], who observed that most studies examine only two intersecting dimensions and called for analyses encompassing multiple factors and broader sociocultural contexts.

The methodological refinement observed between editions parallels the restructuring cycle reported by Menezes *et al.* [2025] in the *Escola de Games* project, insofar as both works indicate that participant feedback and internal evaluation can guide iterative modifications that sustain engagement and satisfaction. This convergence reinforces the value of an evidence-informed and iterative approach to intervention design and delivery [Menezes *et al.*, 2025].

The comparatively lower results for self-efficacy and confidence are also consistent with previous findings that girls may report less favorable perceptions of their own abilities, even when external recognition is positive [Allaire-Duquette *et al.*, 2022; Benavent *et al.*, 2020].

Regarding the measurement of Computational Thinking (CT), this study represents an exploratory application of the CTScale [Korkmaz *et al.*, 2017; Ferreira *et al.*, 2023], with girls enrolled in public Basic Education and with limited prior programming experience. The observed patterns differ from profiles reported in other studies: while problem-solving ranks among the comparatively less valued dimensions in samples of university and high school students [Ferreira *et al.*, 2023; Korkmaz and Bai, 2019], in Hackathon 360 it appears at an intermediate-to-high level, showing greater heterogeneity in 2025. Creativity, cooperativeness, and critical thinking, in turn, show consistently high levels, just as observed among high school students by Korkmaz and Bai [2019].

Taken together, and in relation to the broader set of related studies, Hackathon 360 stands out for four main contributions: (i) providing empirical grounding for theoretical mappings through primary data [Desidério *et al.*, 2024; Amaral and Oliveira, 2024; Szlavi *et al.*, 2023]; (ii) showing how HCI-related socioemotional competencies are expressed in a Social Robotics context [Preece *et al.*, 1994; Nielsen, 1994; Rogers *et al.*, 2013]; (iii) operationalizing intersectionality through participant characterization and artifact production [Amaral and Oliveira, 2024]; and (iv) extending the exploratory use of the CTScale to basic education in a context of structural vulnerability [Ferreira *et al.*, 2023].

7 Limitations

This study should be interpreted in light of methodological limitations. First, the relatively small sample size and the resulting small subgroup sizes constrain statistical generalization. Consequently, the findings should be interpreted as exploratory evidence obtained within the investigated context rather than as broadly generalizable conclusions.

A second limitation concerns the pronounced ceiling effect observed in the post-Hackathon questionnaires. Several items in both editions presented medians at or near the upper bound of the scale, leaving limited room for higher evaluations in the Second Edition and reducing the sensitivity of the comparisons to detect subtle differences. To examine the response patterns more carefully, the study combined mean and standard deviation with median and interquartile range and applied the Mann–Whitney U test to compare the rank distributions across editions. This procedure was used exploratorily to identify possible distributional nuances that might not be apparent from a single descriptive measure, rather than to provide confirmatory evidence of effects produced by the pedagogical redesign. Given the small samples, the concentration of responses at the upper end of the scale, and the absence of statistically significant differences, the results should be interpreted primarily as descriptive indications of stability and heterogeneity across editions, rather than as evidence of improvement attributable to the intervention.

A related limitation concerns the combined effect of the relatively small samples and the pronounced ceiling effect observed in several CTScale domains. Across both Hackathon editions, participants' responses were strongly concentrated in the highest response categories ("Usually" and "Always"), resulting in restricted score variability. Under these conditions, the inferential value of statistical comparisons becomes inherently limited because both the reduced number of observations and the restricted variability decrease the analyses' ability to detect differences between cohorts. Consequently, the CTScale comparisons should be interpreted primarily as descriptions of the baseline response distributions rather than as strong inferential evidence regarding the magnitude of differences between the two cohorts.

A further limitation concerns the exclusion of the Algorithmic Thinking subscale from the CTScale analyses. This decision was methodologically justified because the instrument was administered before any formal programming instruction, and participants consistently reported having little or no prior programming experience. Under these conditions, responses to algorithmic thinking items would likely reflect unfamiliarity with programming concepts rather than meaningful differences in Computational Thinking. Nevertheless, excluding one of the five original CTScale domains reduces direct comparability with studies reporting the complete instrument and limits the interpretation of the present findings to the four retained dimensions.

Another limitation concerns the exclusive use of the CTScale as a baseline measure. Because the instrument was administered only before the Hackathon, the study cannot directly assess individual changes in Computational Thinking attributable to the intervention. Consequently, the CTScale findings should be interpreted as characterizing participants' initial profiles rather than as evidence of learning gains.

An additional limitation relates to the implementation of the Second Edition. Although most participants (12 out of 16) attended the practical programming training, a portion of students (25%) evaluated the Hackathon without directly experiencing the main pedagogical activity of the Second Edition. In small samples, this heterogeneity is sufficient to influence response distributions, especially for items related to language ease, meeting expectations, and hands-on learning. This characteristic contributes to the observed variability and to shifts in the distributions, as indicated by the descriptive statistics and nonparametric analyses.

Even within these methodological constraints, the integration of quantitative and qualitative evidence supports a coherent and contextually grounded understanding of Hackathon 360 as a situated formative Computing experience.

8 Conclusion and Future Work

This study examined how Hackathon 360 constitutes a situated formative Computing experience for girls across two consecutive editions involving distinct cohorts. By integrating participants' perceptions, intersectional conditions, pedagogical adaptations, baseline Computational Thinking dispositions, and the HCI artifacts produced during the activities, the study shows that the formative character of the initiative emerges from the articulation of access, meaningful participation, collaboration, representation, and technical authorship.

Overall, Hackathon 360 constituted a situated formative Computing experience by enabling girls from socially vulnerable contexts to engage with Computing practices in a collaborative, less competitive, and socially meaningful environment. The participants not only took part in design and programming activities but also incorporated identities, barriers, and experiences from their own realities into personas, scenarios, interaction flows, and EvaML prototypes. At the same time, the pedagogical redesign responded to needs identified in the previous edition, while the CTScale characterized the dispositions participants brought to the experience rather than changes attributable to the intervention. The central contribution therefore lies in showing how an outreach initiative can connect access to Computing with belonging, responsive pedagogy, situated representation, and the production of technical artifacts.

Situated within the context of the "grand challenges" of Computing Education and HCI, particularly the expansion of equitable access, the promotion of meaningful participation for historically underrepresented groups, and the development of inclusive and context-sensitive interactive systems, this work positions Social Robotics–mediated projects, grounded in HCI techniques, as a pragmatic pathway to reduce structural barriers and foster situated technical authorship among girls in socially vulnerable contexts.

Future work should scale the study to a multi-site format within RENACEE_MD, with a substantially larger N and a structured comparison between in-person and synchronous hybrid formats in order to test robustness, implementation requirements, and costs. A pre–post CTScale design coupled with longitudinal follow-up is also recommended to examine changes and trajectories of interest and persistence.

Declarations

Acknowledgements

Special thanks are due to the project team whose efforts made this work possible, and to the MídiaCOM Laboratory and the Include Meninas extension project, both at Universidade Federal Fluminense (UFF), for their institutional support. We also gratefully acknowledge RENACEE_MD for their partnership and collaboration.

Funding

This study was partially funded by the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior – Brasil (CAPES; Brazilian Federal Agency for Support and Evaluation of Graduate Education), funding code 001, which previously supported the first author through a doctoral scholarship. The Include Meninas extension project and its scholarship recipients were funded by the Fundação de Amparo à Pesquisa do Estado do Rio de Janeiro (FAPERJ; Research Support Foundation of the State of Rio de Janeiro), which currently supports the first author through a doctoral scholarship. The RENACEE_MD network and its scholarship recipients received support from the Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq; Brazilian National Council for Scientific and Technological Development). In addition, one of the doctoral students involved in this work receives a scholarship from Google Research. We also thank the Financiadora de Estudos e Projetos (FINEP; Brazilian Innovation Agency) for providing funding for the research.

Authors' Contributions

Tainá: Conceptualization; Methodology; Formal analysis; Data curation; Investigation; Visualization; Project administration; Writing – original draft; Writing – review & editing. Estéfani: Investigation; Data curation (repository upload); Writing – original draft (HCI theoretical background, related work, and artifacts). Sandy; Isabel: Formal analysis (CT); Investigation; Writing – original draft (CT theoretical background, related work, and analysis). Anna: Conceptualization (intersectionality framing); Writing – original draft (intersectionality theoretical background and analysis). Elaine: Methodology; Formal analysis (Hackathon comparison and results); Investigation; Writing – original draft; Writing – review & editing. Marcelo: Visualization (figure integration); Investigation; Writing – review & editing (English translation). Debora; Aline: Writing – review & editing. Luciana: Supervision; Investigation; Writing – review & editing. All authors read and approved the final manuscript.

Competing interests

The authors declare that they have no competing interests.

Availability of data and materials

The repository includes research instruments (questionnaires), presentation materials and templates of ethical documents (informed consent, assent forms for minors, and institutional authorization). These materials can be accessed at: `https://github.com/estefanieeller/Hackathon_2025/tree/main`.

Further relevant information

The study followed the guidelines of the Research Ethics Committee of the Fluminense Federal University. All participants (and/or their legal guardians, when applicable) provided Free and Informed Consent prior to the start of the activities. During manuscript preparation, the paid version of ChatGPT and Grammarly were used to improve spelling and grammar, enhance textual clarity, and remove redundancies, without altering the meaning of the content. Additionally, Google Translate was used to translate repository materials into English.

Citation Diversity Statement: We worked to ensure ethnic or other types of diversity in the recruitment of human subjects. We worked to ensure that the study questionnaires were prepared in an inclusive way. One or more of the authors of this paper self-identifies as an underrepresented ethnic minority in their field of research or within their geographical location. One or more of the authors of this paper self-identifies as a gender minority in their field of research. One or more of the authors of this paper received support from a program designed to increase minority representation in their field of research. While citing references scientifically relevant for this work, we also actively worked to promote gender balance in our reference list. To promote awareness of citation bias, we adopted the Citation Diversity Statement proposed in Zurn *et al.* [2020].

References

Allaire-Duquette, G., Chastenay, P., Bouffard, T., Bélanger, S. A., Hernandez, O., Mahhou, M. A., Giroux, P., McMullin, S., and Desjarlais, E. (2022). Gender differences in self-efficacy for programming narrowed after a 2-h science museum workshop. *Canadian Journal of Science, Mathematics and Technology Education*, 22(1):87–100. DOI: https://doi.org/10.1007/s42330-022-00193-7.

Altermatt, B. (2007). Reliability analysis. `https://psych.hanover.edu/classes/ResearchMethods/Readings/Reliability_Analysis.pdf`, Accessed on 20 August 2026.

Amaral, M. and Oliveira, L. (2024). Como abordamos a interseccionalidade na computação? busca por valores interseccionais em uma revisão sistemática de literatura na base sol. In *Anais do XVIII Women in Information Technology*, pages 183–194, Porto Alegre, RS, Brasil. SBC. DOI: https://doi.org/10.5753/wit.2024.2605.

Ashcraft, C., Eger, E. K., and Scott, K. A. (2017). Becoming technosocial change agents: Intersectionality and culturally responsive pedagogies as vital resources for increasing girls' participation in computing. *Anthropology & Education Quarterly*, 48(3):233–251. DOI: https://doi.org/10.1111/aeq.12197.

Benavent, X., de Ves, E., Forte, A., Botella-Mascarell, C., López-Iñesta, E., Rueda, S., Roger, S., Perez, J., Portalés, C., Dura, E., Garcia-Costa, D., and Marzal, P. (2020). Girls4STEM: Gender diversity in STEM for a sustainable future. *Sustainability*, 12(15):1–17. DOI: https://doi.org/10.3390/su12156051.

Brasil (2018). Base nacional comum curricular: Educação é a base. https://basenacionalcomum.mec.gov.br/abase, Accessed on 20 August 2026.

Brasil (2022). BNCC Computação – Complemento. https://www.gov.br/mec/pt-br/escolas-conectadas/BNCCComputaoCompletodiagramado.pdf, Accessed on 20 August 2026.

Briscoe, G. (2014). Digital innovation: The hackathon phenomenon. https://api.semanticscholar.org/CorpusID:31734217, Accessed on 20 August 2026.

Brown, T. (2008). Design thinking. *Harvard Business Review*, 86(6):84–92. `https://www.researchgate.net/publication/5248069_Design_Thinking`, Accessed on 20 August 2026.

Cooper, A. (2004). *The Inmates Are Running the Asylum: Why High-Tech Products Drive Us Crazy and How to Restore the Sanity*. Pearson Higher Education, 2 edition.

Cowan, K. (2013). Hack the barbican: A playground of arts, technology and entrepreneurship. `https://www.creativeboom.com/news/hack-the-barbican-a-playground-of-arts-technology-and-entrepreneurship/`, Accessed on 20 August 2026.

Crenshaw, K. W. (2015). Why intersectionality can't wait. `https://www.washingtonpost.com/news/in-theory/wp/2015/09/24/why-intersectionality-cant-wait/`, Accessed on 20 Aug 2026.

Desidério, S. B., Lelis, M. R. L., Rodrigues, M. E., and Marques, A. B. (2024). How ready for hci? a qualitative analysis of the practice of soft skills related to hci by women involved in the digital girls program partners projects. *Journal on Interactive Systems*, 15(1):504–516. DOI: https://doi.org/10.5753/jis.2024.3852.

Doleck, T., Bazelais, P., Lemay, D. J., Saxena, A., and Basnet, R. B. (2017). Algorithmic thinking, cooperativity, creativity, critical thinking, and problem solving: Exploring the relationship between computational thinking skills and academic performance. *Journal of Computers in Education*, 4(4):355–369. DOI: https://doi.org/10.1007/s40692-017-0090-9.

Ferreira, S., Álekiss Mélo, Oliveira, A., and Andrade, W. (2023). Processo de tradução de instrumento diagnóstico de pensamento computacional para graduandos. In *Anais do XXXIV Simpósio Brasileiro de Informática na Educação*, pages 58–68, Porto Alegre, RS, Brasil. SBC. DOI: https://doi.org/10.5753/sbie.2023.234441.

Kolb, D. A. (1984). *Experiential Learning: Experience as the Source of Learning and Development*. Prentice Hall, Englewood Cliffs, NJ.

Korkmaz, Ö. and Bai, X. (2019). Adapting computational thinking scale (cts) for chinese high school students and their thinking scale skills level. *Participatory Educational Research*, 6(1):10–26. DOI: https://doi.org/10.17275/per.19.2.6.1.

Korkmaz, Ö., Çakir, R., and Özden, M. Y. (2017). A validity and reliability study of the computational thinking scales (cts). *Computers in Human Behavior*, 72:558–569. DOI: https://doi.org/10.1016/j.chb.2017.01.005.

Kos, B. A. (2019). Understanding female-focused hackathon participants' collaboration styles and event goals. In *Proceedings of the International Conference on Game Jams, Hackathons and Game Creation Events 2019*, pages 1–4. DOI: https://doi.org/10.1145/3316287.3316292.

Kovaleva, Y., Happonen, A., and Mbogho, A. (2022). Towards gender balance in modern hackathons: Literature-based approaches for female inclusiveness. In *Proceedings of the 2022 IEEE/ACM 3rd International Workshop on Gender Equality, Diversity and Inclusion in Software Engineering (GEICSE)*, pages 37–44. IEEE. DOI: https://doi.org/10.1145/3524501.3527594.

Marques, A. B., Salgado, L., Moro, M., and Araújo, A. (2026). Intersectional gender dynamics in junior scientific research in computing: Race, income, and territorial dimensions among brazilian girls. In *Anais do VI Simpósio Brasileiro de Educação em Computação (EduComp)*, pages 138–152. Sociedade Brasileira de Computação (SBC). DOI: https://doi.org/10.5753/educomp.2026.18227.

Menezes, M., Genesio, N., Castro, A., Silva, J., Silva, L., Campos, J., and Valle, P. (2025). Como ensinar lógica de programação por meio do desenvolvimento de jogos digitais? In *Anais do V Simpósio Brasileiro de Educação em Computação*, pages 479–490, Porto Alegre, RS, Brasil. SBC. DOI: https://doi.org/10.5753/educomp.2025.5352.

Moreira Oliveira, C. and Pereira, R. (2023). Pense computacionalmente: Uma abordagem para apoiar o exercício do pensamento computacional.

Nielsen, J. (1994). *Usability Engineering*. Morgan Kaufmann, San Francisco.

Nielsen, L. (2013). *Personas-user focused design*, volume 15. Springer.

Oliveira, L. C. d., Amaral, M. A., Bim, S. A., Valença, G., Almeida, L. D. A., Salgado, L. C. d. C., Gasparini, I., and Silva, C. B. R. d. (2024). Grandihc-br 2025–2035 - gc3: Plurality and decoloniality in HCI. In *Proceedings of the XXIII Brazilian Symposium on Human Factors in Computing Systems (IHC 2024)*, pages 1–19, New York, NY, USA. Association for Computing Machinery. DOI: https://doi.org/10.1145/3702038.3702056.

Porter, L., Bailey Lee, C., Simon, B., Cutts, Q., and Zingaro, D. (2016). A multi-institutional study of peer instruction in introductory computing courses. *ACM Transactions on Computing Education*, 16(4):358–363. DOI: https://doi.org/10.1145/2938142.

Preece, J., Rogers, Y., Sharp, H., Benyon, D., Holland, S., and Carey, T. (1994). *Human-Computer Interaction: Concepts and Design*. Addison-Wesley.

Prince, M. (2004). Does active learning work? a review of the research. *Journal of engineering education*, 93(3):223–231. DOI: https://doi.org/10.1002/j.2168-9830.2004.tb00809.x.

Programa Meninas Digitais (2025). RENACEE_MD – Rede Nacional de Educação e Extensão Meninas Digitais. https://meninas.sbc.org.br/renacee_md/, Accessed on 20 August 2026.

Rankin, Y. A. and Thomas, J. O. (2020). The intersectional experiences of black women in computing. In *Proceedings of the 51st ACM technical symposium* *on computer science education*, pages 199–205. DOI: https://doi.org/10.1145/3328778.3366873.

Rocha, M. M. d., Favela, J., and Muchaluat-Saade, D. C. (2025). Design and evaluation of an xml-based language for programming socially assistive robots. *International Journal of Social Robotics*, pages 1–29. DOI: https://doi.org/10.1007/s12369-025-01254-1.

Rodrigues, K., Duarte, R. S., do Nascimento, Á. L. F. F., and César, R. L. V. (2025). Interseccionalidade e tecnologia: Um mapeamento sistemático de publicações em português sobre gênero, raça e classe na participação feminina. In *Women in Information Technology (WIT)*, pages 24–34. SBC. DOI: https://doi.org/10.5753/wit.2025.8067.

Rogers, Y., Sharp, H., and Preece, J. (2013). *Design de Interação: Além da Interação Humano-Computador*. Bookman, Porto Alegre.

Rosson, M. B. and Carroll, J. M. (2002). *Usability Engineering: Scenario-Based Development of Human-Computer Interaction*. Morgan Kaufmann, San Francisco, CA.

Sociedade Brasileira de Computação (2025). *Grandes Desafios da Educação em Computação no Brasil 2025–2035*. Sociedade Brasileira de Computação, Porto Alegre.

Souza, T., Flores, M., Monteiro, N., Eller, E., Cabral, S., Lima, A., Nascimento, A., Muchaluat-Saade, D., and Salgado, L. (2025). Hackathon 360: Estimulando meninas na computação em projetos de robótica social para educação. In *Anais do XIX Women in Information Technology*, pages 139–150, Porto Alegre, RS, Brasil. SBC. DOI: https://doi.org/10.5753/wit.2025.8584.

Sweller, J. (1988). Cognitive load during problem solving: effects on learning. *Cognitive Science*, 12(2):257–285. DOI: https://doi.org/10.1207/s15516709cog1202_4.

Szlavi, A., Hansen, M. F., Husnes, S. H., and Conte, T. U. (2023). Intersectionality in computer science: A systematic literature review. In *2023 IEEE/ACM 4th Workshop on Gender Equity, Diversity, and Inclusion in Software Engineering (GEICSE)*, pages 9–16. IEEE. DOI: https://doi.org/10.1109/GEICSE59319.2023.00006.

Tisha, S. N., Sakib, M. N., and Dey, S. (2026). Competing or collaborating? the role of hackathon formats in shaping team dynamics and project choices. In *Proceedings of the 57th ACM Technical Symposium on Computer Science Education V. 1*, pages 1061–1067. DOI: https://doi.org/10.1145/3770762.3772660.

Universidade Federal Fluminense (UFF), Pró-Reitoria de Extensão (2016). include meninas.uff. https://sites.google.com/view/include-meninas-uff, Accessed on 20 August 2026.

Valença, G. and Santos, R. (2022). Como organizar hackathons inclusivas? In *Simpósio Brasileiro sobre Fatores Humanos em Sistemas Computacionais (IHC)*, pages 1–2. SBC. DOI: https://doi.org/10.5753/ihc_estendido.2022.226574.

Zurn, P., Bassett, D. S., and Rust, N. C. (2020). The citation diversity statement: a practice of transparency, a way of life. *Trends in Cognitive Sciences*, 24(9):669–672. DOI: https://doi.org/10.1016/j.tics.2020.06.009.