WOMEN'S EMPOWERMENT IN COMPUTING: PROMOTING LEADERSHIP THROUGH EDUCATIONAL ROBOTICS

EMPODERAMENTO FEMININO NA COMPUTAÇÃO: PROMOVER O PROTAGONISMO POR MEIO DA ROBÓTICA EDUCACIONAL

EMPODERAMIENTO DE LAS MUJERES EN LA INFORMÁTICA: PROMOVIENDO EL LIDERAZGO A TRAVÉS DE LA ROBÓTICA EDUCATIVA

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ABSTRACT

The underrepresentation of women in Science, Technology, Engineering, and Mathematics (STEM) and computer science is a sociological challenge that demands incentive strategies from basic education onwards. This article presents the extension project "Robotic Girls: Creative Learning to Attract Girls to Robotics at IFRO". The project arose from the observation that 57.1% of students in the Technical Course in Informatics Concurrent with High School (CTICEM) did not identify with the field of computing, citing as obstacles a lack of confidence in their own abilities, limited access to resources, and financial challenges. The methodology adopted is based on Creative Learning and Problem-Based Learning (PBL), using Educational Robotics (ER) as a tool to connect theory and practice. The activities involved the use of block programming (Scratch), Lego Mindstorms EV3 kits, as well as support via a Virtual Learning Environment (VLE) and YouTube tutorials. The results demonstrate that the initiative promoted a significant increase in engagement: the number of participants rose from a low initial participation to the formation of all-girls teams for the Brazilian Robotics Olympiad (OBR). Beyond technical performance in competitions, the project stimulated female leadership, transforming students into knowledge multipliers through community workshops and visits to public schools. It is concluded that the RE (Research and Education), supported by mentoring programs and a collaborative environment, is an effective means to overcome gender barriers, strengthen self-confidence, and promote the empowerment of women in technology.

Keywords: Educational Robotics. Female Empowerment. Creative Learning. Gender Equality.

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RESUMO
A sub-representação feminina nas áreas de *Science, Technology, Engineering, and Mathematics* (STEM) e na computação é um desafio sociológico que demanda estratégias de incentivo desde a educação básica. Este artigo apresenta o projeto de extensão "Meninas Robóticas: Aprendizagem criativa para atrair meninas para a robótica no IFRO". O projeto surgiu da observação de que 57,1% das estudantes do Curso Técnico em Informática Concomitante ao Ensino Médio (CTICEM) não se identificavam com a área de computação, citando como obstáculos a falta de confiança nas próprias habilidades, o acesso limitado a recursos e desafios financeiros. A metodologia adotada fundamenta-se na Aprendizagem Criativa e na Aprendizagem Baseada em Problemas (ABP), utilizando a Robótica Educacional (RE) como ferramenta para conectar teoria e prática. As atividades envolveram o uso de programação em blocos (Scratch), kits Lego *Mindstorms* EV3, além de suporte via Ambiente Virtual de Aprendizagem (AVA) e tutoriais no YouTube. Os resultados demonstram que a iniciativa promoveu um aumento significativo no engajamento: o número de participantes subiu de uma adesão inicial baixa para a formação de times exclusivos de meninas para a Olimpíada Brasileira de Robótica (OBR). Além do desempenho técnico nas competições, o projeto estimulou o protagonismo feminino, transformando as estudantes em multiplicadoras de conhecimento em oficinas para a comunidade e visitas a escolas públicas. Conclui-se que a RE, apoiada por programas de mentoria e um ambiente colaborativo, é um meio eficaz para superar barreiras de gênero, fortalecer a autoconfiança e promover o empoderamento das mulheres na tecnologia.

Palavras-chave: Robótica Educacional. Empoderamento Feminino. Aprendizagem Criativa. Igualdade de Gênero.

RESUMEN
La escasa representación femenina en las áreas de Ciencia, Tecnología, Ingeniería y Matemáticas (STEM) y en informática es un desafío sociológico que exige estrategias de incentivos desde la educación básica. Este artículo presenta el proyecto de extensión "Niñas Robóticas: Aprendizaje Creativo para Atraer a las Niñas a la Robótica en IFRO". El proyecto surgió tras observar que el 57,1% del alumnado del Curso Técnico en Informática Concurrente con la Educación Media (CTICEM) no se identificaba con el campo de la informática, citando como obstáculos la falta de confianza en sus propias habilidades, el acceso limitado a recursos y las dificultades económicas. La metodología adoptada se basa en el Aprendizaje Creativo y el Aprendizaje Basado en Problemas (ABP), utilizando la Robótica Educativa (ER) como herramienta para conectar la teoría con la práctica. Las actividades incluyeron programación con bloques (Scratch), kits Lego Mindstorms EV3, así como apoyo mediante un Entorno Virtual de Aprendizaje (EVA) y tutoriales de YouTube. Los resultados demuestran que la iniciativa promovió un aumento significativo de la participación: el número de participantes pasó de una baja participación inicial a la formación de equipos exclusivamente femeninos para la Olimpiada Brasileña de Robótica (OBR). Más allá del rendimiento técnico en las competiciones, el proyecto impulsó el liderazgo femenino, transformando a las estudiantes en multiplicadoras de conocimiento mediante talleres comunitarios y visitas a escuelas públicas. Se concluye que la Investigación y Educación (IR), apoyada por programas de mentoría y un entorno colaborativo, es un medio eficaz para superar las barreras de género, fortalecer la autoconfianza y promover el empoderamiento de las mujeres en la tecnología.

Palabras clave: Robótica Educativa. Empoderamiento Femenino. Aprendizaje Creativo. Igualdad de Género.

1 INTRODUCTION

The democratization of digital innovation represents a remarkable sociological shift driven by the advancement of new technologies and the reduction of costs, enabling individuals to create and share their inventions. However, the path towards a sustainable economy and a more balanced society requires a greater engagement of diverse people in innovation. In this sense, it is crucial to highlight the worrying low number of women who opt for training and a career in the field of computing (HAPPE, 2021).

The increase in female representation in the areas of *Science, Technology, Engineering, and Mathematics* (STEM) has been the subject of study in several projects in Brazil and around the world. Carrying out projects, workshops, and meetings that aim to present technology in a more practical way to elementary and high school girls is essential, allowing them to know and feel more comfortable in the areas of technologies (ERENO *et al.*, 2023).

In view of this, we understand that gender equality is one of the fundamental pillars for sustainable development and social progress, especially through teaching and teaching practices, which seek to motivate and engage girls in the area of computing. In this context, working in the Technical Course in Informatics Concomitant to High School (CTICEM), we sought to develop a project that would arouse in students the curiosity and motivation to explore the area beyond the context of the classroom, which resulted in the extension project, Robotic Girls: Creative learning to attract girls to robotics at IFRO, Porto Velho North Zone campus.

In this scenario, the project aims to develop creative learning to attract girls to Educational Robotics (RE). To this end, we adopt creative learning, which is a pedagogical approach that encourages students to engage in hands-on projects and activities, combining art, science, technology, and engineering to stimulate creativity and innovation. The students apply the knowledge acquired in the CTICEM classes in the activities of the RE. Also, the Problem-Based Learning (PBL) methodology was used as access points to guide investigation, dialogue and critical thinking. The main objective of the project is to engage students in studies in the area of computing, especially RE, in order to foster the development of fundamental skills and knowledge that can be applied in the area of technology and science, encourage logical and creative thinking in high school students to face complex challenges efficiently.

RE arose from the theories of Jean Piaget's Constructivism and Seymour Papert's Constructionism. He believed that the child learns during the creation of artifacts and experimentation of his theories (SOKOLONSK, 2020). RE promotes the development of

knowledge through situations that challenge the individual to think of solutions. It allows you to relate theory to practice, applying learning in the classroom and in previous experiences to solve specific problems. Building robots in school offers teachers and students to teach, learn, discover, and invent in collective processes. This activity fosters the connection between theoretical abstractions and the concrete world (FERNANDES *et. al.,* 2018).

In the field of computing, historically marked by female underrepresentation, it is essential to support initiatives that not only encourage the participation of women and girls, but also promote their training and the full development of their potential. This article presents an extension project aimed at promoting gender equality and the empowerment of female students in the area of informatics, using participation in the Brazilian Robotics Olympiad (OBR) as an instrument of motivation and training.

2 MATERIAL AND METHODS

Creative learning is a practice that can be stimulated through Project-Based Learning (PBL), where students are driven by meaning (*passion*), produce collaboratively (*peer learning*) and value skills such as creativity, curiosity and resilience (*play*). This concept places students at the center of the educational process, empowering them to plan, create, test, and act proactively in the face of social issues and themes that involve them in real and everyday situations (INEIA *et al*., 2022).

Therefore, the Problem-Based Learning (PBL) methodology, considered a pedagogical approach considered innovative because it allows the student to participate actively in the construction of knowledge, will be the methodology adopted in this project. The ABP or *Problem Based Learning* (PBL) is a pedagogical practice used in teaching in several areas and is perfectly suitable to be used with educational robotics and to develop computational thinking (CABRAL *et al*., 2019). A ABP guided the Activities carried out by the girls, taking into account their experiences and experiences, in addition to exposing girls to situations that stimulate The reflection.

3 RESULTS AND DISCUSSION

At the beginning of the first semester of 2024, a survey was carried out through a questionnaire to understand the profile and perspectives of the students of the two CTICEM classes on campus. At that time, we had 31 girls enrolled in these classes. The results indicate that most students do not identify with the area. **Figure 1** illustrates that 57.1% of the girls who responded to the questionnaire expressed a lack of interest in computer areas, such as programming, data science, artificial intelligence, digital games, among others. While

28.6% have not yet reflected on the subject, only 14.3% have shown a lot of interest in the area.

Figure 1

Level of interest in areas of computing

Source: Authors.

To understand why 57.1% of girls expressed a lack of interest in computing fields, we asked students about the challenges and difficulties they face when considering studying or working in this field. **Figure 2** shows that 28.6% of the girls indicated limited access to resources as one of the challenges or difficulties they face when considering working in the area of computing. In addition, others mentioned include lack of access to educational resources, lack of confidence in skills, difficulties in specific disciplines, and financial challenges.

Figure 2

Challenges and difficulties pointed out by girls when considering studying or working in the area of computing

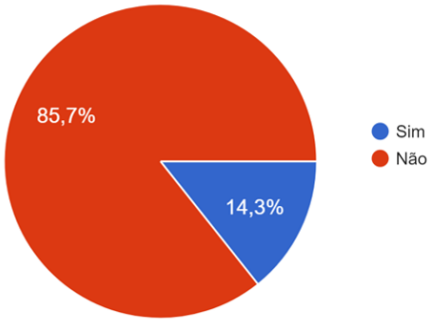
Source: Authors.

Given this scenario, the significant challenge of promoting girls' participation in the area of computing is evident. The fact that most students in CTICEM classes currently on campus do not identify with the area, as demonstrated by the lack of interest expressed by 57.1% of the girls, suggests the existence of significant barriers. By analyzing the challenges and difficulties faced by girls when considering studying or working in the field of computing, we identified a number of obstacles. These factors can contribute to discouraging girls from pursuing careers or studies in computing. Another relevant piece of information is the lack of interest in the participation of the OBR, despite all the girls recognizing the importance of the competition.

Figure 3 presents a scenario that may explain the challenges faced by girls when considering participation in national or state-level competitions . Lack of confidence in their abilities may be a determining factor for disinterest, since 85.7% of the girls did not express interest in participating in the OBR.

Figure 3

Interest in participating in the OBR



Source: Authors.

With this data, we detected that the lack of confidence in girls' abilities is one of the main challenges identified, which can prevent them from fully engaging in robotics and programming activities. To help girls overcome these obstacles, it is essential to adopt approaches that strengthen their confidence and encourage active participation in technology-related activities. Key measures include increasing access to educational resources and opportunities, mentoring programs to bolster girls' self-confidence, and policies to reduce financial barriers. In addition, it is important to maintain the effort to promote an inclusive and diverse culture in the area of computing, highlighting how gender diversity benefits innovation and progress.

The "Robotic Girls" project started on 09/01/2023, derived from an RE project carried out on campus during the first semester of 2023. This first project selected both boys and

girls to learn RE and participate in OBR. However, female participation was low, with only 4 girls initially applying, of which only 2 completed all stages and participated in OBR in August 2023. Against this backdrop, the need to address the low participation of girls has become evident. Thus, we developed the Robotic Girls project, with coordination and vice-coordination of female teachers in the area of Informatics, focused specifically on motivating and arousing the interest of girls in RE. Through practical activities, such as the elaboration of codes and the construction of a robot, we seek to encourage female participation in OBR 2024.

The project's face-to-face meetings took place twice a week, lasting three hours each. They were held at the campus's Center for Technological Innovation (CIT), a space inaugurated in March 2022, equipped with 10 state-of-the-art desktops, a TV, and a digital whiteboard. For the robotics project, through a public notice with resources, 10 complete Lego *Mindstorms* EV3 kits, 2 expansion kits, single sensors, a training track and some elements necessary for participation in the OBR were acquired.

In addition to the physical equipment, the robotics project has a team of mentors and facilitators who guide participants in various areas, from the assembly of the robots to advanced programming. Among them, two students who participated in the OBR 2023 edition were able to contribute with their experience in competitions.

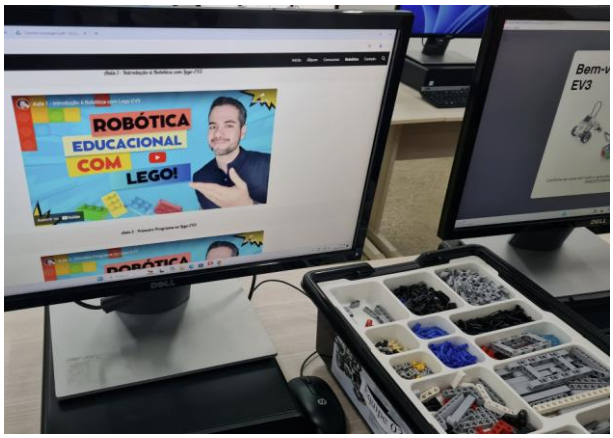
The face-to-face meetings were structured to provide a collaborative and hands-on learning environment where students could work as a team, exchange ideas, and solve challenges together. During the activities at the CIT, participants had access not only to material resources, but also to specific modeling and programming software for the LEGO *Mindstorms* EV3 platform. In addition, the CIT environment provides a space for creativity and experimentation, encouraging students to explore new approaches and innovative solutions to the proposed problems.

The robotics project is not limited to face-to-face meetings at the CIT. Participants also have access to the virtual learning environment (VLE), where they can consult support materials, participate in discussion forums, and interact with mentors outside of face-to-face meeting hours. This combination of face-to-face and virtual activities aims to provide a complete and enriching experience to participants, preparing them not only for the OBR competition, but also for future challenges in the area of robotics and technology.

We also complemented the YouTube Educational Robotics Channel with LEGO with tutorials recorded by faculty members from the campus RE team (**Figure 4**), intensive practice sessions, and *constructive feedback*.

Figure 4

Tutorials on a YouTube channel created by the Educational Robotics professor on campus



Source: Authors.

The positive results of the project include a significant increase in girls' interest and participation. In September 2023, we had the registration of six students, five of whom demonstrated total commitment and engagement in the activities.

The training begins with a module called 'Introduction to block programming', in which students developed programming skills using the Scratch platform , which was chosen for its playful and educational approach. Scratch is a block-based visual programming language, making it easy to create interactive projects such as animations, games, and stories, as well as stimulating creativity and computational thinking.

At the end of this introductory module, the students were challenged to create a game or story in *Scratch* that should include elements such as scenario animation, character movement, dialogues and soundtrack. Overcoming several challenges throughout the process, the girls developed games, demonstrating great evolution and application of the concepts learned.

Figure 5

Girls participating in the robotics project (Sept.2023-Aug.2024)

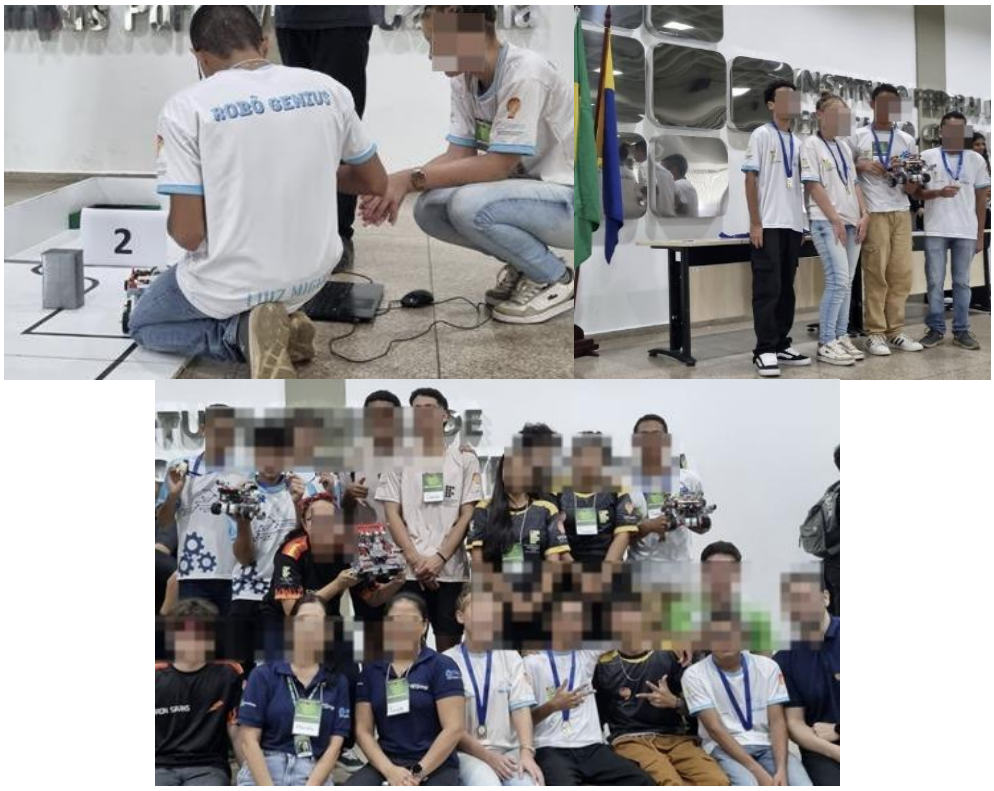
Source: Authors.

Subsequently, (**Figure 5**), the girls prepared for the architectural part in assembling the robots and studied to understand the challenges of OBR through a comprehensive approach that encompasses various aspects of learning and development, organizing their time efficiently, setting goals and schedules to ensure they have enough time to practice programming, Build the robot and prepare for the competitions.

We created a project to make an internal competition on campus as a preparation for OBR with 5 teams of boys and girls, simulating a real competition environment following rules and awards. Finally, the teams presented themselves at the state OBR on September 2nd and 3rd, 2024 (**Figure 6**). Each team performed with the t-shirt created by the members themselves. There were 2 days of competitions with the participation of 20 teams from the state. Our best place was a mixed team that was in 4th place and two more in 10th. and 18th with girls, but the most important was the engagement and companionship developed.

Figure 6

Teams participating in the state OBR (09/03/2024)



Source: Authors.

In October 2024, during the National Science and Technology Week (SNCT), educational robotics workshops were held open to the community. In this context, one of the students had a prominent participation, collaborating both in the organization and in the teaching process of the workshop. Figure **7** shows the student conducting a robotics activity with a group of girls. It is noteworthy that there was no direction or separation of the participants by gender; The composition of the group occurred spontaneously. The image suggests that the performance of a student as a female reference in robotics can contribute to arouse interest and promote greater engagement of other girls in the area.

Figure 7

Robotics student (upper right) supporting the workshop for the external community during the SNCT

Source: Authors.

The challenges initially pointed out by the participants, such as the difficulty in assimilating programming concepts and the complexity involved in building the robot, were gradually overcome throughout the activities, with continuous pedagogical support. This preparation aimed not only at participating in the Brazilian Robotics Olympiad (OBR), but also at developing personal and professional skills, contributing to the formation of relevant skills for future challenges in the field of technology.

Aiming at the sustainability of the project, in September 2024 a new class was started. In this stage, with an improved methodological approach, 11 girls joined, who went through the same training stages, including the introduction to block programming, demonstrating engagement and interest in participating in the next edition of OBR, which took place at the end of August, with the formation of two teams composed exclusively of girls, totaling seven participants. From this experience, the Robotic Girls project gradually consolidated itself as a teaching and extension initiative. As a result of the extension actions, one of the teams carried out activities to disseminate robotics in public schools throughout the second half of 2025, contributing to the dissemination of knowledge and stimulating the interest of basic education students in the technological area.

4 CONCLUSIONS

By addressing these challenges and implementing effective support and encouragement strategies, we can help girls overcome the barriers that prevent them from fully participating in the technology and computing environment. This project not only contributes to teaching, research and extension in Professional and Technological Education (EPT), but also motivates and engages CTICEM students.

Thus, it facilitates the sharing of knowledge both with the internal community, including the class of the Informatics course, and with the external community and the elementary and high schools. In addition, the project stimulates creativity and innovation, encouraging students to find unique and innovative solutions, while developing social and emotional skills, such as collaboration, communication, and leadership, which are fundamental for participation in OBR.

RE has been an effective means to attract more girls to technology, encouraging them to stay in the area and promoting their protagonism as multipliers of knowledge and experiences. Finally, the Robotic Girls project emerges as a direct response to the low female participation in robotics and programming activities, identifying girls' lack of confidence in their abilities as one of the main obstacles. By adopting specific approaches to promote girls' confidence and engagement, such as access to educational resources, mentorship programs, and policies to reduce financial barriers, the project seeks to overcome these challenges and encourage female participation in computing.

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