"Elas nas Exatas" Project: An Evolving Trajectory

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The "Elas nas Exatas" project addresses the underrepresentation of women in Science, Technology, Engineering, and Mathematics (STEM) fields in Brazil by leveraging Research, University Extension, and social media to inspire and empower young girls and women. The project includes mini-courses, workshops, and a YouTube channel featuring stories of women in STEM. Results indicate increased self-efficacy and broadened career perspectives among participants despite ongoing structural challenges. The diversity of interviewees and the visibility provided by the project have been crucial in promoting female inclusion in STEM.

Keywords: Underrepresentation of women in STEM; empowerment of young girls and women; self-efficacy; encouragement of women into STEM careers; evolving trajectory.

Fields of Science, Technology, Engineering, and Mathematics (STEM) face significant challenges in terms of gender and racial inequality, both in Brazil and globally. This scenario is concerning as these fields remain male-dominated, with a notable underrepresentation of women resulting from a combination of complex factors. Several initiatives have been created to promote women's contributions to STEM and encourage girls and women to pursue careers in these areas. However, progress remains limited, highlighting the need for continuous efforts.

In the Brazilian context, the situation remains challenging. According to the National Institute for Educational Studies and Research Anísio Teixeira (INEP), even though women make up the majority of participants in the National High School Exam (ENEM) in all editions and in the university context (Pedagogical Reports - INEP, 1998 - 2012 and in Statistical Synopses of the National High School Exam, INEP, 2013 – 2020) [1,2], they are underrepresented in exact sciences fields. This discrepancy is concerning because performance in exact science subjects can significantly impact young women's academic and professional opportunities, considering we live in a digital and digitized world in many aspects.

Since 2014, various actions have been implemented globally, involving governmental and institutional efforts and university research and extension projects to minimize these inequalities, as exemplified by the "Elas nas Exatas" Project presented here. This project arose from concerns during research for a doctorate completed in 2013. Among many readings, we were troubled by the discussion of whether science is masculine, deepening with authors such as Dr. Áttico Chassot (2003) [3]. Thus, the project emerged to understand this disparity within the university environment and stimulate high school students to choose careers in Earth and Exact Sciences.

Therefore, our intention is to show a bit of the project's journey, its origin, challenges, achievements, and perspectives throughout this article.

Theoretical Bases

The underrepresentation of women in STEM has been a topic of discussion for some time (OECD, 2015 [4]; UNESCO, 2017, 2018 [5,6]; NSF, 2019 [7]; GENEVA, 2020 [8]) because, since the 19th century, women have faced barriers to entering and

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excelling in these fields. Factors such as gender bias, the lack of female role models, and cultural stereotypes contribute to the perpetuation of this inequality, resulting in the invisibility of their achievements in STEM areas. Additionally, the lack of adequate public policies and institutional support further exacerbates the situation, making it difficult for women to access and remain in scientific and technological careers.

It is important to highlight that women's participation in STEM fields is essential and has been discussed by authors such as Chassot (2003) [3] in his book "Is Science Masculine? Yes, Madam." He bases his work on the understanding that patriarchal societies did not emerge by chance. Thus, he examines three influences that have shaped us as human beings in the Western world: Greek traditions with their myths and philosophy, Judaic traditions starting from cosmology and the Torah, and Christian traditions using biblical texts from the apostle Paul and other doctors of the Christian Church. He explores whether the contributions and gaps of these three roots have shaped us with this patriarchal perspective.

Although it is challenging to understand why science is considered a male domain, it is evident that its structure has predominantly been associated with men. However, some women have overcome this established norm, which erroneously assumes women lack the aptitude or competence for the sciences, particularly in the exact sciences. In his work, Chassot seeks to highlight the remarkable contributions of women to the development of scientific knowledge. These accomplishments occurred despite the numerous obstacles that women have faced and continue to face in the scientific field.

In other words, this author is dedicated to highlighting the important contributions that women have made to the development of scientific knowledge. Despite this, they have had to overcome numerous barriers that have been and continue to be systematically imposed.

One of the barriers faced is the underrepresentation of women in the fields of Science, Technology, Engineering, and Mathematics (STEM). As highlighted by Olinto (2011) [9], this phenomenon not only reflects persistent gender inequalities but also represents a significant loss of human potential and innovation for scientific and technological progress. In this context, Research and University Extension, through projects like Elas nas Exatas, emerge as essential means to address this disparity, aiming to understand and seek to minimize it. Extension initiatives that encourage and support the participation of girls and young women in STEM fields are crucial. When these actions are aligned with the principles of University Extension, they can create a more conducive environment for the inclusion of women in the scientific realm of STEM fields. By integrating the objectives and goals of extension programs with the evaluation of the impact of student participation on social issues, as advocated by FORPROEX (2012) [10], these initiatives can effectively contribute to reducing the gender disparity in STEM.

The project is based on essential concepts, such as Deci and Ryan's self-determination theory (1985) [11], which emphasizes the role of intrinsic motivation in personal and professional development. These theoretical bases provide a solid framework that helps the project effectively influence the choices and aspirations of the young participants.

In this way, the Elas nas Exatas project aims to give visibility to women and their contributions to scientific and technological development. Thus, the project has built its trajectory around this purpose through Extension and Research activities.

Materials and Methods

Since its inception, the Elas nas Exatas project has employed various means and methods to achieve its objectives, such as conducting mini-courses, workshops, and interviews with women from STEM fields.

It was launched as a research project in 2017, and in 2018, the extension branch was incorporated. This led to several discussion panels with students

from various courses within the Department participating.

In 2019, the extension project continued under the coordination of two faculty members with degrees in Mathematics and two scholarship holders, one from the Civil Production Engineering course and the other from the Chemistry Teaching course.

Since then, a scientific day has been held in the fourth week of March, titled "Workshop in Honor of the Female Presence in Scientific and Technological Development," which features discussion panels, mini-courses, workshops, and conversation circles, led by women in the fields of Exact and Earth Sciences. The first edition took place in March 2019. This year, as a strategy to engage with the young audience (the focus of our work) and to make the Project more well-known, the Instagram account @elasnasexatas_ssa was created. This account publishes the actions carried out by the project in a more direct language, which has enabled the development of other actions aligned with the project's proposal, engaging students both inside and outside the University.

In 2020, with the onset of the COVID-19 pandemic, it became necessary to suspend all activities that were planned to be conducted in person (with nearly 300 participants registered), and the project needed to reinvent itself. Thus, in June of that year, the YouTube channel Elas nas Exatas (www.youtube.com) was created, and live sessions began to be held weekly using streaming platforms.

In 2023, the fifth edition of the Workshop in Honor of the Female Presence in Scientific and Technological Development was held, along with other activities such as discussion panels, lectures, and school visits, always to promote the presence of women and their contributions in the scientific and technological world, as well as encouraging girls and women to become part of this universe. In 2023, the project had the active participation of five scholarship students and five volunteer monitors (four students and one university staff member). The students involved are from the Bachelor's degree courses in Information Systems (three students), Design (one student), Chemistry Teaching (four students), Civil Engineering (one student), and Law (one – department staff member). The project includes four faculty members and 17 students from the aforementioned fields. In 2024, with the team restructured and the addition of new faculty members and scholarship students, the Project held the VI Workshop, featuring Dr. Julieta Palmeira from Funding Agency for Studies and Projects (Agência Financiadora de Estudos e Projetos) (FINEP) as the opening speaker, along with three discussion panels.

Results and Discussion

The project team has submitted proposals to the University's internal calls and, as a result, continues the actions it has developed over the past years. 2017 - Research Project – Elas nas Exatas – highlighting the contribution of women to scientific development; 2018 - Extension Project – Elas nas Exatas: encouraging girls to pursue careers in sciences – partnership with schools in Cabula; 2019 - I Workshop on Female Presence in Exact and Earth Sciences – March 29 (Sônia Guimarães – Aeronautics Institute of Technology (Instituto Tecnológico de Aeronáutica) (ITA); 2019 – The project coordinators were honored during the I Brazilian Meeting of Women in Mathematics at the Institute for Pure and Applied Mathematics; 2020 – II Workshop on Female Presence in Exact and Earth Sciences – March 17 (transformed into live sessions from June to November); In 2021 – III Workshop on Female Presence in Exact and Earth Sciences – remote – March 25 (Carolina Araújo – Institute of Pure and Applied Mathematics (Instituto de Matemática Pura e Aplicada - IMPA) (Opening lecture link: https://www.youtube.com/watch?v=J8n9ynaKmWI); In the year 2022, it was carried out IV Workshop on Female Presence in Exact and Earth Sciences – remote – March 24 (Christina Brech – University of São Paulo (Universidade de São Paulo - USP) (Opening lecture link: &t=46s); The following year, the fifth edition of the workshop was held – in-person –

March 29 (Carolina Brito - Federal University of Rio Grande do Sul (Universidade Federal do Rio Grande do Sul - UFRGS) – The event was hybrid and had support and participation from Bahia Department of Science, Technology and Innovation (Secretaria de Ciência, Tecnologia e Inovação - SECTI) and Secretariat of Education and Culture of the State of Bahia[1] (Secretaria da Educação e Cultura – SEC). (Opening lecture link: https://www.youtube.com/watch?v=dUCs8QBdpDE&t=338s)

In the year 2023, the Elas nas Exatas Project Connecting Knowledge (aligns with the objectives of the Elas nas Exatas Project in connection with the bicentennial of July 2) was launched, and Elas nas Exatas Project Goal 2030 (aligns with the objectives of the Elas nas Exatas Project in the perspective of the United Nations' 2030 Agenda – UN). Both projects won internal university calls. 2023 – Participation on July 2, honoring the women from Bahia who fought during the struggles for Brazil's independence. This was one of the reasons for launching Connecting Knowledge that year. In the same year, we created a panel for the entrance hall of the Department titled "Women in Sciences.Women in History," featuring women who participated in interviews on the project's channel, some significant in the history of exact sciences in Brazil and abroad, as well as historical women from the struggles of July 2. Continuing, in the first semester of 2023, the Elas nas Exatas project submitted a Technical Note for the University's consideration to create a Program for Women in Sciences aimed at including existing or future Teaching, Extension, and Research projects, actions, and activities, aligned with themes/objectives addressed by the Elas nas Exatas Project. We are awaiting developments. In 2024, with a restructured team and the inclusion of new faculty and scholarship students, the Project held the VI Workshop, and we are resuming the live sessions starting in October.

[1]In the Brazilian governmental system, a "Secretaria" (Secretariat) at the state level is equivalent to a Ministry at the federal level, being a high-level executive body led by a` State Secretary.

The project's methodology, centered on content creation and dissemination through a YouTube channel, deserves an in-depth analysis. With over 100 hours of interviews involving more than 60 educators, researchers, and professionals in STEM fields from both Brazil and abroad, the project has built a valuable repository of experiences and knowledge. The number of accesses and views indicates a significant reach and great interest in the content produced.

The interviews for the project's channel began in June 2020. From the sixth interview onward, it was decided that each conversation would have a specific theme to guide the discussion. However, in each virtual meeting, the interviewer asks the interviewees to share their journey before entering higher education, identify influences on their career choices, and present their future projects. In 2020, the first thirty-eight interviews for Project Elas nas Exatas were conducted. Since then, the channel has hosted 102 videos featuring the academic trajectories of women, stories of women from the past, and girls who already excel in STEM fields, even at such a young age.

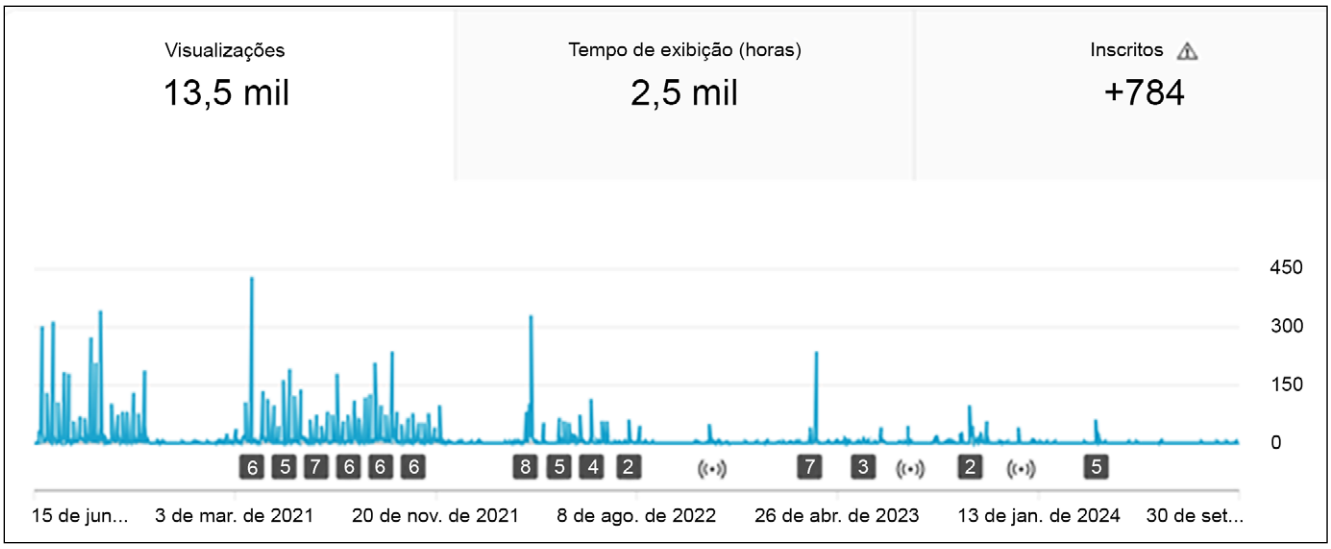
The channel has 784 subscribers who follow the content that has already been published, generating 13.5 thousand views and 2.5 thousand hours of watch time. These are significant metrics for a channel focused on encouraging girls and young women in STEM fields by showcasing interviews that discuss women's journeys in these areas. This is important, as it indicates we are on the right path in disseminating quality material.

Figure 1 shows the fluctuation observed in channel access, which is declining. However, as mentioned before, we resumed live sessions with bi-weekly interviews between October and December 2024.

In summary, the results obtained from the statistics of the Elas nas Exatas Project channel on YouTube are as follows:

- Nearly 13,500 views;
- 2,500 hours of watch time;
- 120,000 impressions;
- More than 100 hours of original content;

Figure 1. Project channel statistics on YouTube.



- Viewers are mainly from Brazil but also from Colombia and Portugal;
- The predominant age group among viewers is 18 to 24 years old, accounting for 43%;
- The channel's audience is primarily female, with 74% of subscribers;
- The use of English subtitles is minimal (0.1%), but it indicates the presence of viewers from English-speaking countries, which broadens the channel's potential reach.

These data demonstrate a significant reach, especially given the specificity of the content. The high number of accesses compared to views suggests that the channel generates initial interest, but there is room to improve audience retention. This can be achieved through content optimization strategies and more targeted engagement, which we are already initiating.

The diversity of interviewees, which includes over 60 interviews with women and men from various STEM fields, career stages, and geographical backgrounds, has contributed to creating a rich and varied panorama of experiences in these areas. This approach aligns with Ausubel's principle of meaningful learning (1968) [12], providing multiple points of connection for a diverse audience. Providing a summary of what was discussed and presented during the interviews, specific patterns can be observed in the experiences of women in STEM, namely:

1. **Importance of Family Support**: Many interviewees highlighted the crucial role of family support in their career choices, which resonates with Deci and Ryan's self-determination theory (1985) [11], emphasizing the importance of relatedness and social support in intrinsic motivation.
2. **Challenges of Representativity**: Most interviewees reported being part of a gender minority group in their classes and work environments, with a predominance of male teachers and colleagues, corroborating Chassot's (2003) [3] observations on the historical masculinization of science.
3. **Barriers in the Workforce**: Experiences of near exclusion from job opportunities and invisibility in male-dominated discussions were reported, aligning with the horizontal and vertical segregation mechanisms described by Olinto (2011) [9].
4. **Perception of Positive Change**: Many interviewees noted a gradual improvement in the situation for women in STEM, indicating an upbeat, albeit slow, trend.
5. **Awareness of the Importance of Representation**: Participants recognized the importance of their visibility in inspiring

other girls, demonstrating a positive cycle of empowerment.

In addition to these aspects, impressions collected from a sample of female viewers revealed positive impacts of the project, the results of which are listed below:

- **Increase in Self-Efficacy**: Many young women reported feeling more confident in their ability to pursue careers in STEM after watching the videos.
- **Broadened Perspectives:** Viewers mentioned discovering careers and opportunities in STEM they were previously unaware of.
- **Identification with Role Models**: The diversity of interviewees allowed many viewers to find role models with whom they could identify, reinforcing the importance of representation.
- **Overcoming Strategies**: Young women value the practical advice and strategies interviewees share to overcome career challenges.
- **Awakening of Teachers to Address the Theme**: Some teachers who watched the channel showed enthusiasm for the topics discussed. They began incorporating these subjects into their classrooms, developing projects with basic education students.

However, we still face challenges:

- **Limited Reach**: Although significant, the project's reach is still limited compared to the potential target population.
- **Sustained Engagement**: Maintaining continuous audience engagement in a saturated digital environment is challenging.
- **Measurement of Long-term Impact**: Evaluating the project's long-term impact on viewers' career choices requires longitudinal follow-up, which has not yet been conducted.
- **Structural Barriers**: The project alone cannot address all structural and institutional barriers hindering female participation in STEM.
- **Low Perception of the Importance of Extension**: Universities need to actively commit to Extension, recognize and value the work of teachers in this area, expand the implementation of incentive policies, allocate adequate resources, and define evaluation metrics that reflect the importance of Extension.
- **Recognition of Extension as a Space for Research and Teaching**: Extension is where academic research translates into social impact, and teaching becomes a two-way street, allowing the University to engage with the community, share knowledge, and learn from its demands.

The potential demonstrated by the results of the "Elas nas Exatas" project, both through the channel and other activities, indicates that it is a tool we should continue to use to promote female participation in STEM. The innovative use of social media, combined with an approach based on established educational and psychological theories, has created a space of visibility and inspiration for women in these fields.

The diverse experiences shared by the interviewees provide a realistic overview of the challenges faced by women in STEM while also offering inspiring examples of overcoming these obstacles. This is particularly important in light of Chassot's (2003) [3] observations on the historical masculinization of science and the segregation mechanisms described by Olinto (2011) [9].

The positive impressions of the viewers, especially in terms of increased 5self-efficacy and broadened perspectives, suggest that the project is fulfilling its objective of empowering and inspiring girls and young women, aligning with the principles of self-determination theory (Deci & Ryan, 1985) [11], by promoting a sense of competence and autonomy in career choices.

Nevertheless, the project's challenges, particularly in terms of reach and sustained engagement, indicate the need for ongoing optimization and expansion strategies. Furthermore, the persistence of structural barriers highlights the importance of complementing initiatives like this with broader political and institutional changes.

Conclusion

The "Elas nas Exatas" project presents a methodology capable of addressing the underrepresentation of women in STEM fields.

The project demonstrates the potential to inspire and empower girls and young women to consider and pursue careers in these areas by combining research and university outreach, strategic use of social media, and strong educational theories. The diversity of the interviewees provided multiple points of identification for the target audience, reinforcing the importance of female visibility in STEM and contributing to increased confidence and broadened career perspectives for the participants. The project's results indicate the significant effectiveness of the digital outreach model, with YouTube as the leading platform, allowing for substantial reach and creating a valuable repository of experiences and knowledge. Nevertheless, the interviewees' accounts confirm the persistence of significant barriers for women in STEM, indicating the need for ongoing and multifaceted efforts. The perception of a gradual improvement in the situation of women in STEM suggests that initiatives like this can contribute to positive cultural change. To maximize impact, higher education institutions need to consider implementing similar projects, leveraging the potential of social media to reach and engage a broader audience. Furthermore, the experiences and reflections generated by the project can be incorporated into STEM curricula, promoting a perspective aimed at a sociocritical, inclusive, and diverse education to increase women's participation in these fields. Cross-sector partnerships and support policies are also crucial for expanding the reach and impact of initiatives like this. Ultimately, the "Elas nas Exatas" project represents an important step towards a future where the talent and potential of all individuals, regardless of gender, can be fully realized in the fields of Science, Technology, Engineering, and Mathematics.

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