

Work-in-Progress: Encouraging Girls in Science, Engineering and Information Technology

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Abstract—This work is related to the Project “Encouraging Girls in Science, Engineering and Information Technology” that is underway at the University of Caxias do Sul. This project aims to involve elementary and high school teachers and students in discussions related to formal education, which can enable them to experience teaching activities and processes that explore the experimentation, and to disseminate in the society the knowledge and technological applications used by the Sciences and Engineering. Based on the planning of a teacher training course for the project's five co-running schools, hands-on workshops, a Science and Astronomy Club, Science and Technology Fairs, Mathematical Olympics, Chats with Scientists and Engineers, and Science at the Movie Theater are being carried out. The results already obtained show that, the way the activities are being promoted, it is possible to contribute to the scientific and technological development and innovation of the country by encouraging the participation and training of girls and women for careers in the Exact Sciences, Engineering and Information Technology; contribute to the insertion of more and better female elementary and high school students in the scientific and technological fields, as well as to reduce the impact of gender inequalities on the career choices of elementary and high school students.

Keywords—gender, girls in STEM, elementary school, high school, integration university-school-community.

I. INTRODUCTION

Over the past few decades, the small number of female Engineering and Exact Sciences students, as well as scientists and engineers working in the western world has been the subject of debate among researchers concerned with gender issues and the importance of female participation in Science, Technology, Engineering and Mathematics (STEM) [1-13].

In Brazil, the process of insertion of women in scientific and technological careers occurred in the same proportions as in other countries of the world, however, during much of the twentieth century there was still a great prejudice related to women's aptitude or even to their intellectual abilities to pursue these careers [10].

In this context, incentive programs and valorization of female participation in STEM are presented as a solution through which this scenario may have possibilities to be reversed. In late 2018, the National Council for Research

and Development (CNPq) launched a public call aimed at supporting projects intended for stimulating the education of women for careers in Exact Sciences, Engineering and Information Technology in Brazil, arousing the vocational interest of female students from basic education (elementary school from the 6th to 8th grade and high school) for scientific and technological research. This public call also aimed to combat the dropout in higher education of female students of undergraduate courses in these areas, which occurs mainly in the early years, as well as to bring public schools closer to institutions of higher education. More than 700 proposals were submitted, of which 70 were approved.

This paper reports, therefore, the preponderant actions of one of these projects approved in the referred public call of CNPq, and that is underway at the University of Caxias do Sul, a community institution of higher education located in the southern region of Brazil. This project, called Encouraging Girls in Science, Engineering and Information Technology is developed in partnership with five public elementary and high schools in the region of the university and is coordinated by a team of instructors that has been promoting for over ten years, various activities to encourage girls in the field of Exact Sciences and Engineering.

The central actions of the project were equally proposed to the five co-executing public schools, with the following objectives: to develop STEM activities; implement a continuing education course for teachers; create a Science and Astronomy club; run hands-on workshops; promote scientific and technological fairs; organize a mathematical Olympics; create an activity of Science at the movie theater; and promote chats with scientists and engineers.

These actions were proposed with the intention of valuing the school as a strategic and important space for the promotion of good pedagogical practices, to approximate the public elementary and high schools and the university, to encourage students from these schools to careers in Exact Sciences, Engineering and Information Technology and to combat the dropout, which occurs mainly in the early years, of academics of these courses, creating opportunities for them to act as scholarship holders for research and extension projects.

The methodology of planning and carrying out the project actions involves the joint action of the participants of the university and the co-executing schools. This team, which comprises 13 faculty and five undergraduate students

from the university, along with five teachers and 15 undergraduate students from the co-executing schools, is responsible for designing and applying the activities to an estimated population of approximately 1,000 students from the co-executing schools.

In order to achieve the proposed objectives of this project and to overcome teaching practices based on “chalk and teacher speech”, the project activities are conceived considering active learning strategies and methods [14-21]. The activities aim to establish connections between the basic knowledge of the Exact and Natural Sciences and the elementary and middle level Mathematics and the practical applications to solve real problems of students' daily lives, including environmental issues, within the scope of the Exact, Engineering and Technologies.

Current teaching and learning strategies and methods consider that students, to accomplish a task, engage in a continuous process of complex thoughts of three types: scientific, critical, and creative [22]. To this end, learning activities, such as those proposed in this project, in the format of challenges, problematizations and competitions, can make knowledge accessible as it promotes the development of the autonomy of those involved in the process.

In the same way, the different learning environments, workshops, science at the movie theater, chats, mathematical Olympics and those of science clubs, are collectively elaborated, seeking to promote the knowledge building and to promote interdisciplinary posture and practice, based on the study and understanding of phenomena in focus and the basic concepts of the different sciences involved and how they collaborate and are integrated in the search for solutions to problems of interest. An interdisciplinary attitude imposes the need for the team to integrate objectives, activities, procedures and attitudes in planning generated by interdisciplinary exchange and dialogue [23].

The proposal of this project assumes that the representations and contextualization of themes in the Exact Sciences and Mathematics areas consider, among other aspects: the relationship between individual and object; the student's role as an active individual; the act of understanding, inventing, rebuilding; and the relationship of the areas with aspects present in the student's social, personal and cultural life. With this, the emphasis can be given to contents that evidence practical applications, related to problematizing situations that encourage students to think, to conjecture and plan the search for solutions and, thus, developing their intellectual autonomy.

Given these considerations, the following sections describe each of the proposed activities and preliminary results are presented. Section II is dedicated to the Continuing Education Course for Teachers in Science and Mathematics Teaching, presenting the planning and actions already taken. Section III presents the proposal for the creation of the Science and Astronomy Club and its activities. Section IV presents the hands-on workshops, from their planning to the results already obtained based on the ones already applied. The Scientific and Technological fairs, already held, are described in section V, followed by section VI, which presents the Mathematical Olympiads, in execution. The last two planned and under development events are presented in sections VII and VIII, respectively

for Chats with Scientists and Engineers and the Science at the movie theater.

II. CONTINUING EDUCATION COURSE FOR TEACHERS IN SCIENCE AND MATHEMATICS TEACHING

The Continuing Education Course for Teachers in Science and Mathematics Teaching was proposed as the space where all activities and events of this project are presented, discussed and planned to be developed in each of the co-executing schools, in order to involve the participating teachers, as main characters involved in the continuity of the actions being promoted in the project. In addition to the continuity of the actions promoted, along with girls and other teachers and school managers, these teachers are being multipliers of ideas and innovative individuals in proposing new actions.

Course development takes place in parallel with the activities presented in the following sections. In the course meetings, the discussions about theoretical aspects are expanded considering scientific, technological, pedagogical and other knowledge related to the competences and skills to be developed by the participating students.

Following the project schedule, for each new situation, together with the undergraduate scholarship holder students, the teachers interact with the project instructors, who designed the workshops and other activities so that they can know, reflect and discuss the fundamentals. and inherent methodologies. Secondly, the workshops and activities are held together with the students, who are the scholarship holders, from the elementary and high schools.

From each experience in which the learning of scientific and pedagogical concepts is promoted, the teachers have the task of adapting the plans, adjusting them to the reality of their schools. With this, and with the help of the fellowship holder girls, and whenever necessary with the undergraduate students, the teachers apply the same workshops and other activities in the co-executing schools, multiplying the number of participating girls, and then have the opportunity to minister the same. learning situations that they experienced at the university.

With such considerations, the next section describes the planning and development of the Science and Astronomy Club.

III. SCIENCE AND ASTRONOMY CLUB

The Science and Astronomy Club was designed to be created and managed at each co-executing school by the responsible teacher and fellow students of the project under the guidance of the coordinating team from the university. The Science and Astronomy Club aims to provide a space in the school where students can reflect, discuss and engage in issues related to science, technology, society and the environment, as scientific issues are not isolated from the social, political, environmental and economic context. The activities carried out at the Science and Astronomy Club take place during overtime and focus on studying, solving complex problems, developing projects and debates on topics involving science and technology. In this context, the club is

the place where the “members” expose their ideas, their curiosities and seek to build knowledge, collaboratively, and using the scientific methodology. The activities promoted at the club have the potential to broaden the students’ horizons regarding the world outside the school and the numerous possibilities of acting as citizens and professionals. Therefore, students have opportunities to know what is beyond the school environment, acquiring a more global human formation, not only based on pragmatic or technical experiences.

IV. HANDS-ON WORKSHOPS

The activities developed in the workshops are first presented in the Continuing Education Course, in 1 or 2 meetings. In the project, six workshops were proposed: Astronomy; Preparation of alcoholic tincture from fresh plants; Solid waste; Smartphone resources; Digital media information systems; and Computational thinking and Robotics. Each of them is prepared by university instructors who, at the first meeting(s), present their planning to the teachers and undergraduate scholarship holders, in the form of studies of theoretical foundation of the contents involved, promoting discussions about the methodological proposal for its application. The following meeting is then intended for the application of the respective workshop, still at the university, for teachers, scholarship holders from university and from elementary and high schools, who, in addition to experiencing the activities, have the opportunity to deepen knowledge and discuss questions that have about content, and methodological or evaluation aspects. From this preparatory meeting, the workshops are adapted by the co-executing schools’ teachers, based on new planning, to their respective realities and then applied to other students, with the accompaniment of the scholarship students and the support of the undergraduate scholarship holders, constituted as actions of science clubs from then on.

In addition to the workshops, other activities, by the initiative of each school, are part of the Science and Astronomy Clubs, but all are committed to promoting research in their clubs, developing projects for a local science fair and participating in a regional scientific fair organized annually by the University of Caxias do Sul.

V. THE SCIENTIFIC AND TECHNOLOGICAL FAIR

The scientific and technological fair, organized in each co-executing school, is an activity in which the students of the co-executing schools present research projects developed during the year. The fair has among its main objectives [24]:

- arouse and/or develop a taste for research and experimentation;
- develop students’ creativity and critical thinking;
- develop students’ social habits and attitudes and a sense of responsibility;
- develop students’ specific skills, interests and competences;
- integrate the community with the school

To achieve these goals, students develop activities in the form of projects, always guided by teachers who are participating in the Continuing Education Course, in which one of the subjects is Research Methodology.

The Scientific and Technological Fair is an activity organized and coordinated by the scholarship holder teacher of each co-executing school and assisted by the students of the Science and Astronomy Club.

VI MATHEMATICAL OLYMPICS

The Mathematics Olympiad (OlimMat) was proposed as a cultural and recreational action, offered to all students from 6th to 9th grade of elementary school and to high school students from co-executing schools. Students participation is voluntary and OlimMat aims to:

- stimulate and promote the study of Mathematics in the participating schools;
- contribute to improving the quality of basic education in these schools;
- promote the diffusion of mathematical culture;
- identify young talents and enthuse them to pursue careers in science and technology at the higher education level;
- encourage the improvement of the teachers of the co-executing schools of the project, contributing to their professional appreciation;
- contribute to the integration of the schools involved, among themselves and with the university;
- encourage students to participate in the Brazilian Public Schools Mathematics Olympiad (OBMEP) (OBMEP - <http://www.obmep.org.br/>)

Thus, inspired by OBMEP, OlimMat was carried out in two phases, preceded by approximately twelve weeks of student preparation by the undergraduate scholarship holders, who produced support material, with the supervision of the instructors responsible, making it available in the virtual environment of the project. For this preparation, a planning was carried out at the university, with elaboration and discussion of questions, around the following selected themes: mathematical patterns, logic, diagrams, mathematical operations, equations, inequalities, flat geometry, analytical geometry, fraction operations, basic statistics, mathematical expressions and percentage.

This material was then used at the co-executing schools, where weekly meetings aiming to prepare the students for "pre-Olympics" were held. Students were followed during the resolution of questions, in stages: in the first stage, discussions were held on one of the above themes; in the second stage, they were then given questions to solve, and at the third stage of each meeting, the answers to the questions were provided and the winners were awarded symbolic prizes.

As a culmination of the studies, an Olympiad was held at each co-executing school and, according to the performance results, a selection of students was made to participate in an Olympics at the university in the form of a competition between the co-executing schools.

VII. CHATS WITH SCIENTISTS AND ENGINEERS

Chats with scientists and engineers are scheduled to take place at the university. Schools are invited and are in charge of transporting their students, as many as they are interested in participating, to meet women who talk about their lives, education path and practices as scientists and engineers, which are part of their struggles, discoveries and creations in Science. Then, in each school and from the chats, activities are derived, usually suggested by the participating students.

Giving teachers and students the opportunity to integrate in a varied, systemic, interdisciplinary and contextualized way with scientists and engineers helps to improve the quality of teaching and learning in educational institutions, providing greater involvement of students in the process of their education and career choices, and in reducing evasion.

VIII. SCIENCE AT THE MOVIE THEATER

The activity “Science at the Movie Theater” was designed to be used as a strategy in the teaching and learning processes, with the conviction that to educate through movies or to use movies in the school process is to teach to see differently. It is educating the way we look at things, at events, at conflicts. As in all areas of knowledge, movies can address subjects of Physics, Mathematics, Chemistry, Biology, Engineering and Science in general. The importance of showing movies that address these areas is also due to the fact that the world is increasingly dominated by technology, so that fiction and reality get confused and, therefore, debate about advances and consequences, in a critical reflection with students, becomes an activity with potential for knowledge building. The selected movies, in addition to having their themes centered on STEM or important social aspects, feature important female characters that can serve as a model and inspiration for the girls participating in the project.

IX. PARTIAL CONCLUSIONS

The project is under development, with activities planned until June 2020. From what can be said, up to now, regarding the activities already carried out:

- five Hands-on Workshops were held at each of the co-executing schools, involving approximately 500 girls;
- the Science and Astronomy Club, already existing in some of the schools, was created in the others, creating a scientific and technological fair in each of the schools.
- at the University of Caxias do Sul was held a regional scientific and technological fair which was attended, among other schools, by all schools co-executing of this project;
- As an activity of the Continuing Education Course, following the completion of the regional scientific and technological fair, all projects presented by teams from the co-executing schools were the object of analysis of the evaluations received, with a view to improving them for the next edition;
- a chat with an astronomer was promoted and it was attended by approximately 100 students;

- As an activity of the Science at the movie theater, the movie “Agora” was presented and later discussed. This movie tells the story of Hypatia, philosopher and teacher in Alexandria, Egypt, between 355 AD and 415 AD (<https://www.imdb.com/title/tt1186830/>). The only female character in the movie, Hypatia teaches Philosophy, Mathematics and Astronomy at the Alexandria School, next to the Library. She devoted her life exclusively to studies and her main concern, in the movie's point of view, is with the movement of the earth around the sun;

- OlimMat is scheduled, as reported in its section, with prizes for winners this time, including boys. The first three places for girls and boys will be awarded, as well as their teachers and schools.

The results have been promising and have motivated us to continue, believing that the activities being promoted can contribute to the formation of more and better female engineers or scientists in the STEM areas, through the development of skills, in an articulated way with the construction of knowledge, the development of skills and the formation of attitudes and values.

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