24th COBEM - 2017

24th ABCM International Congress of Mechanical Engineering
December 3-8, 2017, Curitiba, PR, Brazil

COBEM-2017-2445
FAST GIRLS PROJECT: ENCOURAGING GIRLS IN STEM

Bárbara Xavier de Melo do Nascimento
Eliza Mieka Sakazaki
Luana Mila de Souza Matos
Maryana Oliveira Ananias
Aline Souza de Paula
Maura Angélica Milfont Shzu
Suzana Moreira Ávila
Victoria Venceslau S. Costa
Grazielle Diniz Lopes
Ingrid C. da S. Bezerra de Menezes
Karine Quaresma Lima
Karollyne Araújo da Costa
Sibelle de Jesus Ferreira
Dianne Magalhães Viana
Tânia Mara Campos de Almeida
University of Brasilia, Brazil
barbara.xmn@gmail.com**,** miekazaki@gmail.com, luana.mila@gmail.com, maryananias96@gmail.com, , alinedepaula@unb.br, maura@unb.br, avilas@unb.br, victoriavenceslau@hotmail.com, grazielle.diniz10@gmail.com, ingridcristian@bol.com.br, karinequaresma1997@gmail.com, karoll.araujo2306@gmail.com, sibelle.jesusferreira@gmail.com, diannemv@unb.br, taniamaraunb@gmail.com

Abstract. *Noticing that the lack of equality between men and women is still very present in the engineering fields in universities throughout Brazil, the Fast Girls project was created in order to bring more women to the engineering courses in the University of Brasilia (UnB). The project focuses on working with girl students from a public school in Santa Maria - DF, in which students and professors from UnB are responsible for creating workshops involving Science, Technology, Engineering and Math (STEM) concepts and how one can apply the mentioned subjects on daily situations, in order to teach important concepts belonging to the math/physics field to high school girls. In addition to that, based on the notes of the process conducted - in the daily workshops, we have made a point to observe if the project positively impacts the perspective these girls have of their futures, based on reports made by the students while they spent time at the workshops, and also serving as evidence that the Fast Girls Project can positively influence these girls' lives. The teenagers pointed out the relevance of the "Fast Girls" project to the participating group, although not all of them were attracted to courses related to the Technological areas, they qualified the fact that through the project they were able to get to know a university and approach the women who made their way in engineering.*

Keywords: *Gender, education, engineering, STEM, woman.*

1. INTRODUCTION

Despite the changes some public policies have been promoting in higher education and, consequently, in high school education, other actions are still shy, such as those that can modify the lack of girls access to technological areas and the lack of less favored women´s presence in the scientific-technological field careers.

The IPEA Research (2010) indicates that the female presence in higher education is significant, and focuses mainly on courses that have characteristics related to care, such as Pedagogy, Psychology, Nutrition, Medicine, Social Work, a secular position built for women in the social context. On the other hand, other areas of knowledge, such as the technological ones, still do not count with a significant female participation in their courses.

With reference to the participation of women in some professions characterized by the greater masculine presence, some areas of Engineering stand out for the enormous difference in relation to the feminine presence. Despite this fact,

Lombardi (2015) states women participation in engineering has shown some growth. The author points out that, in Brazil, the female representation in engineering was from 16.8% to 20.6% between 2003 and 2013.

Freitas (2013) reveals that female participation is more concentrated in the Chemical Engineering, Forestry and Environmental Engineering course. On the other hand, there are few new girl students in the Mechanical and Electrical Engineering courses.

While there has been a breakthrough in gender issues, courses in the technology areas remain largely attended by men, emphasizing inequalities in education. According to studies carried out in 2010 by the Ministry of Science, Technology and Innovation, although the number of men and women graduates is practically the same, this fact is more evidenced in the human sciences. According to the research, 64% of scientists are men (RIGHETTI, 2016; OLIVEIRA, 2013; MACHADO, 2015).

In fact, there is a low female participation in scientific education, technology, engineering and mathematics (STEM) and, consequently, STEM careers not only in Brazil, but also in the world.

In the intermediate years of studies, boys' and girls´ preference is equivalent in relation to the areas of Science and Mathematics, however, at the end of high school, there is a great reduction in the number of girls who plan to continue STEM studies at university.

This can be observed through data from the Brazilian Public Schools Mathematics Olympiad (OBMEP), in which the number of girls enrolled in the competition tends to stay stable during scholar life. In 2015, the number of girls in the OBMEP raised from 47.6% in the sixth and seventh grades to 50.5% in the eighth and ninth grades. What changes is that their performance goes down. And thus, they tend be discouraged from applying to an academic career in exact sciences (RIGHETTI, 2017).

And from that point on, stereotypes, gender prejudice and the hostile climate of certain academic circles and workplaces increasingly make women's participation and progress more difficult.

The quest for gender equality, especially in labor relations, includes demands on the international political agenda present in the United Nations (UN) and United Nations Educational, Scientific and Cultural Organization (UNESCO) programs. They claim articulation between institutions, government agencies, segments of society and schools through interdisciplinary projects aimed at raising girls' awareness on the importance of gender equity in the various segments of the social State.

In the sense of deconstructing a cultural feminine position, which directs girls to the care-oriented areas, the "Fast Girls" project proposes to reduce the asymmetries between the genres in Engineering. Thus, the "Fast Girls" project offers teenagers the opportunity to get to know the basic concepts of sciences, technology, engineering and math, as well as the trajectory of women who have traced the professional path in these areas, to encourage girls to STEM careers. And it provokes disruption with gender stigma, considering girls to be fitter for human areas, while boys, to the exact areas.

2. THE "FAST GIRLS" PROJECT

The "Fast Girls" project, an initiative of the Faculty of Technology at the University of Brasilia, together with the CEM 404 Santa Maria High School in the Federal District, is responsible for conducting workshops, activities and experimentation with technological themes for female students in situations of vulnerability. The project organization involves the high school students who participate in the proposed activities, the engineering undergraduate students responsible for developing and applying the activities and the teachers who guide and accompany them throughout the process. The project has an interdisciplinary female group composed of engineering students and teachers, pedagogues, psychologists and sociologists. Meetings with the high school students are held once a week. University intervention in the community is of extreme importance for a positive change in society. The objective of the project is to raise the discussion of women´s role in society, to stimulate the girls to follow the academic career in the technological and related areas and, more importantly, to make them aware that they have the right to equal choice regardless of gender and race.

In this sense, the Fast Girls Project reflects the social commitment of the Faculty of Technology with social inclusion and gender equity in the technological careers, particularly in engineering. In addition to the objective of promoting the interest of high school students in exact sciences and technology, aiming to awaken vocations and motivate improvements in training in these areas, the Fast Girls project objectives also aim at awakening undergraduate students in Engineering for social problems, involving them in the construction of a motivating teaching-learning environment and in the discussion on social inclusion and gender issues in Engineering.

In this perspective, the Fast Girls project was based on the theme of "competition cars", considered as a masculine area of high technological level, providing the necessary context for didactic-pedagogical interventions. The idea is to create a teaching-learning environment with institutional support, based on active methodologies, based on the teaching-research-extension tripod.

The teaching-learning environment is centered on workshops held throughout the year, mainly exploring concepts related to Physics and Mathematics for the conduction of activities with an initial playful nature that evolve to scientific initiation involving mechanical and organizational aspects around automobiles and competition teams. In addition to the

workshops mentioned above, technical visits, social integration dynamics and interactive lectures are held, providing meetings among the project's adolescents, with women from the technological and engineering areas, who are invited to present testimonials about their careers and professional career.

The proposed environment is also organized at functional levels. In the first level there are High School students, who carry out the activities planned in each workshop and participate in the events and meetings promoted. In the second level there are the Engineering students constituted in teams responsible for proposing, developing, applying and analyzing the results of the thematic workshops on learning. The last functional level corresponds to that of the teachers, who are responsible for guiding, making the necessary adjustments and monitoring the entire development of the project. After the completion of the project, the teachers, in partnership with undergraduate students, evaluate the learning process results.

To follow, the methodological approach and also the detailing of the project will be presented through the organization and implementation of the teaching-learning environment.

3. METHODOLOGY

The project is much more than an university extension proposal. This is an action research on STEM education for girls, supported by researchers in Engineering, Education, Psychology and Social Sciences. All participants involved in the development of the project are also its structurers, and so, responsible for the continued development of learning environments, methodologies employed and analysis of results. These steps have been taking place simultaneously.

The methodological proposal for the learning environment has as a guiding approach the active learning, which refers to a set of pedagogic activities that encourage the student to seek knowledge autonomously, as well as meaningful learning. The latter is characterized by an interaction between concepts and relationships brought by the student and the new information or concepts that must be consolidated through teaching and learning activities. In order for learning to be meaningful, it is intended that new information acquire meaning and "be integrated into the cognitive structure in a non-arbitrary and non-literal way, contributing to the differentiation, elaboration and stability of existing knowledge..." (BUCHWEITZ, 2000, p. 1).

Also, the approach used is based on collaborative learning, which focuses on natural learning as opposed to "training" from structured learning situations. The results can be enhanced by teamwork where students have the possibility to think about the problems that are proposed to them and create their own learning situation.

A learning environment is organized through workshops consisted of the following activities:

- Group dynamics;
- Interactive games;
- Hands-on experiments;
- PBL (problem-based learning)
- Talk meetings about professions
- Talk meetings about gender
- Photolanguage experiences

Group dynamics for social integration are applied in the initial phase of the project and again after the mid-year recess due to possible changes in the original team. The interactive games, hands-on experiments and PBL are teaching-learning strategies carried out in teams and inserted in the STEM thematic workshops with spaces for thought on the concepts of STEM involved. Talk sessions on professions and on gender can be included in the scope of the thematic workshop or after a proposed talk about gender or professions.

This pedagogical methodology is attractive because it allows the student to be an active subject in the construction of his / her own knowledge so that a meaningful learning can be processed, which implies giving meaning, meaning and functionality to what is learned. This way of intervening allowed the adolescents an approximation with contents often feared by students in general, such as Mathematics and Physics.

In the experience carried out in 2013, the motivational environment was promoted by thematic workshops conducted by Engineering students who studied, planned and applied teaching-learning methodologies and technologies. It is worth remembering that participating in this construction was a new experience for engineering graduates, who had to evaluate the procedural challenges of the activity with the teenagers.

Based on the previously established assumptions and the defined methodological approach, in order to make the learning environment possible, it was necessary to overcome some challenges, such as: building a motivated team, identifying the needs of the target public, defining a plan of action and seeking institutional support and financial resources for teaching materials, transportation and food.

The resources are limited and project team need to raise funds within the university and, externally, seek sponsorship each year. Transportation is provided by the university as scheduled, and classrooms and laboratories are available during free time.

4.1 Project team and target audience

The project was started in 2013 by a multidisciplinary group, composed of 4 engineering professors, 2 high school teachers, 15 undergraduate students and 4 support professionals, who worked on the planning, execution, control and assessment process. The two high school teachers contributed with the pedagogical support and the integration of project proposal with the school activities. Education and Psychology professionals provided a space for reflection and discussion on gender issues and the way this questions are posed in the project process for developing activities. The non-teaching professionals provided the administrative and technical support to the execution of the activities.

Currently, the organizing team has two more professors, from Social Sciences and Psychology, responsible for studies on gender and social behavior. The undergraduate students come from Engineering and Social Sciences. Almost all participants are volunteers, except one who is a scholarship by an outreach program from UnB Extension Deanate.

Each year, twenty high school students are attended by project and all of them are scholarships of CNPq scientific initiation.

4.2 "Modi operandi"

There are four types of activities proposed: The dynamics of social integration occurs at the beginning of each semester and aim to bring the undergraduate and high school students closer together; the teaching-learning workshops are moments of practice and reflection about the knowledge explored; the visits can be technical or cultural either to broaden the knowledge or to motivate reflections related to the genre; and interactive lectures, generally open to all students of the school, aims to clarify doubts about engineering courses and related areas and ways of joining the university. Whenever necessary, meetings with undergraduate or high school students are held to address some specific aspect related to the planning and development of project activities.

Figure 1 shows the process during the first semester. The school semester begins with project presentation. The second semester begins with another group dynamics, the sequence of activities interspersed and ends with a closing event. In addition to the project development phase itself, there is a pre-project stage when the annual planning and a post-project phase are carried out when the project results are evaluated and the changes to be carried out in the following year are discussed.

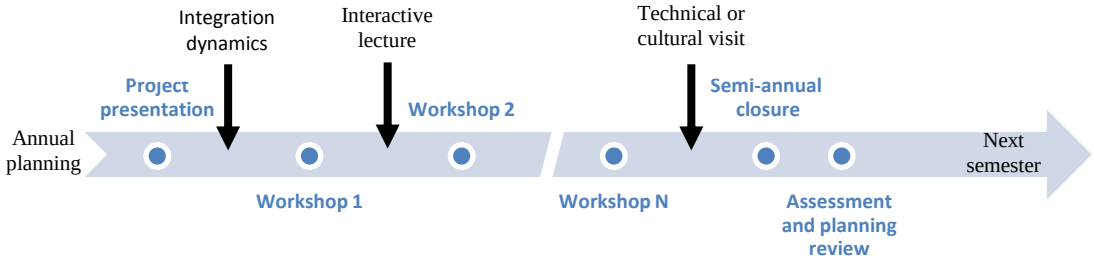


Figure 1. Semi-annual timeline.

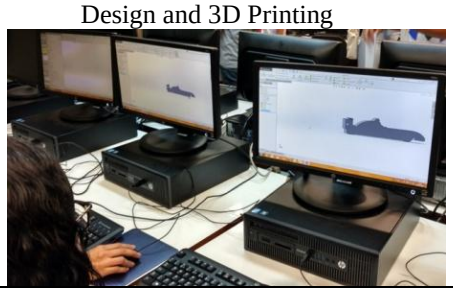
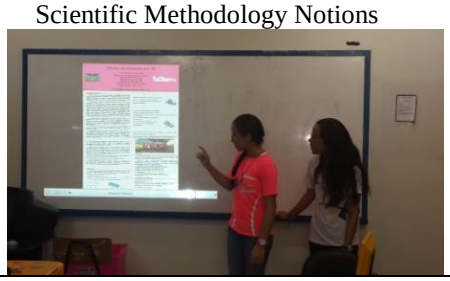
4.3 Thematic STEM workshops

Some thematic workshops are presented in Table 1. The first experience of 2013 was refined each year, with a greater emphasis on practical activities, hands-on and sometimes introducing problem-based learning (PBL) within the scope of workshops.

4.4 Thematic photolanguage workshops

Since the project involves women motivation to the exact areas, it was considered important to identify the gender conception in the school space and the relationships between women, education and technological areas. In that sense, during 2016, five photolanguage workshops were included under the coordination of Psychology and Pedagogy researchers, whose methods and results are detailed in Alencar (2017).

Table 1. Examples of Thematic STEM Workshops.

Thematic STEM Workshops	**Learning Goals:**	**Approaches:**
Vectors and Measurement Units 	• Understand / Consolidate operations with vectors; • Understand / Consolidate measure units for time, displacement, velocity and acceleration.	Interactive game. Graphic representation with vectors; Use of map representing the region that the students attended live; Teamwork. Challenge task: Elaborate an additional step to the game
Time and Movement 	• Understand / Consolidate the knowledge about displacement, velocity and acceleration calculations. • Understand and use measuring instruments. • Understand concepts related to speed up and braking in vehicles.	Practical activities involving measurements; Teamwork. Challenge task: Build graphs from collected data.
Velocity and Acceleration 	• Understand / Consolidate the knowledge about force, velocity and acceleration calculations. • Solve problems and analyze results.	PBL and hands on activities. Teamwork. Challenge task: Planning, assembling of experiments, execution and analysis of results.
Design and 3D Printing 	• Understand and use a CAD software. • Know prototyping tools.	Directed activities in computer and prototyping labs. Individual work. Challenge task: Draw a peace using SolidWorks software and reproduce it in a 3D printer.
Scientific Methodology Notions 	• Apply notions of scientific methodology to elaborate and present a work. • Use edition and presentation tools.	Activities in computer labs. Teamwork. Challenge task: Elaborate and present a banner about a workshop held.

The photolanguage method consists of using as an instrument a set of photographs in the scope of the subjects that it is intended to investigate. According to Schmidt Neto (2012) the dynamics of photolanguage is an interesting tool for

the exercise of symbolic thinking. The goal is to provoke relations, associations and comparisons, to the reality of each participant - that transcends the immediate meaning of the image - within the group dynamic.

The topics covered in each workshop were: (1) Gender and education - being a girl in the middle school; (2) The place of women in education; (3) Fast Girls Project impact; (4) The completion of High School and the prospects for the future; (5) Women and insertion in the world of work and in the technological areas.

4. RESULTS AND DISCUSSIONS

The feeling of being a woman highlighted by the group reveals itself in the pursuit of fulfilling its aspirations, and these are found in the access to education, to professionalism, financial independence, enabling the well-being in them. This analysis also reminds us that, in contemporary times, women are perceived not only as having value by being with a man or of being an object of desire for it, but the adolescents of the group expressed their aspirations for growth in academic life and professional. According to the group, this growth provided by access to studies fosters the construction of a woman, who seeks to break away from feeling like a woman experienced by her mothers and grandmothers.

For high school adolescents participating in the project in the outskirts of Brasília, finishing high school is already an important factor in training, since they exceed the level of schooling of their families. However, the uncertainty arises, regarding the insertion at the higher level, since they have doubts if they can reach this level, being from the periphery, women and mostly black.

The high school students expressed the satisfaction of being part of the initiative: to meet the University of Brasília, the Faculty of Technology of the same, to have the contact with the students of Engineering, with the coordinator of the project and the activities in the workshops make them think that the insertion in the university as well as in the technological areas may be possible.

However, not all are attracted to technological areas. This also points to the way in which girls' education in society is crossed by gender asymmetries, reinforced by the rigidity presented to women, which reproduces their place in the same professions, social functions and care areas.

In this context, most of these students seek insertion in courses that fulfill a social function and a work of care, such as work related to the feminine, such as teaching, nursing, social work, among others. However, those who are attracted to the Engineering are aware of the difficulties they will face, both in terms of joining the university, and the permanence in the course and the conclusion of it. In addition, they are also concerned with the insertion in the Engineering market, the vicissitudes that may arise in companies, regarding salaries, promotion of positions, possible bullying, etc.

In general, they consider the “Fast Girls” project, of great relevance. They reported that the project has been an opportunity to know the specificities of the technological area and to discuss gender and education issues. Even if they do not all want to embark on this path, they find in the workshops promoted by the monitors of the faculty of technology, a demystification of the subjects of the exact areas, such as Mathematics and Physics, and demystify that Engineering would not be a place for them, once, that the coordinators and the monitors of the Faculty of Engineering are women.

The “Fast Girls” project seeks to fulfill the demands related to social markers of difference. However, initiatives like these are still few, since for its implementation and realization, it depends on several instances. In this way, the reinforcement of public policies and related initiatives is necessary.

5. ACKNOWLEDGEMENTS

We thank DEG/UnB, DEX/ UnB, ProIC/ UnB for funding, CNPq and the Faculty of Technology in partnership with Santa Maria CEM 404 for institutional support. Also we thank the other authors who could not be included in this work: Nathalia Shinzato, Rebeca Ribeiro, Tatiana Grasiele, Samyla Queiroz, (engineering students from UnB), Jessica Emanoeli da Costa (Psychologist), Kleucielen Ponte, Vânia Roseli de Alencar and Katia Tarouquella (Catholic University).

6. REFERENCES

Alencar, V. R., 2017. *Desamarrando o preconceito: um estudo de gênero a partir do dispositivo da fotolinguagem*, 198 f. Dissertação (Mestrado em Educação). Universidade Católica de Brasília – UCB. Brasília.

Buchweitz, B., 2000. "Aprendizagem significativa: ideias de estudantes concluintes de curso superior". Available in: <http://www.if.ufrgs.br/public/ensino/vol6/n2/v6_n2_a2.htm>, Accessed in 15 out. 2017.

Freitas, B. B., 2013. *Diferenças de gênero na pesquisa e pós-graduação em engenharia no Brasil*. 70 f. Dissertação (Mestrado) - Centro Federal de Educação Tecnológica Celso Suckow da Fonseca, Rio de Janeiro, RJ.

IPEA, 2010. Brasil em desenvolvimento: Estado, Planejamento e Políticas Públicas. Available in: <http://www.ipea.gov.br/bd/>. Accessed in 15 out. 2017.

Lombardi, M. R., 2015. "Mulheres conquistam mais espaço no mercado da Engenharia". *Sindicato dos Engenheiros do Maranhão*. Available in: <http://www.sengema.com.br/noticias/21867619/mulheres-conquistam-mais-espaco-no-mercado-da-engenharia/>, Accessed in 15 out. 2017.

Machado, P. I. D. S., 2015. "Mulheres graduadas em Engenharia: um Estudo de Caso". *Revista ADMpg Gestão Estratégica*, Ponta Grossa, v. 8, n. 2, p. 35-43, abr. Available in <http://www.admpg.com.br/revista2015_2/Artigos/Artigo4.pdf>. Accessed in 15 out. 2017

Oliveira, T. 2013. "Mais meninas nas ciências: Elas deixam de se interessar pelas áreas de Exatas na puberdade: iniciativas tentam atraí-las para carreiras científicas no Brasil". Available in : <http://www.cartaeducacao.com.br/reportagens/mais-meninas-nas-ciencias/>. Accessed in 15 out. 2017.

Righetti, S., 2016. "Mulheres são menos de 20% nos cursos de ciências exatas da USP". Available in <http://www1.folha.uol.com.br/educacao/2016/11/1835995-mulheres-sao-menos-de-20-nos-cursos-de-ciencias-exatas-da-usp.shtml>. Accessed in:15 out. 2017.

Schmidt Neto, A. A., 2012. "A Fotolinguagem como metodologia transdisciplinar" in: *IV Fórum Internacional Innovación y Creatividad Adversidad y Escuelas Creativas*, Barcelona.

7. RESPONSIBILITY NOTICE

The authors are the only responsible for the printed material included in this paper.