

**EMPOWERING THE EXACT SCIENCES: AN IMMERSIVE EXPERIENCE TO
HIGHLIGHT THE LEADING ROLE OF WOMEN IN MATHEMATICS**

**EMPODERANDO AS CIÊNCIAS EXATAS: UMA EXPERIÊNCIA IMERSIVA PARA
DESTACAR O PROTAGONISMO DAS MULHERES NA MATEMÁTICA**

**EMPODERANDO LAS CIENCIAS EXACTAS: UNA EXPERIENCIA INMERSIVA
PARA DESTACAR EL PROTAGONISMO DE LAS MUJERES EN LAS
MATEMÁTICAS**

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ABSTRACT

The article describes the successful experience of the 2024 Knowledge Fair at the Clóvis Nogueira Alves State Technical School (ETECNA), which addressed the theme of Women in Science, with a specific focus on the underrepresentation of women in the fields of Exact Sciences, in this case Robotics, Physics, Mathematics, and Statistics, seeking to rescue historical figures who are often invisible, such as Hypatia of Alexandria, Sophie Germain, Marília Chaves Peixoto, and Elza Gomide, in addition to connecting their trajectories to contemporary reality through a creative approach. To maintain the attention of the event's target audience, which is mainly 9th-grade students, the exhibition was structured as a science fiction narrative, with time travel, theatrical performances, games, robots, and audiovisual resources, where the immersive experience brought science and pop culture to the same stage, making learning more playful and accessible. The preparation of educational products and the development of activities was carried out by groups of students separated into different thematic areas: History of Mathematics in Brazil, History of Mathematics in the World, Statistics/Probability, and Robotics. This resulted in a positive impact on two fronts: improving the interpersonal and academic skills of participating students, such as oral communication and teamwork, and successfully sparking visitors' interest and awareness of the importance of diversity and women's contributions in STEM fields. The conclusion reinforces the transformative potential of non-instrumental and innovative educational methods that use interactivity and creativity to promote scientific knowledge and social reflection, ensuring that even an area surrounded by prejudice such as mathematics can be palatable and interesting to all audiences, facilitating learning and enabling discussions on the subject.

Keywords: Women in Mathematics. Mathematics Education. Innovative Teaching. STEM.

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RESUMO

O escrito descreve a experiência de sucesso da Feira de Conhecimentos 2024 na Escola Técnica Estadual Clóvis Nogueira Alves (ETECNA), que abordou o tema, Mulheres na Ciência, com foco específico na sub-representação feminina nas áreas de Ciências Exatas, neste caso a Robótica, Física, Matemática e a Estatística, buscando resgatar figuras históricas muitas vezes invisibilizadas, como Hipátia de Alexandria, Sophie Germain, Marília Chaves Peixoto e Elza Gomide, além de conectar suas trajetórias à realidade contemporânea por meio de uma abordagem criativa. Para manter a atenção do público alvo do evento, que são principalmente os alunos do 9º do ensino fundamental, a exposição foi estruturada em uma narrativa de ficção científica, com viagens temporais, encenações teatrais, jogos, robôs e recursos audiovisuais, onde a experiência imersiva trouxe ciência e cultura pop para o mesmo palco, tornando o aprendizado mais lúdico e acessível. A preparação dos produtos educacionais e o desenvolvimento das atividades foi realizado por grupos de alunos separados em diferentes eixos temáticos, História da Matemática no Brasil, História da Matemática no Mundo, Estatística/Probabilidade e Robótica, resultando por meio destes um impacto positivo em duas frentes, com o aprimoramento das habilidades interpessoais e acadêmicas dos alunos participantes, como na oralidade e no trabalho em equipe e o sucesso em despertar o interesse e a conscientização dos visitantes sobre a importância da diversidade e das contribuições femininas nas áreas STEM. A conclusão reforça o potencial transformador de métodos educativos não instrumentalizados e inovadores, que utilizam a interatividade e a criatividade para promover o conhecimento científico e a reflexão social, garantindo que até uma área rodeada de preconceitos como a matemática possa ser palatável e interessante para todos os públicos, facilitando o aprendizado e possibilitando discussões sobre o assunto.

Palavras-chave: Mulheres na Matemática. Ensino de Matemática. Ensino Inovador. STEM.

RESUMEN

El artículo describe la exitosa experiencia de la Feria del Conocimiento 2024 en la Escuela Técnica Estatal Clóvis Nogueira Alves (ETECNA), que abordó el tema «Mujeres en la ciencia», con especial atención a la infrarrepresentación femenina en las áreas de ciencias exactas, en este caso la robótica, la física, las matemáticas y la estadística, con el objetivo de rescatar figuras históricas a menudo invisibilizadas, como Hipatia de Alejandría, Sophie Germain, Marília Chaves Peixoto y Elza Gomide, además de conectar sus trayectorias con la realidad contemporánea mediante un enfoque creativo. Para mantener la atención del público objetivo del evento, que son principalmente alumnos de 9.º de secundaria, la exposición se estructuró en una narrativa de ciencia ficción, con viajes en el tiempo, representaciones teatrales, juegos, robots y recursos audiovisuales, donde la experiencia inmersiva llevó la ciencia y la cultura pop al mismo escenario, haciendo el aprendizaje más lúdico y accesible. La preparación de los productos educativos y el desarrollo de las actividades fue realizada por grupos de alumnos separados en diferentes ejes temáticos: Historia de las Matemáticas en Brasil, Historia de las Matemáticas en el Mundo, Estadística/Probabilidad y Robótica, lo que tuvo un impacto positivo en dos frentes: con la mejora de las habilidades interpersonales y académicas de los alumnos participantes, como la expresión oral y el trabajo en equipo, y el éxito en despertar el interés y la conciencia de los visitantes sobre la importancia de la diversidad y las contribuciones femeninas en las áreas STEM. La conclusión refuerza el potencial transformador de los métodos educativos no instrumentalizados e innovadores, que utilizan la interactividad y la creatividad para promover el conocimiento científico y la reflexión social, garantizando que incluso un área



rodeada de prejuicios como las matemáticas pueda ser agradable e interesante para todos los públicos, facilitando el aprendizaje y permitiendo debates sobre el tema.

Palabras clave: Las Mujeres en las Matemáticas. Enseñanza de las Matemáticas. Enseñanza Innovadora. STEM.

1 INTRODUCTION

The embezzlement in the sciences, especially in the areas of Exact Sciences, caused by the underrepresentation of minority groups, such as women, members of the LGBT community and the black population, reflects a waste of talent and innovation. The absence of diversity limits scientific production and prevents progress in more inclusive and varied solutions to global challenges (Orsi, 2020).

In this context, the annual event of the Knowledge Fair of the Clóvis Nogueira Alves State Technical School (ETECNA), is a demonstration of the creative and methodological potential of the institution's faculty and students, where it aims to demonstrate through interdisciplinary exhibitions the singularities of each area of knowledge, displaying in each edition a central theme that covers various facets of society. In its 2024 edition, which took place in September, it worked on the theme "Women in Science", a very comprehensive theme that could encompass all teaching professionals in the school community, including the topic addressed in this article "Women in the Exact Sciences". As highlighted by Prof. Daniel C. de Moraes Filho, in his article for Revista do Professor de Matemática (RPM), "Women in Mathematics", understanding this theme is extremely important, as it recognizes the trajectory and challenges faced by women throughout history in the scientific field, areas traditionally dominated by men.

The search for female figures in the areas of Exact Sciences, Robotics, Physics, Mathematics and Statistics, proved to be a real challenge, due to the scarcity of information in the literature on the subject. Luckily, articles that address this context were found in the RPM database, for example, the aforementioned "Women in Mathematics" (RPM30), "... And They Have Finally Arrived" (RPM33) and "Stories & Stories" (RPM80). Historical and current personalities are most often made invisible and socially discouraged from pursuing an academic career in some area of Science, Technology, Engineering and Mathematics - STEM (Tarasiuk, 2021), demonstrating the constant need to work on these themes in school.

2 OBJECTIVES

2.1 GENERAL OBJECTIVE

Develop an interactive and playful approach, which contemplates the delimited theme, in order to captivate the attention and arouse the curiosity of the public, in addition to passing on important information in a clear and reliable way.

2.2 SPECIFIC OBJECTIVES

1. Promote scientific knowledge, through active learning, stimulating creativity and curiosity;
2. To pass on in a playful and didactic way the content acquired through research and to present the educational products developed during the process.

3 METHODOLOGY

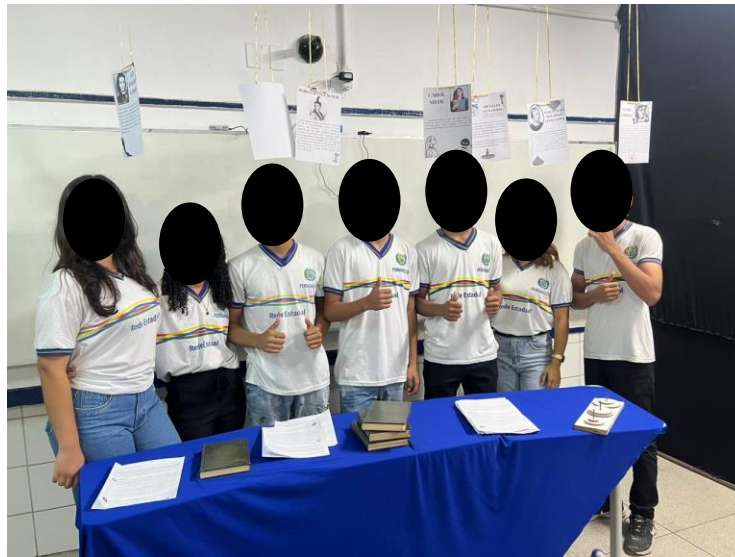
During the event, through the central theme, it was sought to connect the reality of important female personalities erased from history to science fiction, transforming the theme into something current that would attract and become light, and palatable to the target audience, the 9th grade students of the public school system. A generation immersed in Mass Culture, they are in constant contact with utopian realities, time travel and distortions of reality (Costa, 2021), this great influence directly affects the way an entire population sees information and filters what deserves or does not deserve to be consumed, with awareness of these facts an approach was used that aims to bring elements of this experience into the theme presented, involving games, light and sound control, robots, theatrical plays, and most importantly a script that communicates with all parts of the work, taking elements largely present in the content consumed by these young people.

3.1 FIRST STEP

In the meetings, the development of the project followed a series of well-structured stages. The first of these was the formation of separate working groups in the areas of Exact Sciences already addressed, as shown in Figure 1, such committees were made up of students from different classes and sociocultural realities, based on how they identified with the possible topics to be worked on, ensuring the possibility of demonstrating their strengths and expressing themselves, generating knowledge and new proposals from their interactions, adding value to the whole. In this stage, the elaboration of superficial research and the choice of the main figures to be worked on before starting the first drafts of the presentation planning were provided.

Figure 1

Demonstration of the formation of a presentation team



Source: Survey authors, September 2024.

3.2 SECOND STAGE

The second stage consisted of organizing and talking as a team with the students to define a central point that linked the presentations of the different groups, giving a starting point for the production of the material used during the exhibition, defining the theme of Time/Space Travel as a tool for transition and involvement in all parts of the presentation, shaping from the way the guests were going to contextualize and immerse the story to the ending with references to an epic film. Several tools were used to provide an interdisciplinary experience and learning that would draw the attention of the students, with characterization, audiovisual resources, and interactive, such as those already mentioned, means not even considered in the teaching environment, providing a different form of approach to make them aware of the theme.

With the figures arranged, it was possible to determine the functions of the teams, establishing themselves in 4 main axes, "Mathematics in the History of the World", with the theatrical representation and contextualization of the futuristic theme of the presentation, "Mathematics in the History of Brazil", with the continuation of such a story, "Statistical Research and Probability", with the use of Artificial Intelligence (AI) tools and games and "Robotics and Space Rescue", making use of NXT robots developed by the team and a space rescue context.

3.3 THIRD STEP

At this stage, the working groups began to finalize the educational and interactive products that would be part of the exhibition. It was at this stage that the students, with the guidance of teachers and more experienced colleagues, completed the main tools used, such as visual materials, the historical representations of the scientists, the production of the robot, the concepts of the interactive games that would be used, the scripts and the sound effects. In addition, the final concept of the exhibition was defined, ensuring coherence and unity between the different approaches to the presentation.

3.4 FOURTH STAGE

In the last stage, rehearsals were carried out to ensure that each group was prepared for the presentations to the public and the work as a whole made sense (Figure 2). This process included reviewing the students' explanations of the contents, the way they would receive the public, the final adjustments to the audiovisual resources, the souvenirs and the costumes. Rehearsals provided a safe space for students to practice their communication skills and adjust their performances with criticism from teachers and peers.

Figure 2

Teams properly ready to present



Source: Survey authors, September 2024.

There was also the presentation to the visitors, observed in Figure 3, consisting of 2 days of the Knowledge Fair event, with the presence of numerous schools and adjacent visitors, who enjoyed its various attractions, including the presentation that generated this discussion, starting with a time traveling guide who guaranteed the immersion of the guests

throughout the period, transiting between the different temporal openings in a spatial excursion, passing through various contexts that introduced him to figures such as Hypatia, of Alexandria and Marie Sophie Germain in the sector of historical personalities, Marília Chaves Peixoto and Elza Furtado Gomide in Brazilian history, a game about statistics and probability arising from a research carried out with students of the school, and a newspaper narrating important facts for the study of this area of mathematics and a space disaster of temporal consequence, leading to the rescue using the NXT robot, ending the show.

Figure 3

Presentation to the visiting students



Source: Event advisor, September 2024.

4 RESULTS AND DISCUSSIONS

The results obtained can be directly divided into two main parts, glimpsed in individual ways, highlighting the teaching and student performance of the school body. Demonstrating the achievements from different perspectives.

4.1 TEACHING PERSPECTIVE

During the preparation process, the advisors worked on the awareness of both individual and collective potential and skills, with clear examples being orality, research skills, teamwork, among others, skills that are necessary in the learning and growth of students. With the opportunity to express their ideas and use their creativity to prepare the proposal for the edition, an improvement in their self-confidence to perform the proposed tasks was obtained with planning based on the mastery of the theme, broadening the knowledge

generated among the different students when working together, bringing appreciation and learning from the effort dedicated during the meetings, in addition to the rich teaching material produced that improved the learning experience and creative skills of the students.

4.2 STUDENT PERSPECTIVE

The proposal of the Knowledge Fair was successfully achieved by observing the interest and admiration of the visiting students when they watched what was produced with the work of local students, awakening in the public confidence with the mastery of the theme and the skills that the participants acquired throughout the meetings, in addition to the admiration for the audiovisual effects and experience that encompassed the entire presentation, demonstrated by the audience through a podcast produced by Tai, where they told their experiences at the Fair as a whole, which was extremely important to validate and demonstrate the result of the effort applied in the exhibition of what was produced. From the moment of reception to the exhibitions, it was ensured that they felt immersed in the works produced, the awareness of the theme showed them the reality of great personalities who contributed to the current times, exposing studies and achievements that did not receive due recognition.

The challenges faced by the students during the planning meetings resulted in growth and understanding of group work, becoming a personal learning experience for each one, observing their mistakes and having guidance not only from the teacher but also from other students with more experience, this exchange of knowledge generated better performance in the tasks and the opportunity to connect with their colleagues, developing strong interpersonal points that will be taken to other areas even outside of school. The feeling of affection for their own work is one more result of how much effort they put into their performance and the gratification of quality work by themselves, generating the memory of being part of an extremely important theme.

5 CONCLUSION

At the end of the event, "Empowering the Exact Sciences", the significant advances achieved are reflected, both in terms of learning and social and educational impact. The project provided an innovative and engaging experience, which connected the historical reality of underrepresented female figures in the Exact Sciences with science fiction and the Cultural Industry. This immersive approach, by exploring interactivity through games,

robotics, theater, and audiovisual resources, allowed students to absorb content in a playful and accessible way, while encouraging active engagement and creativity. Where the main results in each specific area addressed were demonstrated.

5.1 MATHEMATICS

The great achievement of the project was the experience that encompasses all areas of work, with theater as a highlight, which brought a dramatic and visual perspective to the theme, allowing the stories of these women to be told in a captivating way and in spaces of common recognition, in the case of Mathematics in World History, a laboratory, in Figure 4, and the one on Mathematics in the History of Brazil, a congress, Figure 1. The combination of these activities not only achieved the objective of promoting scientific knowledge, but also encouraged reflection on the importance of inclusion and diversity in the field of Mathematics, mitigating part of the prejudice on the part of students in the study of the discipline.

Figure 4

Part of the decoration seen by visitors in the area of mathematics



Source: Survey authors, September 2024.

5.1.1 Statistics

In the field of statistics, as an area of mathematics, she stood out for leading an innovative research for the institution's environment that sought to understand the dynamics

of women in relation to the exact sciences in the institution, Figure 5, in the male and female view, in aspects such as interest in the area and gender equality in the sector, and from this information a board game was created that aimed to teach probability and statistics through competition, in addition to presenting important figures that had not yet been highlighted, which provided a form of teaching based on problem solving, challenging the audience to think critically about the contribution of these women, presented in Figure 6. In addition to the use of Hedra AI to create a representation of an important female voice in the area, who had already passed away, approached and drew the attention of the public, the newspaper that documented an important part of the process, was a crucial instrument to disseminate the ideas worked on and connect the presentation of robotics.

Figure 5

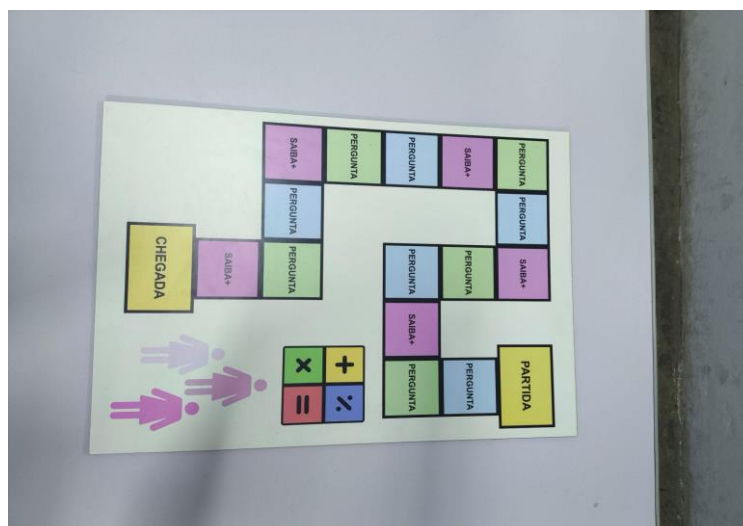
Excerpt from the statistical research carried out



Source: Statistics team, August 2024.

Figure 6

Board for learning probability and statistics



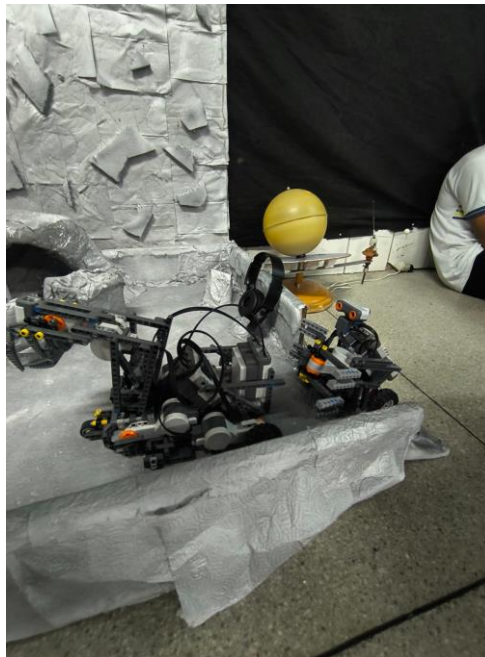
Source: Statistics team, August 2024.

5.2 ROBOTICS

The robots, built to simulate the rescue of people trapped in a rocket on the Moon, using the NXT system, being a crane robot and a claw robot, observed in Figure 7, it was evident the adaptability and variety of uses that modern robotics can perform, with several women being involved in these advances, such as Ada Lovelace, known as the Mother of Computing, among countless other women who make room in the area for future enthusiasts, in addition to demonstrating how technology can be used creatively and educationally, serving as an example of teamwork and cooperation.

Figure 6

Robots used in the simulation of space rescue



Source: Robotics Team, September 2024.

5.3 PHYSICS

The physics indirectly worked throughout the project was an essential part for the construction of the effects, with Optics for the lights and sound direction techniques to improve acoustics, in addition to being demonstrated in the presentation of ancient mathematics that guaranteed great contributions to the area, such as Marie Sophie Germain who made important contributions to the dynamics of materials, including those used in the construction of the Eiffel Tower (Green, 2023) and Maria Gaetana de Agnesi, who ensured important advances in Calculus, which is used in several areas of physics, such as Classical

Physics, Thermodynamics, and Electromagnetism, and was responsible for its popularization as a discipline (Green, 2023)

In terms of results, the goals were largely achieved, the participating students developed interpersonal and intrapersonal skills, expanded their knowledge, and above all gained confidence in their abilities when they saw the impact that the project had on the public. The success of the Knowledge Fair highlighted the transformative potential of innovative educational methods, while bringing visibility to crucial female figures in the history of Mathematics and Exact Sciences in general.

The main achievements obtained were guaranteed from the creative approach, with the use of common elements in approaches to the media scene, with the strategic use of sound effects that complement the experience of a visit, and a facet of theater and constant presence of effects and visual elements held the attention of the audience from the beginning, already demonstrated in Marcelo Picaro Cerigatto's 2022 research, where he demonstrates the beneficial effects of a non-instrumentalized education that adapts to the new reality of students for their learning.

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