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REGULAR PAPER

Machine Learning and Data Visualization to Evaluate a Robotics and Programming Project Targeted for Women

Danielli A. Lima[1] · **Maria Eugênia A. Ferreira**[1] · **Aline Fernanda F. Silva**[1]

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Abstract

Around the world women end up being less interested in areas related to the sciences, technology, engineering and mathematics, or shortly STEM. Therefore, it is important that governments around the world maintain an active interest in getting women to continue in STEM careers. In this context, this work was divided into three main phases, the first was to conduct a search through a related works that were published involving the development of projects aimed at the engagement of girls students or female teachers/professionals within the context of STEM or Robotics, between the years 2018 and 2020. In this case, seven works were found within these criteria, including one Brazilian project. Subsequently, analyzes were carried out of the 85 projects that are being financed by the federal government of Brazil within STEM. The last analysis was a case study to evaluate the engagement of female teachers and students in a medium-sized city in the interior of the southeastern region of Brazil. In this case, we carried out the analysis with the teachers and students, as well as with an external audience. We carry out our analyzes through statistics and analysis of feelings and opinions, in addition to data visualizations. In the end, we conducted through data mining of unsupervised machine learning, analyzes of the groups of people we are interested in engaging, which are groups of young people, especially girls who are interested in STEM, but with little knowledge in Robotics. This strategy was put on the schedule, because we will aim to increase the knowledge of these girls in STEM, especially in robotics, which is the focus of our study and research group. Finally, results have shown that this project has improved a major social and encouraging role for these girls in the field of exact sciences, computing and engineering.

Keywords Machine learning · Data visualization · Survey · Female projects · STEM area · Robotics and computing

1 Introduction

Robotics is a part of the areas of education and technology that deals with systems made up of automatic mechanical parts and controlled by integrated circuits, making mechanics automated [2] by programming smart controllers. This technology generally excels in matters related to cost reduction, increased productivity, security and various functional problems [1, 4]. Robotics replaces activities that are inhospitable to humans, such as surveillance [3, 8], garbage collection [5, 6, 15], search and rescue [9, 12], navigation [7] and furthermore prevents repetitive work from being occupied by humans [10, 11, 13, 16].

Thus, it is important that young people of all genders become interested in science and technology [14], so that in the coming decades they will be qualified professionals for the future of the enterprises [26, 45]. Most elementary school students today are immersed in an environment where technology is easily perceived: cars, smartphones and computers are examples that everyone knows and many use [17], however, few have an understanding and mastery of these tools. These same students spend much of their time at school studying mathematics and physics and,

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✉ Danielli A. Lima
danielli@iftm.edu.br

Maria Eugênia A. Ferreira
meugeniadeavila@gmail.com

Aline Fernanda F. Silva
alinefurtado@iftm.edu.br

[1] Laboratório de Inteligência Computacional e Robótica (LICRo), Instituto Federal do Triângulo Mineiro (IFTM) Campus Patrocínio, Avenue Avenida Líria Terezinha Lassi Capuano, 255, Bairro Universitário, Patrocínio, MG, Brasil

paradoxically, the concepts presented to them seem far from practical application in everyday life [18].

In this context, educational robotics, as well as the programming of electronic devices, can provide a way to enable scientific-technological knowledge while stimulating creativity and experimentation with a strong playful appeal [2]. In this way, the student comes into contact with new technologies through practical applications related to subjects that are part of your daily life, because robotics requires knowledge of mechanics, mathematics, computing, among others [5, 19]. Through educational robotics students will be able to explore ideas and discover new ways in the application of acquired concepts However, women are under-represented in the so-called STEM (Science, Technology, Engineering and Mathematics) areas [27].

There is a record of a wide gender inequality in mathematics, information technology, engineering and physics [20], either as students or teachers. Therefore, there is a clear gender segregation [22] and these areas are said to be male, as women are encouraged from primary school to enjoy humans or biological issues [23]. This is a reality based on gender biases. According to [24], since women intellectually have the same skills than men, although historically they have not had the same opportunities [21, 22, 24, 25].

In this sense, research on STEM has recently been dedicated to promoting an increase in female interest and representation in these areas [27]. Proposals that aim to increase girls' interest and self-esteem in technology-related activities through theory-based interventions have shown to have significant potential in narrowing the gender gap [28]. Stimulating situational interest in topics such as robotics is at the forefront to increase women's interest in computer science and engineering [27].

Gender stereotypes can have an adverse influence on technology behaviors, but this can change positively in the right circumstances. For both genders, being involved in robotics activities creates a reward and encouraging experience [27]. In this scenario, we proposed the "Elas na Robotica" project, which emerged in the face of the universal call of CNPq/MCTIC 31/2018 "Girls in Exact Sciences, Engineering and Computing". Regarding the extension, the project coordinated and executed by women, throughout 2019 in person, and during 2020 remotely, promoted several courses and workshops on introduction to robotics, programming, 3D modeling, in addition to lectures with STEM women on careers and other relevant topics. Regarding the research, five public schools of basic education were contemplated, in which groups constituted by a female teacher and three scholarship female students (from elementary to high school) and in some cases also counting on volunteer female students.

The purpose of this paper is to (i) conduct a systematic review of all projects around the world between 2018 and 2020 that had the theme of girls in STEM and Robotics; (ii) perform a data visualization to understand the latest STEM projects in Brazil; (iii) conduct an assessment of the effectiveness of the "Elas na Robotica" project as a means of encouraging women's participation in the areas of robotics and computing. Apply data mining to questionnaire responses (iv) to create means for the project continuous improvement. Thus, it is also intended (v) to highlight the importance of robotics as an educational tool, and (vi) to gather information about the importance of girls in the exact areas through a qualitative analysis.

The article is divided as follows. In Section 1, the introduction was presented. Section 2 will present the related works and STEM projects in Brazil. In Section 3 we present the methodology for obtaining the evaluation results of "Elas na Robotica". In Section 4 we will present the quantitative and qualitative results of the project and data mining for data understanding and future planning. In Section 5, we will present the final discussions, conclusions and future work.

2 Related Works

In this section we will present the state of the art of all articles published around the world between the years 2018 to 2020 on projects directed to STEM and Robotics aimed at female engagement, whether for women or girls. Subsequently, we will analyze Brazil from the point of view of the Brazilian projects that were approved by Call. This CNPq Call, as previously presented, aims to strengthen the engagement, insertion and success of girls in STEM, Computing and Exact Sciences careers.

2.1 Works Related to the Terms: STEM, Programming and Robotics

The Systematic Review of Literature (SRL) is a research methodology that provides for the execution of a series of procedures to identify a set of articles that brings a careful prospecting of the research topic addressed [33]. A feature of this research methodology is that all its procedures are registered, allowing the study carried out to be reproducible by other researchers.

The SRL developed in this work was based on the original concepts found in [33]. To help in the development of SRL the tool StArt[1] was used. The main objective of

[1]Developed by the University Federal de Sao Carlos (UFSCAR) and can be downloaded at Laboratorio de Pequisa em Engenharia de Software (LAPES) at http://lapes.dc.ufscar.br/tools/start_tool.

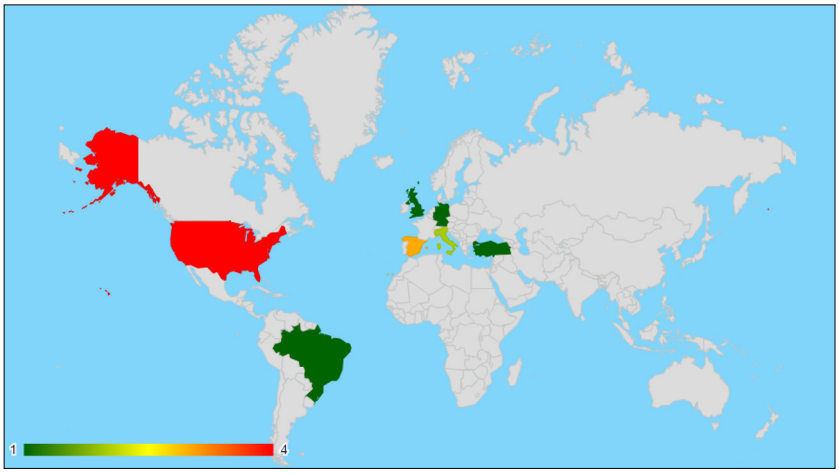


Fig. 1 World map created from the results of the first phase of the systematic review search, only seven countries appeared

the SRL carried out is to identify the state of the art in the development of projects that use the teaching of STEM and robotics as a means to encourage women in exact sciences and engineering and to engage them in these careers. For the research, a search string was used that combined the main keywords considered relevant to the area of STEM and robotics for projects aimed at female engagement. A string used in Google Scholar, and the search engines have been configured to search for the string in the title. The search string that was used in this article: (project AND robotics AND (girls OR girl OR women OR woman OR female)) OR (project AND STEM AND (girls OR girl OR women OR woman OR female)). The exclusion criteria were: (a) the article was published before 2018 (year of publication of CNPq Call 31/2018), (b) the article did not focus on a girls project in STEM or Robotics, (c) the article has less than 3 pages, (d) the article represents little difference from another article, (e) the article is not written in English, (f) the article is very similar to another.

The process of analyzing the articles returned by Google Scholar consisted of four main phases. In the first phase, searches were performed using the previous string only in the title, in which case 19 results were returned. Then, in the second stage, we apply one filter per year, from the year 2018, which represents CNPq Call's start year, until the year 2020. This period was considered because it is recent for the area, although other older papers are extremely relevant to the area, such as [29–31] and [32] they do not correspond to the years in which the project "Elas na Robótica" was carried out by us in Brazil, so they were not selected in this SRL. According to the exclusion criterion's, in the second stage, only 14 articles were returned. Figure 1 shows the results from the second stage of search.

In the third step, we applied the StArt Tool filter, in which duplicate articles were disregarded. However, in some cases, we had to make this selection manually, as the articles had different titles and order from different authors. In this case, we had the exclusion of 1 article, leaving 13 articles for the last two stages. In the fourth stage, the abstract of each publication was read and the less relevant ones were excluded, or articles with or also papers with less than 3 pages, in this stage remained only 7 articles, as is possible to see in Fig. 2.

The articles can be in state: accepted, rejected and duplicated; or articles must be read at very high importance and high importance (for accepted papers) or low importance and very low importance (for rejected papers). Finally, in last stage, the articles were read in full, only those that were classified as very relevant or relevant to the scope of this article and each paper can be shown in Table 1.

We will make a brief summary of the papers that were selected from the systematic review, for the best data visualization, we will present the results through word cloud, as shown in Fig. 3. In the project by [34]

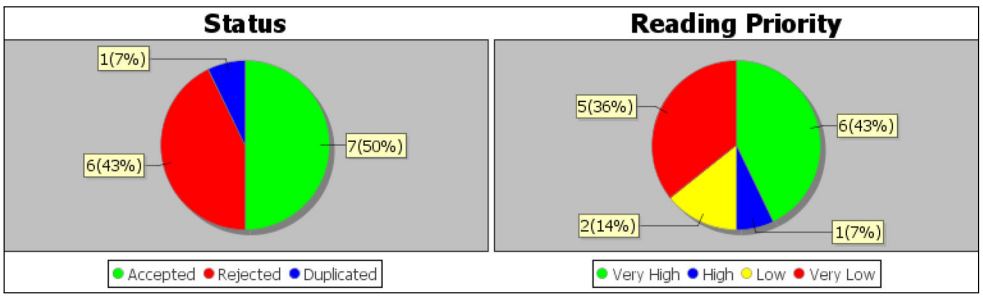


Fig. 2 At left shows the status of article and at right shows the reading priority

Table 1 Articles selected in the systematic search review

Authors	Title	Country	Year	Conference Journal	Approach
[Schnit-tker et al. 2018]	Strengthening the self-and external perceptions of young women STEM professionals (YWSP) during career entry and advance-ment: a research project	Germany	2018	Proceedings of the 4th Conference on Gender & IT	Women Professio- nals STEM
[Mich and Ghislandi 2019]	Young Girls and Scientific Careers: may a course on robotics change girls' aspirations about their future? The ROBOESTATE project	Italy	2019	Qwerty-Open and Interdisciplinary Journal of Technology, Culture and Education	Students Elementary School Robotics
[García-Holgado et al. 2019]	Engaging women into STEM in Latin America: W-STEM project	Spain	2019	Proceedings of the Seventh International Conference on Technological Eco-systems for Enhancing Multiculturality	Undergraduate student STEM
[Semra et al. 2019]	The Impact of STEM Project Writing Education on Candidate Female Teachers' Attitudes, Their Semantic Perceptions and Project Writing Skills towards Stem Education	Turkey	2019	International Journal of Curriculum and Instruction	Candidates Teachers STEM
[Ferreira, Lima and Silva 2019]	Data Analysis for Robotics and Programming Project Evaluation Involving Female Students Participation	Brazil	2019	2019 Latin American Robotics Symposium (LARS), 2019 Brazilian Symposium on Robotics (SBR) and 2019 Workshop on Robotics in Education (WRE)	Teachers, students basic school, undergraduate STEM Robotics
[Glover 2019]	An evaluation of a project aimed at increasing participation of young women in STEM activities and training in Wales	United Kingdon	2019	International Journal of Gender, Science and Technology	Students Elementary and High School STEM

Table 1 (continued)

Authors	Title	Country	Year	Conference Journal	Approach
[Davis 2020]	Socially Toxic Environments: A YPAR Project Exposes Issues Affecting Urban Black Girls' Educational Pathway to STEM Careers and Their Racial Identity Development	United States	2020	The Urban Review Springer	Students High and Elementary School STEM

outlines a project that explores the influence of the self-and external perceptions of young women STEM professionals (YWSP) at the time of their career entry and advancement in Germany Fig. 3a. Thus, action recommendations were created with precision, and contributed to the increase of gender equality and a greater number of highly qualified women in male-dominated STEM areas. In [35] paper the author presents a study intended to investigate the effects on children's career choices of the ROBOESTATE project from Italy, a summer camp aimed at introducing boys, but especially girls, to STEMs through educational robotics activities Fig. 3b. The authors conducted a quantitative and a qualitative analysis. Although the limited number of data collected during ROBOESTATE it does not give a statistical significance to their results, but they said that ROBOESTATE-like courses increase boys', and especially girls', interest in STEM careers.

In Spain's work of [36] the authors said that are significant progress has been made during the last decades to achieve gender equality, but there is still much work to do. In this context, the W-STEM project seeks to improve strategies and mechanisms for attracting, accessing, and guiding women in Latin America in STEM higher education programs. Their work aimed to describe the main results to prepare a set of attraction campaigns in secondary schools in the Latin American countries involved in the project (Chile, Colombia, Costa Rica, Ecuador, Mexico). In particular, they proposed self-assessment tool about gender equality in higher education institutions in Latin America, an interview protocol for female role models, and a mobile application to show those role models. The cloud of words is represented in Fig. 3c.

Other works that were not considered in this paper from the same thematic project were described [37] and [38]. The Turkey project from [39] investigated the impact of female STEM Science on female candidate teachers' attitudes towards STEM education, their semantic perceptions of STEM discipline scopes, specifying their needs in writing STEM projects, their learning outcomes from education, and the difficulties they face in the process of project writing. Four sub-dimensions were analyzed STEM: science, technology, engineering and mathematics. Semantic perception essentially consists of accompanying, on the meaning plane, the perceptual principles that we know that govern sensitive perception, that is, dissimilation of assimilation. Prior to the education process, the participants (Biology, Science, Primary Education Maths candidate teachers 'semantic perceptions of STEM fields before and after project writing teaching were asked). were given a STEM educational attitude scale, a STEM semantic contrast scale. The authors observed, in the end, that the semantic perception points were factors only in the average in the sub-dimension of "technology" on female teachers towards Turkey STEM education were observed. The difficulties they faced during developing projects were specifying project topics/problems, budget calculations, writing reports, forming a time schedule, overviewing literature and drawing prototype product. The cloud of words is represented in Fig. 3d. On the other hand, in paper [40] the authors of the work discussed the preliminary data

(a) Schnittker et al. 2018. (b) Michand Ghislandi 2019. (c) García-Holgado et al. 2019. (d) Semra et al. 2019. (e) Ferreira, Lima, Silva 2019. (f) Glover 2019. (g) Davis 2020.

Fig. 3 Cloud of words resulted from each paper read in the systematic review

of the project called "Elas na Robotica". In this case, the authors discussed the importance of a project that takes scholarships to promote STEM careers for women in a city in the interior of Brazil. In the article, they showed the views of female scholarship students, and their mentors who were also female teachers. It was discussed that girls from non-technical schools had less interest in STEM and Robotics than girls from technical schools and higher education, in the first phase of the project, that is, in the first half of 2019, the discussion of the entire project will be dealt with in this paper. The cloud of words from abstract can be seen in Fig. 3a.

In paper [41] the author reports findings from a youth participatory action research (YPAR) project, aimed to engage a group of black girls from a low-income urban high school, in United States, in a social justice project, which was conducted during the 2015 and 2016. The cloud of words from abstract can be seen in Fig. 3f. The paper focus was a critical examination of the high school educational pathway to specialized fields, such as STEM careers. Author findings from phase one of the project showed that lack girls knows race and class affects their educational experiences, but these girls know little about racial and gender disparities along STEM educational pathways. Finally, in the paper [42] the authors report on the delivery and impact of a European Union funded project in Wales, United Kingdom. The cloud of words from abstract can be seen in Fig. 3g. The project STEM Cymru 2 encouraged girls in participation in engineering activities and improvements in Science, Technology, Engineering and Mathematics (STEM) skills for young people aged between 11 and 19 years, different activities were delivered for females aged 12-16 years to raise awareness of study and career opportunities in this field. Female participants reported improvement in transferable skills such as communication, teamwork and problem-solving following engagement with project activities. The author also reported the achievement that female participants in the project were spokespeople for the project in their respective schools.

From the analysis of the seven articles resulting from the systematic review, it can be seen that in several countries there has recently been an interesting incentive about female participation in STEM. The approaches focused on several different actions and projects to understand the engagement of each country to encourage STEM students, teachers and professionals. However, no project has managed to support teachers and students encompassing teaching: elementary, secondary, technical and undegraduate students. In this sense, in this work, in the next section we will focus on the results of projects approved by the federal government of Brazil to encourage women teachers and girls students in STEM. Subsequently, we will focus on the results achieved by one of these projects, "Elas na Robótica", through quantitative, qualitative results and planning future work for data mining.

2.2 Current projects in Brazil

The CNPq Call - "Girls in Exact Sciences, Engineering and Computing" aimed to support projects that aimed to contribute significantly to the scientific and technological development and innovation of the country, by encouraging the participation and training of girls and women for careers in exact sciences, engineering and computing in Brazil. In all approved proposals, there was a partnership between the proposer and one, three or five public schools of Basic Education. In each participating public school, one Education teacher was chosen Basic (from the areas of science, mathematics, physics, chemistry, computing or technologies) that were responsible for organizing the project activities in the school. These teachers participated in training activities offered by the project coordinator and the others activities foreseen in the project. After that, these teachers will be trained as responsible for the replication of knowledge acquired from other teachers at their school.

Each one of the 85 projects that were approved by CNPq Committee had the potential to interest Basic Education students the areas of exact sciences, engineering and computing and enhanced the vocation of undergraduate students in these scientific areas, as well as improving the training of teachers and the teaching of these subjects in participating schools. Only 5 projects approved in this "Call CNPq/MCTIC 31/2018 Girls in Exact Sciences, Engineering and Computing", as shows the website results[2], were coordinated by men, representing 5.88% of all 85 approved projects, and the other 80 projects (94.12%) are coordinated by women. In this call, as it is possible to see in Fig. 4, at least one project from each province in Brazil was contemplated. However, the states that stood out the most were Rio Grande do Sul with 13 approved projects (15.29%), Rio de Janeiro with 10 approved projects (11.76%), Minas Gerais with 8 approved projects (9.41%), Paraná with 7 projects approved (8.23%), Goiás with 6 approved projects (7.05%), Alagoas with 5 approved projects (5.88%), Paraíba and São Paulo each with 4 approved projects (4.70%) each one.

This means that the South and Southeast regions have about 51.76% of all projects approved to stimulate the participation and training of girls and women for careers in exact sciences, engineering and computing. Thus, there is a need for greater engagement by higher education

[2]CNPq/MCTIC N- 31/2018 Public Calls Results Website: http://www.cnpq.br/web/guest/chamadas-publicas?p_p_id=resultadosportlet_WAR_resultadoscnpqportlet_INSTANCE_0ZaM&idDivulgacao=8402&filtro=abertas&detalha=chamadaDetalhada&id=47-1198-5840.

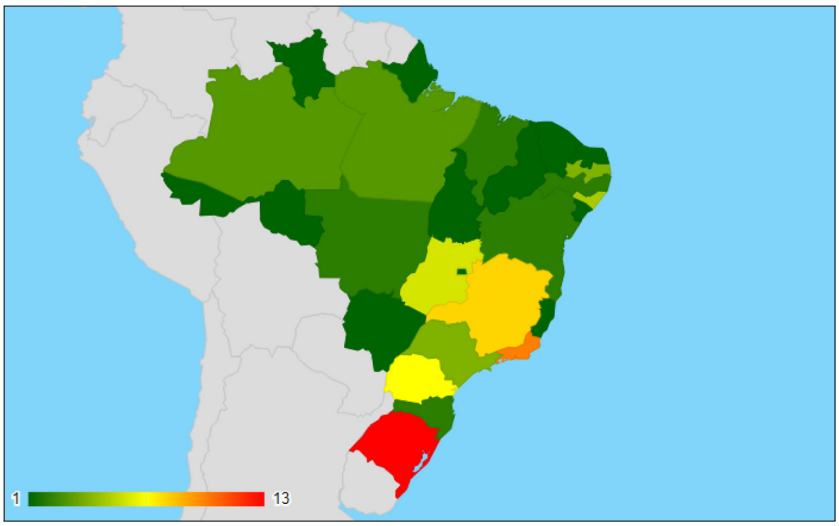


Fig. 4 Map of Brazil representing the distribution of how each of the 85 approved projects was distributed among the states

institutions in the North and Northeast, which are regions marked by socioeconomic inequalities. There is a consensus in the literature that the most vulnerable areas have a directly proportional relationship with the high cases of femicide and that some common characteristics among the victims function as risk factors [46]. Thus, with greater support from universities in these regions, it is expected that these women, with better working conditions, especially in the areas of STEM, Robotics, Computing and Exact Sciences, will create an ecosystem of entrepreneurship and innovation in these regions.

In this work we will focus on the project "Elas na Robotica" which is one of the 85 projects approved in the CNPq Public Call 31/2018 MCTIC. In the project, were considered five schools from one in southeastern Brazil. The project was divided into four groups, for better management and planning. Each group was responsible for one year for a scientific initiation research in the robotics area. The project also had a research group made up of four undergraduate female students, three from Electrical Engineering and one from Systems Analysis and Development. In addition, the girls contemplated by "Elas na Robotica" were able to participate in several scientific events, both as listeners and speakers, exhibited their work in national exhibitions, being awarded in categories such as 3rd best paper award in [40], robot dance competition, poster presentation, among others.

3 Methodology

The first part of this article consisted of presenting studies more relevant to the context of STEM as a motivation for women in the labor market and in education. In this case, an indirect form of research that we used was secondary sources, through periodicals and conference articles, and the data source was through Google Scholar, through a Systematic Literature Review.

In the second part, which will be presented in the next Results section, we will present a quantitative and qualitative research methodology. In quantification, we will make an analysis and interpretation of data collected from the study of girls in STEM areas in one of the projects approved in the public notice CNPq 31/2018. The preliminary results of CNPq 31/2018 were published in [40]. In this paper we are presenting the results of the girls who are graduating from the "Elas na Robótica" project. The results are analyzed using descriptive statistics using percentages and graphs, such as histograms, pie charts and parallel coordinates. The KNIME Analytics Platform is a program that was used in this article to analyze this data and generate different graphs. This data analysis tool allows, besides artificial intelligence techniques for grouping and classifying data, it also allows interesting data visualization schemes. In this context, we performed some data mining techniques to group data through unsupervised learning [44], using the k-means and k-medoids algorithms [43]. In the qualitative part, we will try to show through the "Cloud of Words", the students' sentiment analysis, teachers and external people, text mining about sentiments, opinions and the behaviors about the "Elas na Robotica" project.

The results of our project "Elas na Robótica" were divided into three main parts, one part for the engagement of female students. The second part we will do a data mining on the behavior of female teachers as advisor and collaborators of the project. The last part refers to the external public that attended the lectures given by the research group called "Elas na Robótica". We had a total of 66 responses including the three groups of respondents: female students, female teachers and external audiences. Different questionnaires were applied

to assess the sentiment analysis of three groups of people participating in the project. The questionnaires applied had different types of questions, as we would like to evaluate each group with different approaches.

4 Project Description

Our project "Elas na Robótica" takes place in the Southeast Region, in a city in the state of Minas Gerais, non-metropolitan with about 100 thousand inhabitants. The project consisted of presenting elements of artificial intelligence, programming and robotics for girls from 5 schools in Patrocínio City, including 4 girls from Middle School (from the 6th year in Brazil), 8 girls from the High school, 3 girls from undergraduate students and 11 girls voluntary students. In addition, 1 general coordinator, 5 teachers with a CNPq scholarship in the STEM area, and 5 volunteer teachers in the STEM area participated. The project had scholarship and non-scholarship girls.

Our project included activities in our school such as: workshops, lectures, courses, robotics competitions and posters exhibitions. Besides that, we promoted training courses for teachers from participating schools in the areas of science exact, computing and technologies, focusing in programming and robotics sub-dimension (field). Besides that, we elaborated training and/or qualification program for girls and young people in exact sciences, engineering, computing, specially in robotics and programming field. The undergraduate girls participated in Brazilian Robotics Exhibition, an Olympic Competition, and high school and elementary girls participated in the Youth Robotics Tournament. Girls participated in activities of the NSTW (National Science and Technology Week), scientific initiation seminars and other similar activities. Finally, lectures and workshops with the use of audiovisual resources (YouTube Channel, Google Meet and Zoom meetings) that demonstrate to the school community the existence of women as scientists and researchers with significant contributions to science and technology in Brazil and worldwide.

5 Results

In this section we will present the results referring to the data of one of the projects approved in the CNPq / MCTIC Call No. 31/2018. The section was divided into 3 parts, the first brings results from the students and volunteers registered in the "Elas na Robótica" Project. The second part about the female teachers involved. Finally, the third part is a view of the external public on the lectures given by the Research Group.

5.1 Sentiment analysis for students in project

The first part of the analysis consisted of conducting interviews with scholarship students or volunteers of the project called "Elas na Robótica". A questionnaire was applied with 11 questions of objective questions and a single open question. From these interviews, we can see the importance of this type of project in the training of students and their engagement in STEM, Programming and Robotics projects. In addition, many girls did not know applications of mathematics or physics within a practical and industrial context, and with this project it was possible that they could have a greater interest in the areas of Computing, STEM and Robotics. The results of the questions were summarized in pie charts for the 11 students who answered the questionnaire, and are showed in Table 2 and are summarized in Figs. 5 and in 6.

It is possible to notice that in Q_1 (1st question), in Fig. 5a, there was a tie between girls of regular high school (red) and girls of technical education (yellow), with 36.4% each one (tech and high school). Only 27.3% of the students were in elementary school (blue), and although we had 3 scholarship students from higher education, they were not interviewed, as they are already engineering or computing students and they participated from our previous work [40].

Subsequently, in question Q_2 (second question), in Fig. 5b, the students answered that 36.4% are from federal schools (blue), 36.4% from state schools (yellow) and only 27.3% are from municipal schools (red). These results correlate with previous results, in which only federal schools offer technical education in the city of Patrocínio, MG, Brazil. The municipal government provides elementary education, and the state government provides regular education. Subsequently, the girls were asked in Q_3 (third question), in Fig. 5c, whether they were scholarship holders (90.9% in blue) or volunteers (9.1% in red) of the interviewees. Thus, most of the girls who responded were volunteers for the project.

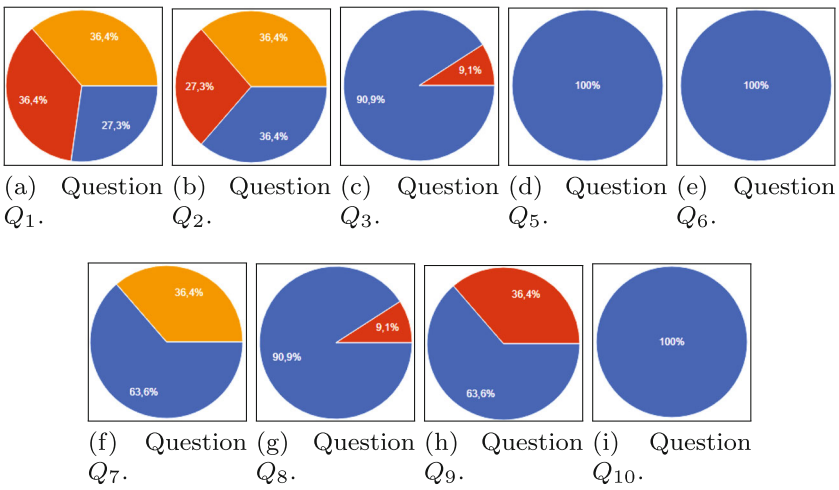
In the fourth question Q_4, we have the presentation of the results regarding the motivation of the girls to participate in the project "Elas na Robotica", the results can be seen in the Fig. 5e, and the most relevant option for the girls was because the project is about exacts and they are interested in learning more about exact sciences, programming and robotics. Notice that question Q_4 allowed more than one answer on the part of the interviewees, that is why the sum for each item exceeds the value of 100%. In Fig. 5d for Q_5 we have that all female students responded that they felt motivated to participate in an exclusively female project (100% in blue), the same could be observed for Q_6 in Fig. 5e, in 100% (blue) of them they felt more motivated to participate in exact science disciplines and also 100% (blue)

Table 2 Questionnaire applied to students

#	Questions	Options	Answers
1	What is your level of education?	a) Elementary School b) High School c) Technical	27,3% 36,4% 36,4%
2	What kind of education do you study in?	a) Municipal b) State c) Federal	27,3% 36,4% 36,4%
3	What is your type of participation in the project?	a) Scholarship Holder b) Voluntary	90,9% 9,1%
4	What motivated you to participate from the project "Elas na Robotica"?	a) It's a girls only project b) It's a exact project and I like it c) It's an exact project and I want to learn more about this area. d) I really like programming/robotics e) I want to enter an exacting or science career.	45,5% 18,2% 81,8% 45,5% 27,3%
5	Did you like to participate a girls-only project?	a) Yes b) No	100% 0%
6	Did the project encourage you to improve in science and exact subjects?	a) Yes b) No	90,9% 9.1%
7	After "Elas na Robotica", did you notice an improvement in your performance in science and exact subjects?	a) Yes b) No c) Partially	63,6% 0% 36,4%
8	Did you feel more motivated by the participation of other girls in the project?	a) Yes b) No	90,9% 9,1%
9	After the project, are you interested in courses in Exact Sciences?	a) Yes b) No	63,3% 36,4%
10	With the end of the "Elas na Robótica" project, would you participate in other projects related to robotics?	a) Yes b) No	100% 0%
11	What is your opinion about the project?	Open question.	Free.

time in Q_{10}, in Fig. 5i, said that they would participate in other projects related to the STEM and Robotics areas.

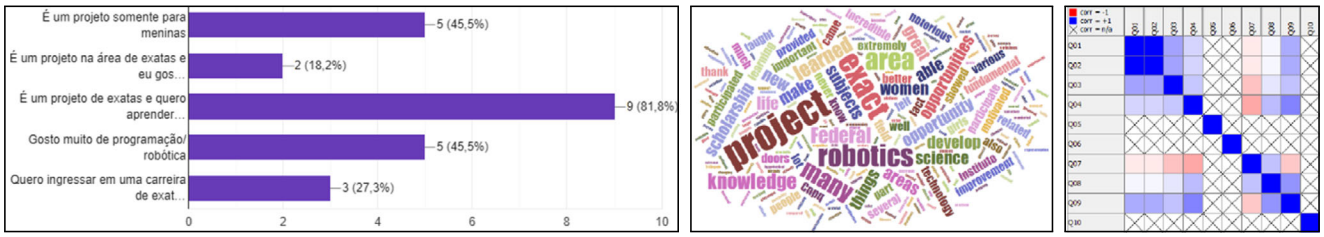
For Q_7, in Fig. 5f, we had 63.6% (blue) of the girls replied that the project helped them in the disciplines of exact sciences and only 36.4% (yellow) said that the project partially helped them. For Q_8, in Fig. 5g, we had 90.9% (blue) said they were motivated to see other girls in the project and 9.1% (red) replied that this fact did not influence them. For Q_9, in Fig. 5h, we had 63.6% (blue) of the girls replied that the project made them want higher education in STEM areas, while 36.4% said that the project was not able to motivate them to choose exact areas.



(a) Question Q_1. (b) Question Q_2. (c) Question Q_3. (d) Question Q_5. (e) Question Q_6.

(f) Question Q_7. (g) Question Q_8. (h) Question Q_9. (i) Question Q_{10}.

Fig. 5 Summarization in pie charts for the 11 student responses obtained



(a) Bar chart for question Q_4. (b) Perception question Q_{11}. (c) Correlation.

Fig. 6 On the left we have a bar chart for question Q_4 in which it shows the summary of the most voted answers. On the middle, we have the analysis of the students' feelings for Q_{11} using a word cloud. On the right has the correlation matrix between all questions

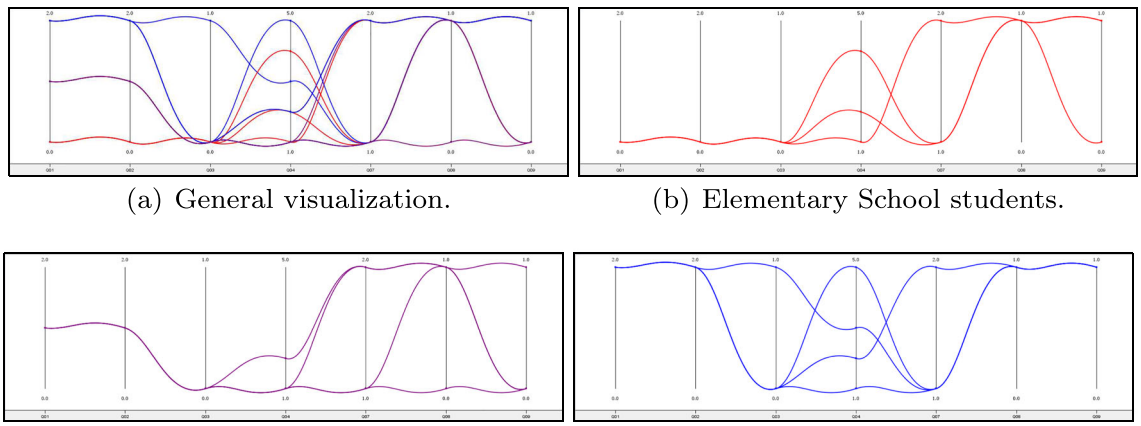
In Q_{11}, in Fig. 6b, the questionnaire presented an open question about the feeling in relation to the project "Elas na Robotica". The analysis of feelings was extracted from the word cloud in which the most outstanding words were: "school subjects, motivation, notorious, improvement, project, opportunities, scholarship, robotics, exact and development". For the word size, was used the $\log(n)$ function according to n number of times the word appear. Reading the comments, it was possible to notice that many girls had high self-esteem due to being able to participate in a project that supports girls in STEM, Computing and Robotics.

The last analysis carried out was the plot of parallel coordinates that can be seen in the Fig. 7. Each question of the parallel coordinates is ordered in alpha numeric sequence according to Correlation Matrix, to visualize question from parallel coordinates showed in Fig. 6c. Correlation Matrix which: (■) represents strong negative correlation (-1) value, (■) represents strong positive correlation ($+1$) value, (□) represents independents variables (0) value and (☒) represents no correlation values. This was a convention adopted for all correlation matrices.

Parallel coordinate analysis is used to compare different data values. Values are shown as points on a line with one point per column of data. Visualization is also useful for examining patterns. In this case, in the Fig. 7a, we have the global vision for female students. In Fig. 7b we will observe the behavior of girls in elementary school, who are all students of municipal public education in the city of Patrocínio, MG, Brazil.

All girls in elementary school are scholarship holders and most have indicated that they liked at least 4 characteristics from project, and they all felt motivated to be on a girls-only project. Few of these girls were interested in pursuing STEM.

The girls from the regular high school are all students of State Schools and they all like the project, while those from federal schools attend technical education. In terms of their tastes for the project, girls from state schools have indicated that they were attracted to at most two issues in motivation to participate in the project. The girls in technical education, in turn, claimed that they were attracted to up to 5 questions. Regarding the improvement in the disciplines of exact sciences, both in regular high school and in technical education, they claimed to have improved or partially improved the reasoning for disciplines of exact sciences. Some girls from state schools claimed that they are not attracted because it has only girls, different from technical



(a) General visualization. (b) Elementary School students.

(c) Regular High School students. (d) Technical School students.

Fig. 7 Parallel coordinates visualization considering only questions with correlation

education girls, as well as all claimed to be interested in continuing in areas of exact sciences, differently of regular high school girls who are not all interested in pursuing the exact sciences area.

5.2 Sentiment analysis for STEM teachers in project

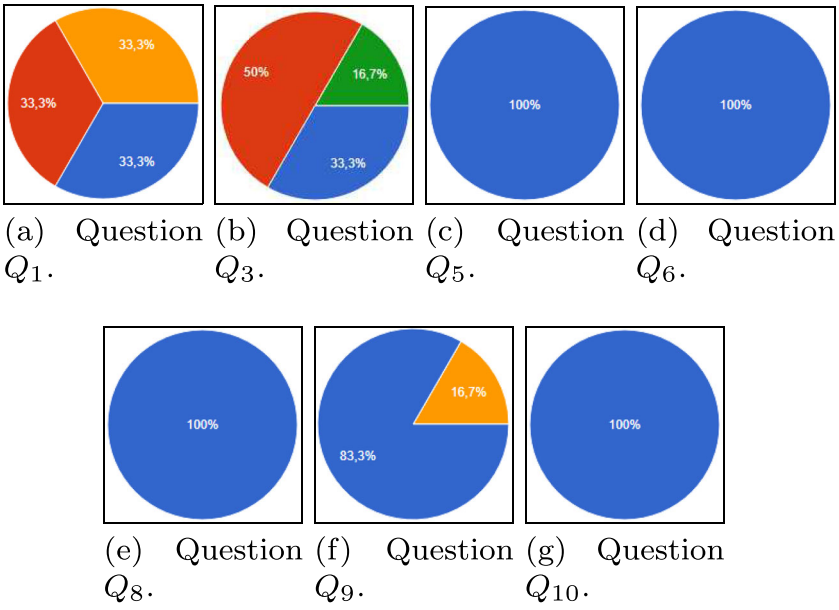
The second part of the experiments was with supervising and collaborating teachers who work with STEM. The results are presented in the Table 3 and summarized in the Figs. 8 and 9. In question Q_1, in the Fig. 8a, the distribution of teachers was presented, with 33.33% for each of the three segments: federal (blue), municipal (yellow) and state (red).

In Q_2, Fig. 8b, a configuration of the levels that each teacher worked on was presented, and most of them, besides working at more than 1 level of teaching (elementary and high school) at the same time, still work preferentially in elementary school. In Q_3, Fig. 8c, we had that 50% has an academic level of specialization (red), 33.3% has an undergraduate level (blue) and 16.7% (green) has a doctorate level. In Q_4, Fig. 8d, on the subjects taught, we had a tie of 2 answers for computing, science and mathematics, and chemistry and physics are not subjects taught by any teacher.

In Q_5, Fig. 8e, we had that 100% (blue) claimed that the project contributed to the formation. As in Q_6,

Table 3 Questionnaire applied to teachers

#	Questions	Options	Answers
1	Do you work on what kind of education net?	a) Municipal b) State c) Federal	33,3% 33,3% 33,3%
2	At what level of education do you work?	a) Elementary b) High School c) Technical d) Graduation e) Post Graduate	66,7% 16,7% 16,7% 33,3% 16,7%
3	What is your level of education?	a) Graduated b) Specialist c) Master d) Doctor	33,3% 50% 0% 16,7%
4	What subjects do you actually teach?	a) Technical b) Mathematics c) Science d) Biology e) Chemistry f) Physics g) Other	33,3% 33,3% 33,3% 16,7% 0% 0% 16,7%
5	Do you believe the project has contributed to your knowledge?	a) Yes b) No	100% 0%
6	Do you believe the project has contributed to your performance in the classroom?	a) Yes b) No c) Partially	100% 0% 0%
7	Why did you subscribe in the project?	a) I believe that girls should be encouraged to follow the exact areas b) I'm interested in program/robots c) I like to participate in research and extension projects d) Opportunity to join research and extension projects e) Opportunity to enhance my curriculum f) Financial opportunity for project coordination g) It's a girls only project	66,7% 33,3% 33,3% 50% 50% 50% 33,3%
8	Did you reported some improvements your students performance in the disciplines of Sciences?	a) Yes b) No c) Partially	100% 0% 0%
9	Do you believe that the project aroused interest in your students in the areas of Exact Sciences?	a) Yes b) No c) Partially	88,3% 0% 16,7%
10	After "Elas na Robótica", are you interested in participating in more projects related to robotics or continuing your studies in that area?	a) Yes b) No	100% 0%
11	What is your opinion about the project?	Open question.	Free.



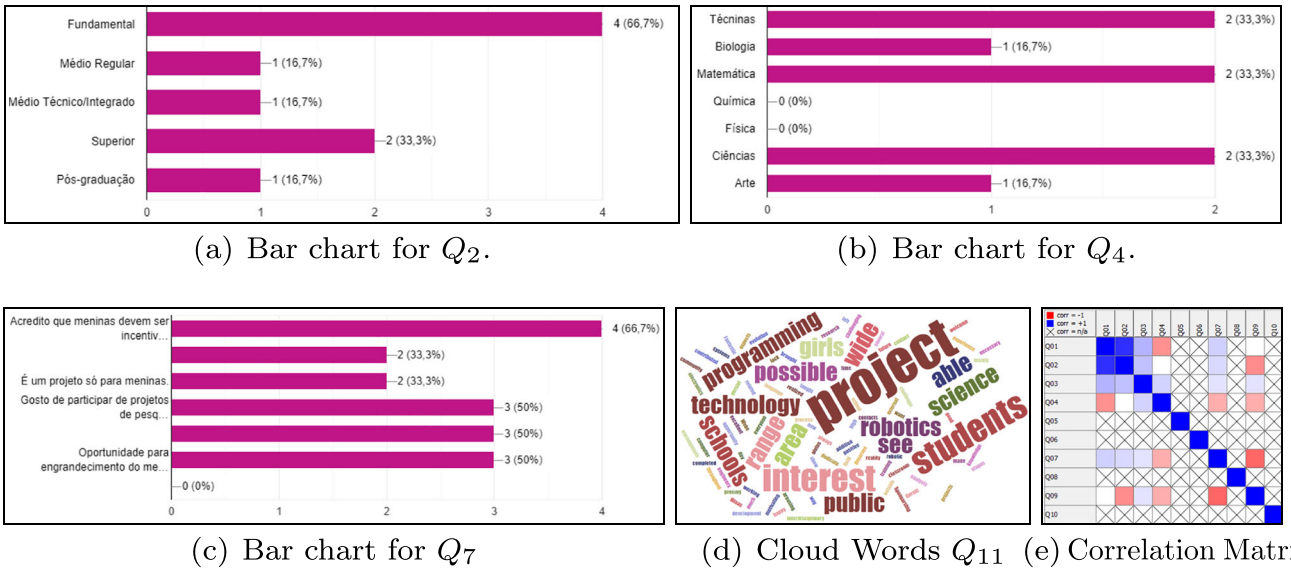
(a) Question Q_1. (b) Question Q_3. (c) Question Q_5. (d) Question Q_6.

(e) Question Q_8. (f) Question Q_9. (g) Question Q_{10}.

Fig. 8 Summarization in pie charts for the 11 teacher responses obtained

Fig. 8d, in which 100% (blue) claimed that the project improved classroom techniques and in Q_8, Fig. 8c, 100% (blue) claimed that the project specifically improved exact science classes. As in Q_{10}, Fig. 9g, in which all teachers are interested in continuing projects in these areas. In Q_7, Fig. 9c, we had that most of the answers about the motivation for participating in the project "Elas na Robotica" was due to the fact that girls should be encouraged in exact sciences. In Q_9, Fig. 9f, the teachers claimed that the majority of the teachers (83.3% blue) claimed that the project aroused the students' interest in STEM, however, 16.7% (yellow) claimed that the project only partially motivated the students. In question Q_{11} we performed a sentiment analysis from STEM teachers using a cloud of words. In this context it was possible to discover that the teachers felt happy and fulfilled with the project. For many, the project was a novelty. They felt motivated with programming, robotics, science and technology, as shown by the keywords in the nuances of words. Some found the topic of programming challenging and others believed that they could dedicate themselves more to the project.

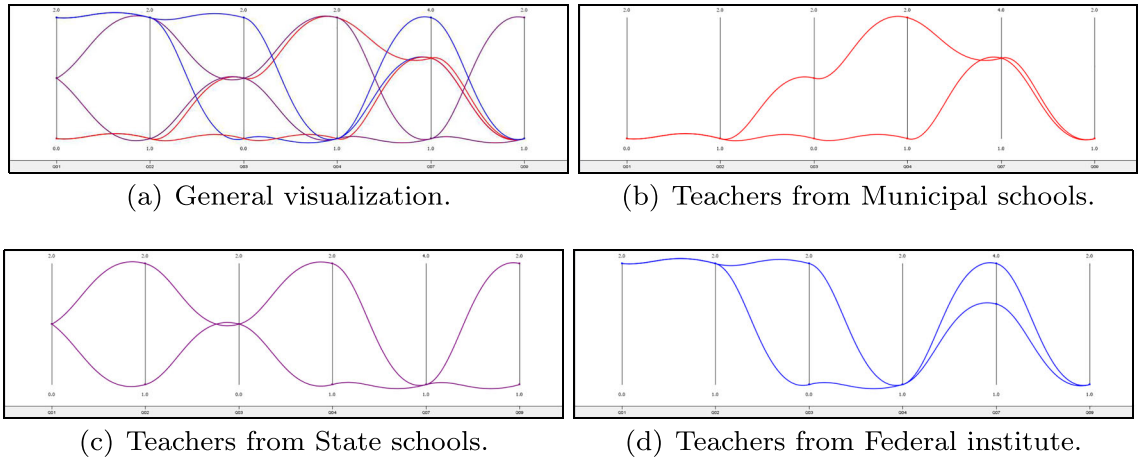
Subsequently, we performed a data visualization using parallel coordinates, Fig. 10. The questions that would appear in the data visualization were selected using



(a) Bar chart for Q_2. (b) Bar chart for Q_4.

(c) Bar chart for Q_7 (d) Cloud Words Q_{11} (e) Correlation Matrix.

Fig. 9 First line: on the left we have a bar chart for question Q_2 and on the right a bar chart for Q_4. Second line: on the left a bar chart for Q_7, on the middle, we have the analysis of the teachers' feelings for Q_{11} using a word cloud. On the right has the correlation matrix between all questions



(a) General visualization. (b) Teachers from Municipal schools.

(c) Teachers from State schools. (d) Teachers from Federal institute.

Fig. 10 Parallel coordinates visualization considering only questions with correlation for teachers

filters made using the correlation matrix. In other words, questions without correlation with the other coordinates were excluded from this data visualization. The Fig. 10a presents an overview of the data. The Fig. 10b shows a view only of teachers from the municipal school system. In this case, the teachers of the municipal network work only at the Elementary School level. Elementary school teachers claimed to have an undergraduate or specialization level. The teachers teach 1 or 2 different contents, and all scored 3 points that aroused interest in joining the project and that the project aroused interest in their students.

Later, we made an analysis of the teachers of the state and federal teaching, in Fig. 10c e d, respectively. For teachers in the state network, they claimed that they teach classes at more than one level of education. Thus, as for teachers in the federal network. State school teachers claimed to have specialization. Teachers from the federal network, on the other hand, had different levels of education, until the time of writing this article. Teachers from the state network teach classes in more than one content, while teachers from the federal network only teach 1 content, which are subjects of Computing and Programming. The teachers of the state network had only 1 motivation to enroll in the project, while teachers of the federal network presented 4 or more reasons. Finally, teachers in the federal school believe that their students have improved in STEM, while teachers in the state network were divided in "yes, the project helped" and "partially helped" the girls in STEM area.

5.3 Impact of the project on the external public

The last analysis we did about the project "Elas na Robotica" was in relation to the perception of the external public, as well as their engagement with the activities promoted by the research group in STEM area. In this case, 49 people were interviewed with a questionnaire containing 10 questions. The results are presented in Table 4 and summarized in Figs. 11 and 12. In the first question Q_1, Fig. 11a, the distribution of participants was presented, in which 22.4% (red) said they were male and 77.6% (blue) said they were female. In question Q_2, Fig. 11b, 71.4% (green) said they were students of higher education, 24.5% (yellow) said they were from technical education and 14.3% (red) said they were from regular high school. In question Q_3, Fig. 11c, 4.1% (red) claimed to be from a municipal school, 24.5% (yellow) to be from a state school and 71.4% (blue) to be from a federal school. In question Q_4, Fig. 11d, 59.2% (Blue) claimed to know "Elas na Robotica" through social networks, 16.3% (yellow) through their teachers, 6.1% (red) through friends and family and 18.4% (other colors) claimed to have known it by other means.

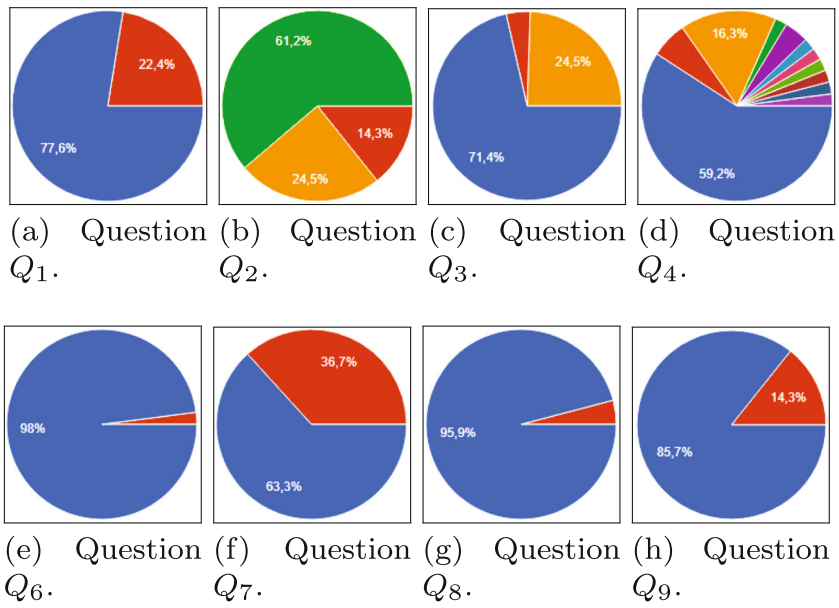
In question Q_5, Fig. 12a, 73.5% stated that they were interested in the events for being something related to Robotics and secondly stated that it was because they would like to learn more about STEM. In question Q_6, Fig. 12e, 98.0% (blue) of the people said they liked to participate in a robotics workshop, while 2.0% (red) said they did not like it. In question Q_7, Fig. 11f, the public was asked if they had already had any contact with Robotics, and 39.7% (red) said "no" and 63.3% (blue) said "yes". In question Q_8, Fig. 11g, 95.9% (blue) said they were interested in participating in more robotics workshops, while 4.1% (red) said they were no longer interested. In question Q_9, Fig. 11h, 85.7% (blue) said they were interested in participating in projects related to robotics, while 14.3% (red) said they were not interested. In question Q_{10}, Fig. 12b, we asked the impression of the external public about the subject addressed in the lecture, most of the interviewees found the lecture "interesting", as many had never had the opportunity to have contact with the topic of "robotics" up close, the word that the "project was great" also appeared very often, others have already thanked for the "opportunity" and for the "practical" knowledge acquired. Many encouraged the "continuation"

Table 4 Questionnaire applied to external audience

#	Questions	Options	Answers
1	What is your gender?	a) Female b) Male c) Other	77,6% 22,4% 0%
2	What is your level of education?	a) Elementary School b) High School c) Technical d) Undergraduate	0% 14,3% 24,5% 61,2%
3	What kind of education do you study in?	a) Municipal b) State c) Federal	4,1% 24,5% 71,4%
4	How did you hear about the workshop?	a) Social media b) Friends and Family c) Teachers d) I have a friend participating in Elas na Robotica e) Other	59,2% 6,1% 16,3% 2% 16,4%
5	What motivated you to participate in the "Elas na Robótica" workshop?	a) It i s a workshop in the exact area and I like it. b) It's an exact workshop and I want to learn more about this area. c) I want to enter an exacting or science career. d) It's a robotic workshop and I want to learn more about this area	26,5% 28,6% 16,3% 73,5%
6	Did you enjoy participating in a robotics workshop?	a) Yes b) No	98% 2%
7	Have you ever had contact with robotics?	a) Yes b) No	65,35 36,7%
8	Are you interested in participating in more workshops offered by the "Elas na Robótica" project?	a) Yes b) No	95,9% 4,1%
9	Would you participate in other projects related to robotics?	a) Yes b) No	85,7% 14,3%
10	What is your opinion about the project?	Open question.	Free.

of the project due to the "importance of the lecture and project area".

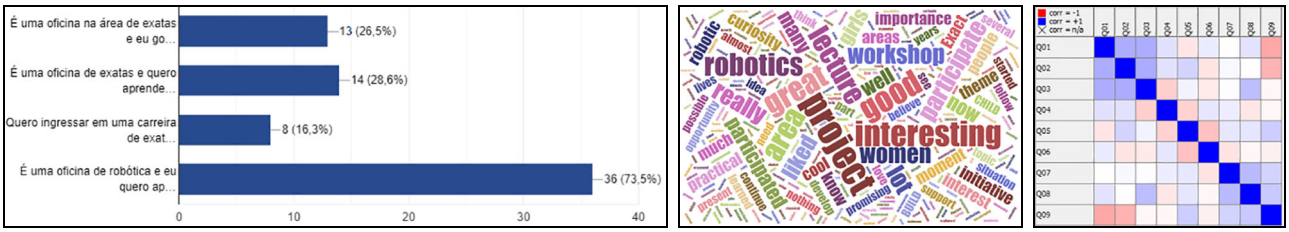
Subsequently, we analyzed the results using parallel coordinates, as shown in Fig. 13. In this case, the graphs were plotted from the filters of the correlation matrix, shown in Fig. 13a. In the Figure, we have an overview of the results. In the Figure, we have the results of regular high school in state schools where all are female students. The girls had



(a) Question Q_1. (b) Question Q_2. (c) Question Q_3. (d) Question Q_4.

(e) Question Q_6. (f) Question Q_7. (g) Question Q_8. (h) Question Q_9.

Fig. 11 Summarization in pie charts for the 49 public external responses obtained



(a) Bar chart for question Q_5. (b) Cloud words Q_{10}. (c) Correlation matrix.

Fig. 12 On the left we have a bar chart for question Q_5 in which it shows the summary of the most voted answers. On the middle, we have the analysis of the students' feelings for Q_10 using a cloud of words. On the right has the correlation matrix between all questions

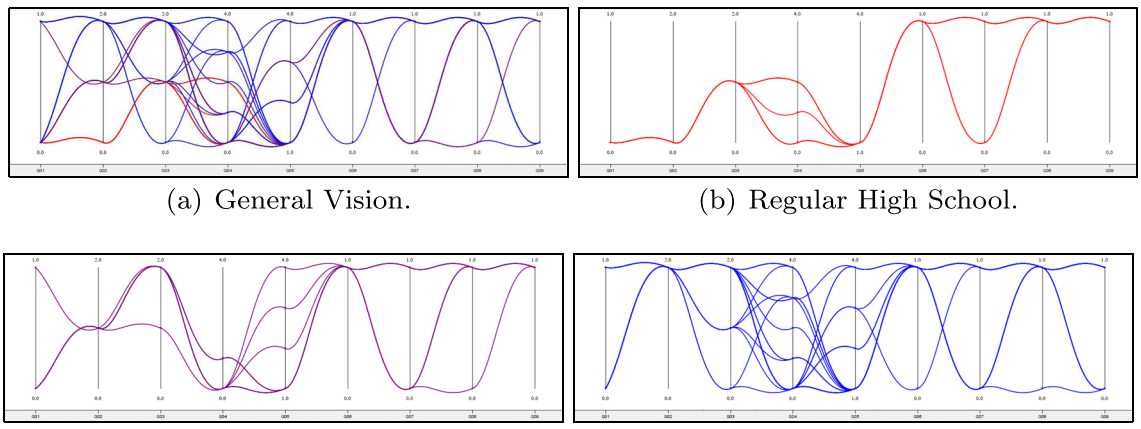
at least 3 types of interests when participating in the event and discovered the event because they participated, social networks or teachers. Everyone liked to participate in the event, because not all of them had the opportunity to work with robotics and for that reason they would participate in other projects in robotics or other projects of "Elas na Robotica".

In the last analysis we will make a comparison between the public of technical, higher education and the external community, Fig. 13c and d. In this case, we had an audience with men and women from municipal, state and federal schools. The public heard about the event through several communication networks. The participants said that their interactions with the event were mainly due to being a robotics workshop, but for both cases, we had interactions with all other possibilities, as can be seen in the Table 4. Having the technical education participants liked the presentation, however, not everyone had previously had contact with robotics, as well as in higher education. They had positive and negative responses to participate in other workshops. However, for higher education, not everyone intends to continue the projects, while for technical education, everyone intends to continue developing within STEM and Robotics.

5.4 Data clustering for planning next STEM project

In the last phase of interpretation of the data obtained, we will perform a data mining, using unsupervised data learning for the understanding of the 49 people in external public. Our future goals are to engage the external public so that these participants can learn more about STEM, Computing and Robotics. Data grouping is a technique that consists of partitioning a data set into groups according to some dissimilarity function. There are several grouping techniques and they can be classified as hierarchical and non-hierarchical. At first, we tried to group the data using hierarchical data grouping. Hierarchically clusters the input data using a distance matrix. The algorithm implemented in KNIME Platform is bottom-up (or agglomerative), i.e. the algorithm starts with every datapoint as one single cluster and tries to combine the most similar ones into superclusters until it ends up in one huge cluster containing all subclusters.

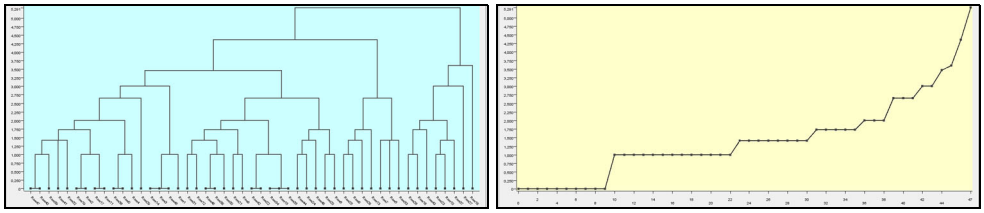
The results of the hierarchical grouping were used as preliminaries to better understand about how many different clusters we would have, the results are shown in the Fig. 14. The dendrogram was presented in the Fig. 14a and it gives a temporal notion of how each cluster was being grouped.



(a) General Vision. (b) Regular High School.

(c) Technical School. (d) Undergraduate students and other.

Fig. 13 Parallel coordinates visualization considering only questions with correlation for external public



(a) Dendrogram for hierarchical clustering. (b) Distances graphic for hierarchical clustering.

Fig. 14 Graphs about grouping data using the Hierarchical algorithm, dendrogram, on the left, and distance graph, on the right

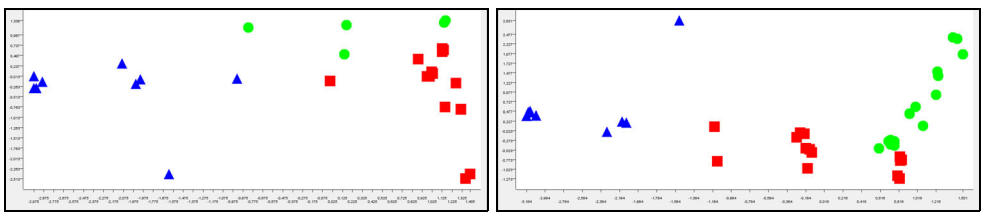
In this case, the Fig. 14b shows the distance graph, with a distance ($d = 2.75$). Thus, the hierarchical clustering algorithm suggests that in a normalized distance of 2.75, we have 3 clusters with good inter-cluster dissimilarity.

The non-hierarchical methods of cluster analysis are characterized by the need to define an initial partition and by flexibility, since the elements can be exchanged in groups during the execution of the algorithm. In this case, we use two non-hierarchical optimization algorithms: k-means and k-medoids, as can be seen in the Fig. 15. K-means outputs the cluster centers for a predefined number of clusters. K-means performs a rigid clustering, that is, the algorithm assigns a data vector to exactly one cluster. The algorithm terminates when the cluster assignments do not change anymore. We used $k = 3$ (considering the hierarchical clustering suggestion) and the algorithm was configured to perform a maximum of 99 iterations, and the output was $\{c_0, c_1, c_2\}$ and it can be seen. The centroids of each k-means cluster can be seen in the Table 5. To show each cluster was used the Scatter Plot. The PCA algorithm was used, where the input data $\{Q_1, Q_2, \cdots, Q_9\}$ is projected from its original feature space into a space of (possibly) lower dimension (in our case, 2 dimensions) with a minimum of information loss [44]. The interpretation of the clusters is as follows, the first cluster c_0 contains students mostly from technical schools and who heard about the event through social networks, who had a high interest in the workshop topics and robotics.

The second cluster c_1 contains students, mostly from the regular state network and technical education, who marked only one area of interest, but liked the workshop and is interested in robotics. Already c_2 cluster, they are the top level participants, with level in STEM projects, but they are not necessarily interested in working with robotics. Each cluster can be seen at Fig. 15a using the Scatter Plot view and k-means clusters are in Table 5. Each cluster is represented in one color: (c_0) is red, (c_1) is green and (c_2) is blue.

For the last analysis, the k-medoids algorithm was used in which algorithm starts with a random initialization of the medoids, it iteratively performs an exhaustive search on the input data by determining the cost for swapping any medoid with any input data row. Subsequently, 3 lines were found to represent each of the $k = 3$ clusters. In this case, three lines are $\{r_2, r_{22}, r_{23}\}$ were found to be the representatives of each cluster. The r_2 line represents the cluster in which it is mostly composed of women, who mostly do not know the robotics area, but who are interested in participating in robotics courses. Cluster r_{22} is a group in which most students are from higher education, but have little contact with robotics. Finally, the r_{23} cluster is a cluster with most people with higher education who discovered the course other than through social networks, with a lot of interest in robotics. The Scatter plot in Fig 15b. Each cluster is represented in one color: (r_2) is red, (r_{22}) is green and r_{23} is blue.

Our main focus of interest is to work with the groups c_2 and r_{22} to bring knowledge of Programming, STEM and Robotics to those who still have little experience in these areas, aiming at the axis of engagement, especially women, in technology areas. The other groups will focus only on working to continue motivating them to pursue careers in STEM, Computing or Robotics.



(a) Scatter plot for algorithm K-means. (b) Scatter plot for algorithm K-medoids.

Fig. 15 Scatter plots about grouping data using the non-hierarquical algorithm, dendrogram, on the left, and distance graph, on the right. For plotting we use a technique called PCA to reduce dimensionality

Table 5 Clusters and size clusters for algorithms k-means and k-medoids

Questions	Q_1	Q_2	Q_3	Q_4	Q_5	Q_6	Q_7	Q_8	Q_9	Cluster size
k-means										
C_0	0.26	1.68	1.84	0.05	1.58	1.0	0.57	0.95	0.84	31
C_1	0.00	0.14	1.14	1.14	1.00	1.0	0.85	1.00	1.00	9
C_2	0.33	2.00	1.55	3.33	1.33	1.0	0.55	0.89	0.78	9
k-medoids										
R_2	0	1	2	1	1	1	1	1	1	20
R_{22}	0	2	2	0	2	1	1	1	1	21
R_{23}	0	2	2	4	1	1	0	1	1	8

5.5 Discussion

In this section we will have a more in-depth discussion and analysis. Firstly, we could see that although the Middle School girls are part of the project, they represent the minority of the students. Thus, we see that they could represent a higher percentage in future projects, since these girls should be encouraged earlier. The project did not help approximately 10% of the girls to improve their grades and motivated to participate in a only girls' project. Girls should be encouraged to pursue careers in exact sciences, since 36.4% do not want to continue in careers in exact sciences. This is a large percentage, because in Brazil the exact careers give few opportunities for entrepreneurship. Theses careers does not attract much attention from women, who prefer careers in Health or Law, which allow the person after graduation is already a liberal professional regardless of being employed by a company or university.

Regarding the questionnaire answered by the tutor teachers, we realized that they should be encouraged to qualify more in the STEM area, another important characteristic is that many teachers were sincere in observing that about 16.7% of these students in the classroom and they did not notice significant changes in the improvement of their students in the STEM subjects during the project. In addition, many teachers coordinated the project for the financial opportunity or the curriculum. But the issue of encouraging girls in exact sciences or gaining more knowledge should have been the most important aspect for the teacher to join as a tutor in the project.

In relation to the external public, the results referring to the questionnaire indicate that most of the public are students from technical schools. In addition, although many want to know about robotics, even from the external public, most of them are also not interested in careers in STEM. In addition, from data mining we intend to engage, not only those who are already motivated by STEM, but especially those who do not know the STEM area and who are potential to continue these careers in Brazil. These incentives in Brazil, which is a country with low labor in computing, robotics, engineering and exact sciences in general, and for that reason these areas need support and partnerships between the school and the industry, are very important.

6 Conclusions

From the bibliographic review, we conclude that women are weakly inserted into the labor market in STEM areas. However, we know that most of the labor market demands with industrialization 4.0 are focused on areas such as Computing, Engineering and Robotics. In this context, it is important to insert and engage women in STEM. In the paper presented here, we conducted a search by means of related works around the world that engaged women in STEM and Robotics, starting in 2018. In the first moment, 14 works were found around the world with this theme. From the filters and readings of abstracts, we found 7 publications pertinent to the topic of women's research in STEM and Robotics. One of these works found was the work in Brazil by [40], but works from Germany, the United States, Turkey, among others, were also found.

From this reading, we sought to deepen the study within Brazil, more specifically 85 projects that were recently funded by CNPq for women in STEM. We know how important it is for women to be encouraged to hold positions in STEM around the world, and this would not be a different perspective for Brazil. In this context, we seek to understand the distribution of projects approved by Brazil through data visualization generated through maps. It was possible to discover through this analysis that more than 50% of all approved projects were concentrated in the South and Southeast regions, which are more developed regions. Thus, for this phase of analysis, we conclude that it is important to create incentives for educational institutes to support projects of this nature in other regions of the country, especially in the North and Northeast, as these are areas where women are most vulnerable.

The third and last part of this article consisted of analyzing the data of one of the 85 projects approved within the CNPq Public Call 31/2018 MCTIC "Girls in Exact Sciences, Engineering and Computing", called: "Elas na Robotica". Within this context, we could see that the project worked not only with girls in the area of Programming, Robotics, Computing and STEM, but also with female teachers in the areas of STEM. In addition, it was possible to work with members outside the project in lectures and workshops. For this reason, we divided our analysis into 3 distinct parts and one part for planning future work. This analysis is the final step of the work, to understand the results of the first phase of the project, it is necessary to read [40]. In the first phase of the final analysis of the project "Elas na Robotica" of this work, we analyzed how important it was for the girls in the project, the scholarship and the incentive. We did a sentiment analysis and the girls reported greater motivation, improved grades in STEM subjects, and greater self-confidence in these careers. Most who were interested in working on a STEM project because it was a project for women only, and also that many can now dream of attending a federal and free STEM degree. In the second phase of the final analysis of the project, we carried out an analysis of the teachers' feelings, most of the teachers reported that the project helped the students achieve better grades in STEM and that they believe that this type of project is very important and significant, and that the results achieved were very good, especially for giving research grants to girls in public schools. Finally, in the third phase, we promote cycles of lectures to the public outside the project, in this context, we conduct interviews and carry out the analysis of opinions of this public. Most of these people stated that the cycle of lectures was very good for presenting an overview of how robotics can help in times of pandemic, as well as, how much the project is able to insert people in areas of STEM and Robotics.

In the end, for future works, we conducted data mining to understand how we can encourage even more girls and young students in the areas of STEM and Robotics. In this case, we use unsupervised machine learning, through clustering algorithms. In this context, we divided the audience into 3 clusters on the two algorithms used: k-means and k-medoids. For both cases, it was possible to identify our target audience. In this case, we are interested in clusters in which they were mostly female, but who DOES NOT have a lot of knowledge in Robotics but who are VERY interested in being part of this type of project. From this survey, we hope in the future, to get more investments in this area to take young people, mainly girls to STEM, Computing and Robotics areas and make sure that girls from undergraduate courses in STEM areas do not escape the course. We also intend to create a new nomenclature for STEM, which would be SCIRTEM, Science, Computer, Informatics, Robotics, Technology, Engineering and Mathematics. This area is more comprehensive and fits better within the context of what we are developing, which is taking robotics, information technology, computing through the STEM base.

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Danielli Araújo Lima received a B.Sc., M.Sc. and Ph.D. degree in Computer Science at the Federal University of Uberlândia, Brazil, in 2010, 2012 and 2017, with their respective emphases: cryptography, artificial intelligence and robotics. She is a full-time professor at the Federal Institute of Triângulo Mineiro, Campus Patrocínio and teaches courses in the areas of discrete mathematics, procedural programming and artificial intelligence. Since 2018, she is specialist in Analysis and Development of Systems applied to Business Management with emphasis on Software Engineering at the Federal Institute of the Triângulo Mineiro, Campus Uberlândia. At the same time she is reviewer of IEEE Transactions on Cybernetics Journal; Advances in Science, Technology and Engineering Systems Journal; Applied Soft Computing; IEEE Access; Computer Methods and Programs in Biomedicine; Environment Systems and Decisions and IEEE Transactions on Automation Science and Engineering. Currently she is the leader of two research groups registered by CNPq coordinating Laboratory of Innovation in Technology (LabITec) and Laboratory of Computational Intelligence and Robotics (LICRo). Her main research interests are in the field of artificial intelligence, robotics, modeling of complex systems, neuroscience applied to gamification and discrete mathematics.

Maria Eugênia de Ávila Ferreira graduated in Systems Analysis and Development at the Triângulo Mineiro Federal Institute, she has experience in Web Development with a focus on Electronic Commerce. She was a professor at the Triângulo Mineiro Federal Institute, in addition to having worked as an ATP scholarship holder by CNPq in a project named "Elas na Robótica". Currently pursuing a degree in Professional Pedagogical Education at the Triângulo Mineiro and a Master's degree in Computer Science with emphasis in Artificial Intelligence at the Federal University of Uberlândia.

Aline Fernanda Furtado Silva brazilian, graduated in Electrical Engineering from the Federal University of Uberlândia MG, specialist in Higher Education Teaching from PUC-MG, Master in Technologies, Communication and Education also from the Federal University of Uberlândia MG, is a student of the Post-Stricto Sensu Graduation in Computer Science, in the field of Robotics at the Federal University of Minas Gerais. Professor of Higher Education and Integrated High School courses at the Triângulo Mineiro Federal Institute for 8 years. He coordinates the Elas na Robótica Project, promoted by the CNPQ. Conducts research and extension in the areas of technology, education and robotics.