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DEMYSTIFYING BORDERS: PROMOTING ACADEMIC LEADERSHIP OF WOMEN IN STEM IN «NON-STEM» HIGH SCHOOL SPACES

DESMISTIFICANDO FRONTEIRAS: PROMOVER A LIDERANÇA ACADÊMICA FEMININA EM STEM NOS ESPAÇOS «NÃO-STEM» DO ENSINO MÉDIO

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Abstract: **Introduction:** The United Nations' 2030 Agenda for Sustainable Development outlines goals for Quality Education under objective 4, which includes targets for eliminating gender disparities in education. Therefore, actions that aim to reduce gender disparity in Science, Technology, Engineering, and Mathematics (STEM) are relevant, given that girls and women continue to be underrepresented in this field and in leadership positions in Brazil. **Method:** We present a descriptive study with a qualitative approach, collecting data through the researcher's narrative technique based on an experiential report on the interactive lecture «Feminine Academic Leadership in STEM». This lecture was delivered to students enrolled in the Integrated High School Education with Professional Education (EMIEP) in a non-STEM professionalizing programs in Brazil. The interactive lecture encompassed five structured stages: sensitization, engagement, motivation, self-perception, and creative synthesis. **Results:** The primary results and considerations of this study advocate for the importance of implementing strategies and activities to develop academic leadership, both in STEM professional programs and non-STEM programs. The interactive lecture expanded the career perspectives of the students and prompted reflection on their self-efficacy perceptions.

Conclusion and Discussions: We address the significance of fostering feminine academic leadership skills from high school, contributing to sustaining the professional development of girls and women, as well as building a more inclusive and diverse academic environment. Thus, we also highlight the importance of future investigations into women's academic leadership in Higher Education.

Keywords: gender equality; leadership; women; STEM.

Resumo: **Introdução:** A Agenda 2030 para o Desenvolvimento Sustentável das Nações Unidas prevê no objetivo 4, que corresponde à Educação de Qualidade, metas para eliminar as disparidades de gênero na educação. Assim, são relevantes ações que buscam reduzir a disparidade de gênero em Ciência, Tecnologia, Engenharia e Matemática (STEM), uma vez que meninas e mulheres continuam sub-representadas nessa área e em cargos de liderança no Brasil. **Metodologia:** Apresentamos um estudo descritivo com abordagem qualitativa, com dados coletados por meio da técnica narrativa do pesquisador, a partir do relato de experiência sobre a palestra interativa «Liderança Acadêmica Feminina em STEM», que foi destinada a estudantes que cursam o Ensino Médio Integrado à Educação Profissional (EMIEP) em um curso profissionalizante não-STEM, no Brasil. A palestra interativa envolveu cinco etapas estruturantes: sensibilização, aproximação, motivação, autopercepção e síntese criativa. **Resultados:** Os principais resultados e considerações deste estudo defendem a importância da aplicação de estratégias e atividades para desenvolver a liderança acadêmica, tanto em cursos profissionais STEM quanto em cursos não-STEM. A palestra interativa proporcionou a ampliação das perspectivas de carreira das estudantes e a reflexão sobre suas percepções de autoeficácia. **Conclusão e Discussões:** Abordamos a importância do desenvolvimento de competências de liderança acadêmica feminina desde o ensino médio, aspecto que contribui para a manutenção da formação profissional de meninas e mulheres, bem como para a construção de um ambiente acadêmico mais inclusivo e diversificado. Assim, destacamos também a importância de investigações futuras sobre a liderança acadêmica de mulheres na Educação Superior.

Palavras-chave: igualdade de gênero; liderança; mulheres; STEM.

1. INTRODUCTION

The United Nations' 2030 Agenda for Sustainable Development outlines Goal 4, which corresponds to Quality Education (United Nations, 2015). This goal includes targets for eliminating gender disparities in education, as well as targets aimed at ensuring equal access for women and men to Technical, Vocational, and Higher Education.

Women's access to Higher Education and the expansion of female presence in universities are achievements supported by feminist struggles (Guedes, 2008). However, in Brazil, there is still low female representation in the fields of Science, Technology, Engineering, and Math (STEM) (Inep, 2020), both in undergraduate studies and in companies, particularly in leadership positions (Beck *et al.*, 2022; Rais, 2023; Unesco, 2021).

In order to reduce gender inequalities in education, various programs and projects with different purposes and actions have been established. One such program, initiated in Brazil in 2011 with a focus on the field of Computing, is the Meninas Digitais Program (Maciel *et al.*, 2018). This program encompasses partner projects, among which we highlight two: 1) the Meninas Digitais Mato Grosso Project (MDMT), which undertakes initiatives with students in Basic Education to stimulate interest in Computing careers (Figueiredo *et al.*, 2016); and 2) the Equality in Leadership for Latin America STEM (ELLAS) research network, which engages in activities related to female leadership in STEM in Latin America (Maciel *et al.*, 2023) and carries out an international-level project. These proposals work towards gender equity in the STEM field and are closely aligned with the focus of this study.

To enhance gender equity, it is crucial to implement actions across various educational levels, such as Integrated High School Education with Professional Education (EMIEP). EMIEP aims to integrate the content of high school education with technical-level professional training (Ribeiro, 2020), which students choose upon entering educational institutions that offer this modality, as outlined by Decree No. 5.154/2004 in Brazil.

EMIEP represents an «opportunity to simultaneously complete high school and acquire specific training for inclusion in the workforce» (Ribeiro, 2020, p. 43). Consequently, EMIEP students are already on a path of professional development, attaining a technical level in a specialized field.

As indicated by Ribeiro (2020), who conducted research with Integrated High School students in Informatics to explore the factors influencing their decision to continue or discontinue professional training in the field of Computing, being enrolled in EMIEP in Informatics alone is not a sufficient factor for students to stay in this field. Although exposure to the field contributes to retention, it is essential to consider the factors that either draw students closer to or distance them from the area.

In the face of this issue, we raise the question of how students in EMIEP in Secretariat, which pertains to a non-STEM professional formation, can develop an affinity and motivation for careers in STEM fields. Considering that the environment and educational content in EMIEP in Secretariat do not inherently stimulate immediate interest among students to pursue STEM-related degrees, exploring strategies to bridge this gap becomes imperative.

In light of this, we took action in a non-STEM professional programs within EMIEP, focusing on Secretariat, where the majority of participants are women. Our aim was to help broaden the students' sensitization of career possibilities in STEM fields to inspire them. We decided to center our efforts around the theme of academic leadership as a means to engage the students with STEM. Academic leadership can be understood through three key aspects: a) cultural, b) scientific, and c) administrative.

The cultural aspect encompasses academic leadership positions aimed at effecting changes in the culture and atmosphere of educational institutions. These transformations can be achieved through resource allocation, the implementation of institutional strategies, and the promotion of initiatives, such as educational projects, which may involve actions like mentorship (Luthi and Kosloski, 2023; Hodari *et al.*, 2014).

The scientific aspect addresses positions that drive professional development, such as participation in conferences, contributions to scientific journal editorials, coordination of research groups, engagement in technological innovation, and the achievement of high academic productivity (Liévano-Latorre *et al.*, 2020; Forte-Celaya *et al.*, 2021).

The administrative aspect pertains to academic leaders who assume formal positions of authority, often performing administrative management roles in schools and universities, such as rectors, academic directors, coordinators of student organizations, or professional societies (Su *et al.*, 2015; Parker and Welch, 2013).

With these definitions in mind, the initiative fostered discussions on academic leadership in STEM, which are presented as an experiential account in this study.

2. METHODOLOGY

This is a descriptive study with a qualitative approach (Bogdan and Biklen, 2007), focusing on the interactive lecture initiative «Feminine Academic Leadership in STEM». The lecture took place in the second semester of 2023 and was aimed at students enrolled in EMIEP in Secretariat, a non-STEM professionalizing programs, in Brazil. This initiative is associated with the MDMT project and the ELLAS research network.

The data were collected using the researcher's narrative technique (Macêdo and Caldas, 2011), which involves communication or the sharing of experiences (Grollmus and Tarrès, 2015). By employing this technique, the researcher is inherently connected to the study's results, synthesizing shared meanings within the experience. As highlighted by Macêdo and Caldas (2011), this approach proves suitable for the methodological systematization of the study while maintaining a scientific commitment. It is worth noting that narrative reports of experience do not require approval from a research ethics committee; thus, we adhered to all ethical considerations for conducting this study (Casarin and Porto, 2021).

The initiative took place as part of a programs event organized by the students themselves. A total of 62 students participated in the activity, representing all three years of the EMIEP program. The participants were predominantly female, with only 6 students identifying as male.

To conduct the initiative, one of the researchers from the MDMT Project and ELLAS research network, who is a psychologist, was invited as a speaker. The proposal was implemented as an interactive lecture, lasting for two hours. During this time, we chose to engage socially with the students to provide and elicit perspectives that would enhance their understanding of the scientific information presented. Other researchers from the involved projects supported the planning, execution, and subsequent documentation of the initiative, with leadership from the first author of this article.

The implementation of the interactive lecture comprised five structured stages: 1) Sensitization; 2) Engagement; 3) Motivation; 4) Self-perception; and 5) Creative Synthesis.

Regarding the structure of this experiential account, an effort was made to incorporate the researchers' lived experience of the initiative into the narrative. This includes the perception

and observations of the authors involved in the structured stages, all of which were documented as the study's results. It is emphasized that the authors' perceptions and observations were informed by theoretical frameworks related to feminine academic leadership in STEM.

3. RESULTS

One of the researchers from the MDMT and ELLAS projects, who is a psychologist, was invited to deliver an interactive lecture on «Feminine Academic Leadership in STEM» in a Secretariat program within the EMIEP program. With this invitation, we identified the programs interest in broadening the students' perception of career options in Higher Education. Consequently, we recognized the importance of implementing strategies and activities to develop academic leadership, both in STEM and non-STEM programs.

Initially, we established the structure for the interactive lecture, consisting of the stages enumerated in the methodology. The outcomes identified in these stages are presented sequentially.

3.1. Sensitization

To conduct the sensitization stage with students regarding the theme, we elicited their prior representation of leadership. As emphasized by Moscovici (1978), knowledge construction occurs both individually and collectively. In the process of identifying a social representation, the reconstruction of an object is observed, influencing the formation of a subject situated in a social and material universe (Alves-Mazzotti, 2000).

Therefore, to uncover the students' social representation, we carried out the following tasks: 1) Upon entering the room, students were given a post-it to write their names, and at the beginning of the lecture, they were invited to record a word symbolizing a desirable characteristic in a leader. 2) Some students were selected to introduce themselves and share the chosen word; students with similar or related terms would also stand up and present. 3) After four rounds of this procedure, an opportunity was given for any student wishing to share their word. 4) The post-its were collected and arranged on a cardboard sheet, forming a manual word cloud organized based on semantic proximity between the words.

Thus, utilizing cloud-shaped cardboard, post-its in three different colors, and pens, we manually created a «disconnected» word cloud, as illustrated in Figure 1.

Figure 1. Representative Word Cloud on Leadership Traits

Source: Photograph from the MDMT project collection (2023).

Through this method, it was observed that the most frequent words in the group were empathy, respect, patience, and communication. These words align with the traits of leaders in Authentic Leadership Theories (Pritchard and Grant, 2015), which represent «positive» leadership theories, including empowerment, transformation, charisma, spirituality, and authentic leadership, among others. These theories emphasize the establishment of a leader's legitimacy through honest relationships with followers, where the leader values contributions based on an ethical foundation.

Therefore, the social representation of a leader for this group deviates from theories that attribute leadership capacity as inherent and as a masculine quality, such as the Great Man Theory (Pritchard and Grant, 2015). This allows us to identify that the conception of leadership is intrinsically linked to the social context of the group.

Developing skills in Feminine Academic Leadership from high school, considering Authentic Leadership Theories, can contribute to the professional development of girls and women. According to Eriksen (2009), the proposal to develop leadership based on Authentic Leadership Theories helps students navigate their decision-making and actions, providing criteria for students to assess their leadership effectiveness. Authentic Leadership Theories assist students in defining themselves through their values and beliefs, allowing students to create a clear sense of self upon which they can base their leadership style (Eriksen, 2009).

3.2. Engagement

With the aim of assisting students in creating their sense of self, we proceeded to the engagement stage. In this phase, we took two steps: 1) categorizing feminine academic leadership and relating it to the personal experiences of the group; and, 2) defining STEM and connecting this field to the everyday actions of the students.

To execute the first step, we presented two categorizations of feminine academic leadership and asked students to try to associate examples with each category. The first categorization was related to administrative academic leadership, encompassing positions held by women. We explained that feminine academic leadership can be achieved by assuming administrative roles within the educational institution, such as academic or research coordination, directorship, or rectorship (Alotaibi, 2022). Students associated this category with the position of the student council.

With the second categorization, we illustrated that women within the educational community can exercise scientific and cultural academic leadership by playing roles that inspire others to follow in their footsteps or develop themselves, such as through mentoring initiatives (Gorman *et al.*, 2010). Students associated the second category with contexts they experience during their EMIEP education, such as taking leadership in a workgroup or event, or serving as role models to encourage other women facing challenges in academic organization.

Later, in the second step, we defined the STEM field by providing examples of careers within this domain, specifically in the field of Computing, such as Computer Science, Information Systems, Computer Engineering, Network Computing Technology, and Digital Games Technology. We asked the students about the challenges and potentialities they experience in the context of academic leadership within the institution, encouraging them to reflect on how this scenario might unfold in a STEM professional area.

We observed that this engagement stage with the theme allowed the students to consider academic leadership as part of their experiences. This phase also led to an expansion of the students' career perspectives regarding STEM professions and a reflection on their perceptions of self-efficacy, defined as the «ability of the individual to organize and execute actions to achieve goals» (Menezes *et al.*, 2020).

3.3. Motivation

To proceed with the motivation stage, we introduced topics related to Feminine Academic Leadership in STEM, including: cyberculture; the development of emerging technologies; interdisciplinary connections between knowledge areas; gender barriers in childhood that may impact personal choices; and female self-efficacy in common STEM disciplines such as mathematics.

Additionally, we shared current reasons, emphasizing that less than 30 % of students and scientists in STEM are women (Unesco, 2021); women can serve as inspiring role models for other women (Lima, 2013); the theme of Feminine Academic Leadership has been promoted in projects (Maciel *et al.*, 2023) due to its potential for social transformation; women,

especially in STEM, playing crucial roles in academic leadership, contribute significantly to promoting gender diversity (Su *et al.*, 2015); and investing in this theme represents a significant step towards cultural transformation (Baird, 2008).

Concerning the topic of inspirational women in STEM, we introduced a female leader in the STEM field who is a manager at a genetic research company in the United States. The showcased leader was a former student at the institution where the interactive lecture took place and had been part of the same non-STEM vocational programs as the participating students. Sharing female role models in the STEM field is an essential strategy, aiming to promote a motivational factor in the face of gender barriers experienced by women, especially in predominantly male programs (Herrmann *et al.*, 2016).

This strategy aimed to bring the students closer to the STEM field by also considering relevant factors, such as socioeconomic and intersectional aspects. These factors should not be overlooked during educational motivation initiatives.

3.4. Self-Perception

To promote the self-perception stage, we employed a strategy using guiding questions developed based on theories of gender in STEM (Reinking and Martins, 2018), such as the Gender Stereotype Theory (Cheryan *et al.*, 2015); the Gender-Based Socialization Theory (Dasgupta and Stout, 2014); and the Peer Group Theory (Leaper *et al.*, 2011).

Eight guiding questions were formulated, in the form of questions, with the following purposes: 1) The first: «Which subjects do you feel more encouraged in high school?», aimed at subjects encouraged in STEM and non-STEM; 2) The second: «Is there any preconceived idea about gender that influences your academic choice?», related to the theory of gender-based socialization; 3) The third: «Do you believe that in your next professional choice, being in a place surrounded by peers of the same gender as you is important? Does it influence your choice?», referring to the theory of peer groups; 4) The fourth: «Considering your experience and the image you have of a person in the STEM field, do you believe that this person has specific personality traits or characteristics?», addressing the theory of gender stereotypes; 5) The fifth: «What skills do you recognize as yours, and which ones would you like to develop?», directed for students to identify their personal qualities; 6) The sixth: «When thinking about the professional position you want to achieve, what is the first skill you believe you need to develop?», aiming to stimulate strategies to improve skills, focusing on authentic leadership; 7) The seventh: «What feeling do you most often experience when recognizing a career opportunity? What is your automatic reaction?», with the purpose of addressing cognitive and behavioral reactions to career and academic opportunities; and 8) The eighth: «How can we recognize gender barriers in professions?», aiming to provoke reflections on identifying gender barriers in professional careers.

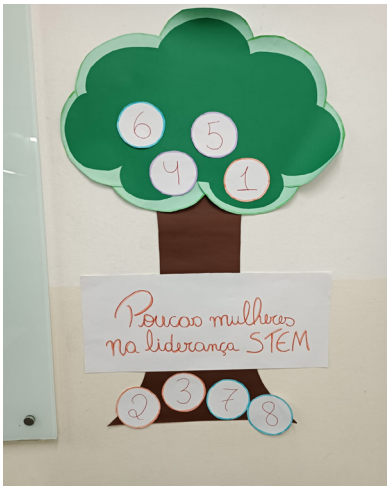
The purpose of the guiding questions was to provide the inducing theme for reflections on the listed purposes. The speaker delved into these reflections during interactions with the students, drawing on her expertise in the fields of Psychology, Education, and Academic

Leadership in STEM. Additionally, we chose to incorporate theories on gender in STEM as part of the guiding questions, aiming to prompt the students to reflect on self-efficacy, the influence of relational environments, and the recognition of stereotypes formed about professionals in the STEM field.

3.5. Creative Synthesis

For the Creative Synthesis stage, and for students to share their insights, a cardboard tree named the «Solutions Tree» was brought to the presentation (Figure 2).

Figure 2. Solutions Tree crafted during the action on Female Academic Leadership in STEM



Source: Photograph from the MDMT project collection (2023).

The solutions tree was adapted from a technique known as the problem tree (Siqueira *et al.*, 2019). In the interactive lecture, we identified the central problem as the scarcity of women in STEM leadership, which was written «Few women in STEM Leadership» on cardboard and placed on the tree trunk.

Faced with this problem, we asked the students to select factors contributing to the cause of this central problem. The chosen factors were: few motivated female students in STEM areas; low gender diversity in professions; gender stereotypes and barriers; and low cultural change. These factors were written on a slide, numbered, and positioned at the roots of the tree.

Next, we asked them to identify the effects that may arise due to the central problem. The identified effects were: limited technology for females; women perceived as less qualified for science; low recognition of inspiring women in STEM; and the need for investment in

projects for women in STEM. Similarly, these effects were described on a slide, numbered, and arranged on the branches of the tree.

Lastly, we conducted an activity on the essential actions and investments to change this situation. In the exercise, we used affirmative verbs aimed at triggering transformative actions, such as increase, encourage, and combat.

Through this interactive and dynamic strategy, it was possible to observe the acquisition of knowledge about some of the challenges faced by women in seeking leadership positions in STEM academia. Additionally, we can infer that the content learned during the lecture may have significant impacts on the process of career decision-making.

4. FINAL CONSIDERATIONS

This experiential account highlights the importance of developing female academic leadership skills from high school onwards and conducting STEM-themed activities in non-STEM spaces.

With the results, it was possible to observe the importance of bringing EMIEP students closer to both STEM and non-STEM professional programs with the theme of Female Academic Leadership. Among the factors observed during the experience, we identified that the students were able to relate the leadership theme to their experiences and educational context.

In encouraging reflections on the topic, the lecture facilitated an expansion of perceptions regarding the possibilities of pursuing STEM careers. It was observed that the students gained new insights into STEM professions and felt motivated towards this field, factors that could broaden their reference points for career choices.

From an operational perspective, the feasibility of conducting «unplugged» activities in educational institutions is emphasized, similar to the teaching of Computational Thinking in Basic and Higher Education through the use of Unplugged Computing (Sassi *et al.*, 2021). Thus, activities can take place even without access to technological devices. In initiatives like this, it is crucial to have more than one operational plan and not be entirely dependent on technologies.

In light of the above, we consider that the interactive lecture was crucial in providing students with exposure to the concept of female academic leadership and the STEM field. Besides facilitating learning about this subject, it contributed to professional development, reducing gender-related limitations in leadership positions, suggesting viable paths for future careers, and proposing a strategy for socioeducational and cultural interventions.

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