



EMPOWERING THE NEXT GENERATION OF SCIENTISTS: A WRITING OF GRADUATE STUDENTS' PERSPECTIVES



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Katerine de Jesús Rincón Pérez¹, Adriane Chaves Lima Montenegro² and Camila Carla Gomes Araújo³

ABSTRACT

This study investigates the role of STEAM (Science, Technology, Engineering, Arts and Mathematics) education, integrated with the Sustainable Development Goals (SDGs), in the empowerment of girls and young women, with an emphasis on the space sector. The qualitative research is based on the action research methodology to analyze the experience of tutors in educational projects aimed at promoting inclusion and gender equality. The results point to concrete academic advances, such as awards and approvals in engineering courses, as well as subjective improvements, such as the strengthening of self-confidence and the increase of the participants' professional aspirations. The work of tutors, particularly those linked to graduate programs, proved to be essential for the success of the initiatives, showing that inclusive pedagogical practices contribute significantly to the reduction of gender inequalities in the sciences. Finally, the relevance of institutional partnerships and continuous evaluations in the process of consolidating inclusive educational environments is highlighted.

Keywords: Educational Projects. Girls. Young Women. STEAM. ODS.

¹ DoctoratePPGEEC

Federal University of Rio Grande do Norte

E-mail: katerinerinconp@gmail.com

² Master's student PPGEF

Federal University of Rio Grande do Norte

Email: montenegroadriane114@gmail.com

³ Master's student PPGEF

Federal University of Rio Grande do Norte

E-mail: camilacgaraujo@gmail.com

INTRODUCTION

The empowerment of women in science, especially in technological and innovation areas, represents an ongoing challenge in many parts of the world. In this context, the UN Sustainable Development Goals (SDGs) present an important milestone for building a more equitable and inclusive society. SDG 4, which seeks to ensure inclusive, equitable and quality education, is fundamental for the empowerment of women and girls, promoting opportunities for them to become leaders in traditionally male-dominated areas, such as science and technology. SDG 5, in turn, focuses on gender equality, aiming to eliminate all forms of discrimination against women and girls and promote their full participation in all sectors of society, including science and technology (UN, 2015).

The integration of the SDGs into teaching and pedagogical practices, especially in the areas of *STEAM* (Science, Technology, Engineering, Arts and Mathematics), constitutes a promising strategy to reduce inequalities and empower the next generation of scientists.

The issue of gender in the sciences has been a topic of growing interest in recent decades, with studies showing that, despite advances in some areas, women are still a minority in fields such as physics, engineering, and especially in sectors related to space exploration (Bordón, 2021). The gender gap in these domains is related to a number of factors, including gender stereotypes, the absence of inspirational role models, and structural barriers in educational institutions and the labor market. Encouraging girls and young women to engage in scientific and technological disciplines, while also working to deconstruct these stereotypes, is crucial to reducing this inequality and fostering a more inclusive generation of scientists.

The space sector is one of the most emblematic fields to discuss gender inequality in science and technology. Technological advancement and space exploration have historically been dominated by men. However, the growing recognition of the importance of gender diversity in scientific and innovation teams in the space sector has generated initiatives to include more women in these spaces, as observed in international training and education programs aimed at developing future leaders in space science (NASA, 2020). The space sector, with its complexity and potential for innovation, offers an excellent opportunity to engage young women in high-impact fields and spark an interest in applied sciences, engineering, and technology, while aligning with the SDGs, promoting education and gender equality.

University educational initiatives, with a focus on the space sector and strengthening *STEAM-related* areas, have proven effective in promoting science education for girls and women. Projects such as "Space4Girls", promoted by the UN, introduce young people to

practical aspects of space exploration, offering mentoring and concrete experiences with scientists and engineers in the sector. In addition, the implementation of university programs that include inclusive and multidisciplinary pedagogical practices contributes to the creation of a more welcoming and egalitarian environment for future scientists (Gao *et al.*, 2020). In the Brazilian context, several initiatives by public and private universities have brought graduate students closer to girls and young women in secondary schools, through partnerships that involve extension projects and mentoring programs.

Finally, the impact of training female tutors is a crucial aspect in building an educational environment that promotes gender equality. Women who act as tutors and mentors in the academic context play a key role in building references for girls and young women. The training of these educators, who need to be prepared to deal with gender challenges and encourage young women's self-esteem and confidence, is essential to ensure that female empowerment in the sciences materializes effectively. In addition, continuous training programs for tutors help to create a support network among them, strengthening the articulation between generations of scientists and contributing to the change of culture within scientific and educational institutions (BINNS *et al.*, 2021).

Building an inclusive and empowering environment for young women in the *STEAM* sector, especially in the space sector, is a challenge but also a significant opportunity to transform educational and scientific dynamics, promoting gender equality and access to quality education for all.

The development of skills and competencies in the participants is essential for careers in *STEAM*, and the challenges and opportunities encountered during the teaching and learning process reveal effective strategies to foster female participation in these areas. The author's experience and personal perspective as a PhD student can also influence and inspire future scientists.

The objective of this work is to present how education in *STEAM* (Science, Technology, Engineering, Arts and Mathematics), allied to the SDGs and with a focus on the space sector, can empower girls and young women between 15 and 18 years old. In addition, it seeks to report, through qualitative data, the impact of this education from the perspective of graduate students.

METHODOLOGY

The methodology adopted for the elaboration of this study is qualitative in nature, focusing on the analysis of experiences lived by tutors in educational projects aimed at the empowerment of girls and young women in the areas of *STEAM* (Science, Technology,

Engineering, Arts and Mathematics), with emphasis on the space sector. The qualitative approach allows for an in-depth exploration of the perceptions, challenges and contributions of the tutors in the teaching and mentoring process, in addition to enabling the understanding of the impact of their educational practices on the training of the graduate students who participate in the project.

This study is characterized as an educational experience research, using action research as the main methodology. Action research is particularly well-suited to the study of educational interventions. The objective is to understand how the experience of these tutors, in an educational leadership role, contributes to strengthening the confidence and scientific skills of girls and women in training.

RESULTS

During the development of the project, different courses and modules were taught, in which girls and young women had the opportunity to get closer to topics that they were unaware of or that they might consider impossible for them. These courses included an astronomy module, relating physics and mathematics concepts acquired during his formal education. The courses served about 100 girls and young women from public schools. As a result of this immersion, they had the opportunity to apply for the Brazilian Astronomy Olympiad in 2023, by teams. Of the teams registered, we obtained extremely positive results, as one of them won the medal of runners-up for the state. In addition, after completing the project, many of these young women decided to pursue engineering degrees and were approved at different universities in the state, demonstrating the positive impact and empowerment generated by the project.

It is also noteworthy that these were tangible and quantifiable changes. However, intangible results, such as the belief in one's potential, the broadening of professional prospects, the decision to alter the course of one's lives and the impact on future generations, as well as the transformation of the community mentality, represent equally significant and transformative, although not directly measurable, effects.

Previous research shows that *STEAM* education has a substantial impact on young women's self-perception and career aspirations. Sadler *et al.* (2012) showed that educational experiences that integrate scientific concepts into everyday life significantly increase female interest and participation in scientific careers. In addition, Blackley and Howell (2015) emphasize that educational programs that include female role models in science and technology are capable of reconfiguring gender perceptions in these areas,

corroborating our findings on the relevance of offering role models and enriching educational experiences to promote empowerment and inclusion in *STEAM*.

This perspective reflects the role of tutors, graduate students, as agents of change in the community. This role imposes on tutors the responsibility to conduct their investigations, studies and content development seriously, acting as guides and models in the transformation of a new generation.

The participation of tutors, especially those linked to graduate programs, is crucial for the success of educational initiatives in *STEAM*. As agents of change, these tutors not only share advanced technical knowledge, but also serve as inspiring role models for the participants.

By exposing their trajectories and the challenges they overcame, the tutors demonstrate that gender barriers can be overcome and that success is within everyone's reach. In addition, their involvement in teaching and mentoring activities contributes to the construction of an indispensable support network for young women. The program offers not only academic guidance but also emotional and motivational support, which are essential elements for sustaining interest and perseverance in *STEAM fields*. Finally, the extramural ties, now consolidated in the university environment, strengthen the continuous impact of the project.

DISCUSSION

The implementation of projects of this nature is not limited to the transmission of technical knowledge, but also strengthens a support network essential for young women to advance in their academic and professional careers. In this context, it is crucial that educational policies and community programs continue to encourage female participation in *STEAM*, promoting inclusive and innovative learning environments.

The effectiveness of the actions carried out is proven by results such as winning medals at the 2023 OBA and passing engineering courses. In addition, measurable impacts, such as strengthening self-confidence, reassessing one's own capabilities, and developing protagonism, are equally relevant. These elements indicate that the role of the tutors goes beyond the dissemination of technical knowledge, also covering the promotion, the construction of new perspectives of life for the participants.

For future projects, it is recommended to expand mentoring initiatives, strengthen partnerships with universities and companies in the technology sector. Such actions can provide practical experiences, internship opportunities, and a broader view of available careers. Finally, the continuous performance of qualitative evaluations, through interviews

and focus groups, will allow for constant adjustments and improvements, ensuring that the programs effectively meet the needs of the participants.

CONCLUSION

The study highlighted the importance of integrating *STEAM* education into the SDGs, with a focus on empowering girls and young women in the space sector. The analyses indicated that gender inequality in scientific and technological areas, although historically consolidated, can be mitigated through inclusive pedagogical practices. The incorporation of tutors as reference models stood out as an effective strategy, contributing both to the development of technical skills and to the strengthening of the scientific identity of the participants.

The results showed significant impacts in multiple dimensions. In the tangible sphere, relevant academic achievements were recorded, such as awards in scientific competitions and approvals in higher engineering courses. On the intangible level, an evolution in the participants' self-confidence and professional aspirations was observed. These results are in line with studies that reinforce the importance of educational environments that combine technical education with emotional support, favoring gender equality in traditionally dominant sectors.

The participation of tutors linked to graduate programs was decisive for the success of the initiatives. In addition to the dissemination of technical knowledge, these educators played an essential role in promoting support networks and overcoming cultural barriers. The continuity of these actions is essential for the training of new generations of women, scientists and engineers.

Based on the results, it is recommended to expand partnerships between universities and technological industries, as well as the implementation of continuous evaluations, both qualitative and quantitative. Such measures aim to ensure the constant improvement of pedagogical practices, contributing to the construction of more inclusive educational environments aligned with the principles of the SDGs.



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