INTERSCHOOL SCIENCE AND TECHNOLOGY FAIR: STEAM PROJECT SHOW AND THE VOICE OF STUDENTS

FEIRA DE CIÊNCIAS E TECNOLOGIAS INTERESCOLAR: MOSTRA DE PROJETOS STEAM E A VOZ DOS ESTUDANTES

FERIA INTERESCOLAR DE CIENCIA Y TECNOLOGÍA: STEAM PROJECT SHOW Y LA VOZ DE LOS ESTUDIANTES

Adriana Aparecida de Lima TERÇARIOL[1]
e-mail: atercariol@gmail.com

Agnaldo Keiti HIGUCHI[2]
e-mail: agnaldo.higuchi@ufvjm.edu.br

Andressa Algayer da Silva MORETTI[3]
e-mail: andressa.algayers@gmail.com

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[1] Nove de Julho University (UNINOVE), São Paulo – SP – Brazil. Professor in the Graduate Program in Education (PPGE) and Master in Management and Educational Practices (PROGEPE). Post doctoral (UAB-PT).
[2] Federal University of the Jequitinhonha and Mucuri Valleys (UFVJM), Teófilo Otoni – MG – Brazil. Professor at the Graduate Program in Public Administration (PPAP). Doctorate in Administration (UFMG).
[3] São Paulo State University (UNESP), Bauru – SP – Brazil. Doctorate student in Science Education.

ABSTRACT: The present article shows part of the results obtained from the holding of the " First Interschool Science and Technology Fair" during the first semester of 2022, with the attendance of schools which carried out projects aimed at the integration of Digital Information and Communication Technologies, robotics and computational thinking towards pedagogical practices. This article is built as a cut-off from the research project “Robotics, Computational Thinking and Digital Technologies in Basic Schooling: Improving the Learning Process and Competences in the Process of Resignificating Science Teaching”, developed between November 2019 and October 2022, through funding from the Universal Call MCTIC/CNPq - Notice No. 05/2019 - Science at School Program - Science Teaching in Basic Education with support from Nove de Julho University-Uninove/SP-Brazil. In this sense, in this article, the main objective was to highlight the potentialities and perceptions of students about the process of elaborating their learning projects and their respective presentation at this Fair promoted within the scope of the research project.

KEYWORDS: Basic Education. Technologies. Science. Projects. STEAM.

RESUMO*: Este artigo traz parte dos resultados obtidos com a realização da “I Feira de Ciências e Tecnologias Interescolar”, realizada no primeiro semestre de 2022, com o envolvimento de escolas que realizaram projetos voltados à integração das Tecnologias Digitais de Informação e Comunicação, da robótica e do pensamento computacional, às práticas pedagógicas. A promoção dessa Feira constituiu-se como uma das ações vinculadas ao projeto de pesquisa: “A Robótica, o Pensamento Computacional e as Tecnologias Digitais na Educação Básica: Potencializando Aprendizagens e Competências em Processos de Ressignificação do Ensino de Ciências”, desenvolvido entre novembro de 2019 e outubro de 2022, a partir da Chamada Universal MCTIC/CNPq – Edital nº 05/2019 – Programa Ciência na Escola – Ensino de Ciências na Educação Básica, com apoio da Uninove/SP-Brasil. Nesse sentido, no presente artigo, o principal objetivo foi evidenciar as potencialidades e percepções dos estudantes sobre o processo de elaboração de seus projetos de aprendizagem e de sua respectiva apresentação nessa Feira promovida no âmbito do referido projeto de pesquisa.*

PALAVRAS-CHAVE*: Educação Básica. Tecnologias. Ciências. Projetos. STEAM.*

RESUMEN*: Este artículo presenta parte de los resultados de la “Primera Feria Interescolar de Ciencias y Tecnologías”, realizada en el primer semestre de 2022, con la participación de escuelas que realizaron proyectos dirigidos a la integración de las Tecnologías Digitales de la Información y la Comunicación, la robótica y el pensamiento computacional, a las prácticas pedagógicas. La promoción de esta Feria se constituyó como una de las acciones vinculadas al proyecto de investigación: “Robótica, Pensamiento Computacional y Tecnologías Digitales en la Educación Básica: Potenciando Aprendizajes y las Competencias en Procesos de Resignificación de la Enseñanza de las Ciencias”, desarrollado entre noviembre de 2019 y octubre de 2022, a partir de la Convocatoria Universal MCTIC/CNPq – Edital nº 05/2019 – Programa ciencias en la escuela - Enseñanza de las ciencias en la educación básica, con el apoyo de Uninove/SP-Brasil. En ese sentido, en este artículo se tuvo como objetivo principal resaltar las potencialidades y percepciones de los estudiantes sobre el proceso de elaboración de sus proyectos de aprendizaje y su respectiva presentación en esta Feria promovida en el ámbito del mencionado proyecto de investigación.*

PALABRAS CLAVE*: Educación Básica. Tecnologías. Ciencias. Proyectos. STEAM.*

Introduction

According to the National Program of Support to the Science Fairs of Basic Education Fenaceb (BRAZIL, 2006), the first Science Fairs in Brazil arose during the 1960s, in the city of São Paulo, specifically, in the premises of the Prestes Maia Gallery, extending then to the interior of this state. In others, such Fairs occurred with the local support of the Science Centers. The document below also explains that it was in Rio Grande do Sul (RS), from the 1960s on, that these Fairs reached their greatest development.

> Initially, they were events held in schools, later they were officially called School or Internal Fairs. Each one had its own regulation, and the first written record found, in RS, refers to the Science Fair of the Colégio Estadual de Vacaria (1965), inspired by the movement from São Paulo. Later, in 1967, there is the record of the Science Fair of the Instituto de Educação General Flores da Cunha, of Porto Alegre - RS, without any connection with fairs held in other schools of the same city [...] (BRAZIL, 2006, p. 14, our translation).

From 1969 on, the leadership and control of the Science Fairs in RS were taken over by the Training Center for Science Teachers of Rio Grande do Sul (CECIRS in the Portuguese acronym), based in Porto Alegre. The biggest Fairs of that time were programmed by CECIRS, which, in 1973, managed to "gather experiences from all the regionals in a first big State Fair (I FECIRS), thanks to the tireless work of Professor Nelson Camargo Monte, director of the Center for many years and one of the biggest supporters of the event in the State of RS" (BRAZIL, 2006, p. 15, our translation).

> In May 1991, the State Program of Science Fairs of RS was created, linked to the Pedagogical Department of the State Education Secretariat, under the responsibility of CECIRS. The RS State Science Fairs continued to take place until 1998, when the XVII FECIRS took place in Santo Ângelo. (BRAZIL, 2006, p. 15, our translation).

The Science Fairs and other activities aimed at disseminating the scientific production of students in Basic Education, extended into the 80's and 90's, occurring in Brazil and in other Latin American countries. Nowadays, Science Fairs are very present all over Brazil, occurring also in several other countries around the world.

They are events that have great impact not only to the academic area, but also to society, for they concentrate several scientific knowledge, in an interdisciplinary way, and at the same time, become a vehicle for scientific and technological dissemination. These Fairs promote an understanding of science as a process, which goes beyond a merely static knowledge, that is, science as problem solving. The investigations are motivated by real challenges and guided by the search for possible solutions in the context in which they emerge, thus favoring the construction of new knowledge, in a contextualized way.

In recent times, the realization of Science Fairs has been adding numerous technologies, among them the Digital Information and Communication Technologies (DICT), both in its feasibility and in the solutions presented as results of the projects, which highlights an important space for the development of scientific and technological culture, as contributions to the awakening of interest in students for issues related to multiple areas of knowledge, among them the technological ones, also favoring the exercise of skills for the search for information and continuous learning (SANTOS, 2012), and, consequently, the development of skills essential to the contemporary world.

In view of this, Ribeiro (2018, p. 23, our translation) defines Science Fair as:

> [...] an event that brings together works of a scientific nature, in general, developed by young elementary school students, in several areas of knowledge, under the guidance of a responsible teacher. The works are exhibited, by the students, to visitors and evaluators, with the objective of demonstrating the proposed problem, the importance of its solution and how they reached it.

In these events, the public presentation of the students' work contributes "to the increase of their creative potential and achievement, besides the intensification of social interactions [...] it favors the cognitive development, the exercise of cooperation and the construction of autonomy of teachers and students involved in the work" (SANTOS, 2012, p. 157, our translation).

In this scenario, this article presents the results achieved with the organization of a fair entitled: I Interschool Science and Technology Fair [4], which materialized as an extension of a Science Club, organized in the second half of 2021[5]. From this experience, in the first half of

[4] The I Interschool Science and Technology Fair received this name because it was an event with a social, scientific and cultural character to be held, at that time, in a given school, but with the participation of other school units. This event was conceived with the intention of encouraging and providing opportunities for the presentation of projects developed by students and their teachers, in an interdisciplinary perspective, using in particular, the Digital Information and Communication Technologies (DICT) as support tools for the planning and creation of various solutions.

[5] This Club brought together young people from four school institutions, among them two public schools belonging to the state education system, one of them located in the East zone and the other in the North zone of São Paulo; and a State Technical School (ETEC), located in the West zone, also in the city of São Paulo. As a fourth institution, an Adventist Higher Technological Institute was involved. The meetings for this Club took place synchronously, via Google Meet (TERÇARIOL; MORETTI; SOUZA, 2022).

2022, some schools were invited to design learning projects aimed at integrating Digital Information and Communication Technologies (DICT), especially robotics and computational thinking to teaching practices, in order to give new meaning to the teaching and learning process in science and other areas of knowledge, in an interdisciplinary perspective in the final years of elementary and high school.

It is worth considering that both actions, that is, the realization of the Interschool Science and Technology Club (2021/2) and the I Interschool Science and Technology Fair (2022/1), were part of the actions linked to a larger research project, called: "Robotics, Computational Thinking and Digital Technologies in Basic Education: Enhancing Learning and Skills in Processes of Re-signification of Science Teaching", developed between November 2019 and October 2022. One of the objectives of this research comprised the development of interdisciplinary projects focused on the use of digital technologies, robotics, and computational thinking.

In this sense, in this article, the main objective was to highlight the potentialities and perceptions of the students about the elaboration process of their learning projects and their respective presentation at the I Interschool Science and Technology Fair promoted in the scope of the aforementioned research project.

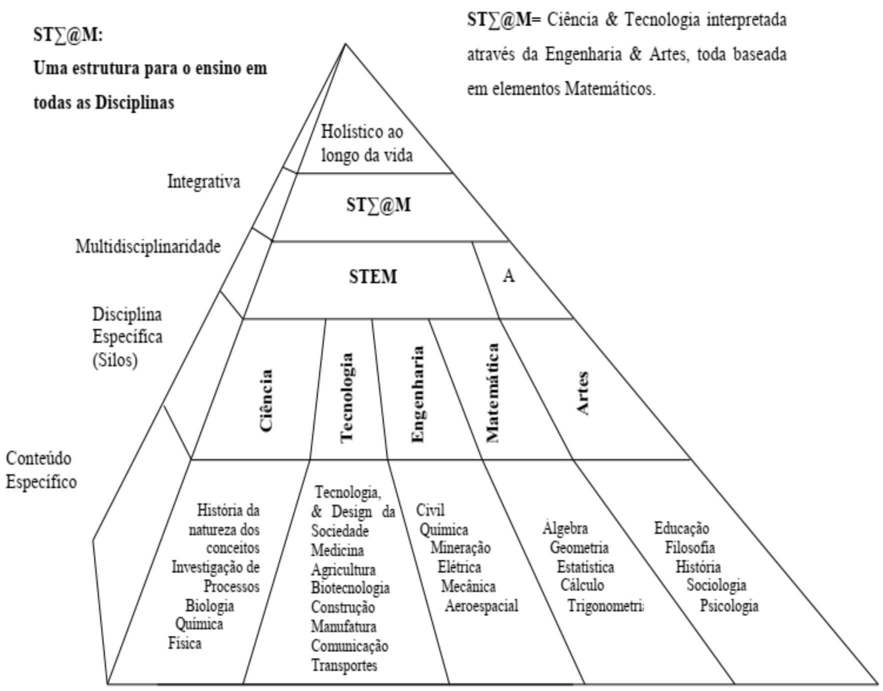
In the sequence, the theoretical framework that supports the experience reported here is addressed, the methodological approach adopted for the implementation of this experience and data collection, the analysis and discussion of the results achieved with this section of the research and, lastly, the final considerations.

Theoretical framework

According to the literature, the term STEAM has undergone several adaptations since its origin, such as STEM, STEME, STEAM, STE@M, among others. In general, the term refers to the initials for Science, Technologies, Engineering, Mathematics, and Arts, with the goal of integrating and articulating different areas of knowledge to create an integrative model of education. One of the biggest incentives to prioritize education in this format, such as STEAM, is that it has been seen by different countries as a vehicle to develop in students the much desired 21st century competencies - knowledge, skills, and values (MPOFU, 2019).

For Yakman (2010), students need the breadth literacy of the primary disciplines that include the ability to construct knowledge with higher order thinking across disciplines and for this to occur, they need to develop what the author calls functional literacy. In this sense, from all the investigations carried out in this field of research, Yakman (2008; 2010) created the diagram (Figure 1) to establish a structure and have the possibility to analyze the interactive nature of both practice and study of the areas of science, technology, engineering, mathematics and arts.

Figure 1 – Steam: A framework for teaching across the discipline



Source: Adapted from Yakman (2010)

According to this author, at the top of the pyramid is the universal level. This relates to the concept of holistic education, as being the interpretation of each person's universe of influence. The results of these influences, both internal and external, help shape what they do, what they are exposed to, and what they understand, so this first level of the pyramid refers to lifelong education.

At the second level of the pyramid is the integrated level. This is where students can get a broad scope of all fields and a basic view of how they interrelate with reality, teaching them with an intentionally planned interdependence based on reality. It is at this stage that students begin to understand what and how to explore all areas in the educational field (YAKMAN, 2010).

The third level of the pyramid refers to the multidisciplinary level, where students can get a scope of specifically chosen fields and a concentrated overview of how they relate, in reality. This is where they can begin to have a concept of specific areas of interest to explore, such as career possibilities, the most relevant being the high school stages (YAKMAN, 2010).

The fourth level of the pyramid is called the discipline-specific level. This is where the divisions of individual 'silos' of fields, or disciplines, are taught at focus levels, where the main subject is explored significantly more in depth, and only then does one move into related fields. It is at this level that the specific divisions of each 'silo' should be given an overview. This is the level at which one explores what areas of specialization a person wishes to acquire as a career (YAKMAN, 2010).

The content-specific level, the fifth level of the pyramid, is where the specific content areas are studied in detail. It is at this stage that professional development takes place and students study the specific content areas of their choice in more depth, and so it is at this point that education and professional practice relate most fully, to one's development (YAKMAN, 2010).

Despite the vast research on the topic, its operationalization remains a major challenge in many countries, as most educators lack a cohesive understanding of STEAM education in the classroom, as well as lack the structure to implement it (MPOFU, 2019). In this perspective, Bacich and Holland (2020, p. 5, our translation) take a position and describe that for them "STEAM is not considered a methodology, nor a practice based on the manufacture of artifacts or experiments that lead to the application of the concepts of related areas." According to these authors, the use of STEAM in the classroom should be based on the construction and realization of projects and, thus, associated with the Project-Based Learning (PBL) methodology, because it will contribute to develop in students, a sense of relevance of scientific knowledge worked in basic education.

It is not new that professionals in the field of education have been concerned with bringing new teaching and learning methodologies to the classroom, which differ from the so-called traditional approach. This is because today, students, future professionals, are required to be able to develop activities in an active, participative, and collaborative way. Therefore, in the classroom, there is a need for the teacher to work in a way to encourage, mainly, student autonomy and this can be developed through active methodologies.

Venturelli (2017, apud CIPOLLA, 2016) systematized the principles that guided the emergence of the practices of the different existing active methodologies, which are based on the principle of interactive pedagogy and the conception of critical and reflective pedagogy, presented in the Chart 1.

Chart 1 – Principles of innovative education versus principles of traditional education

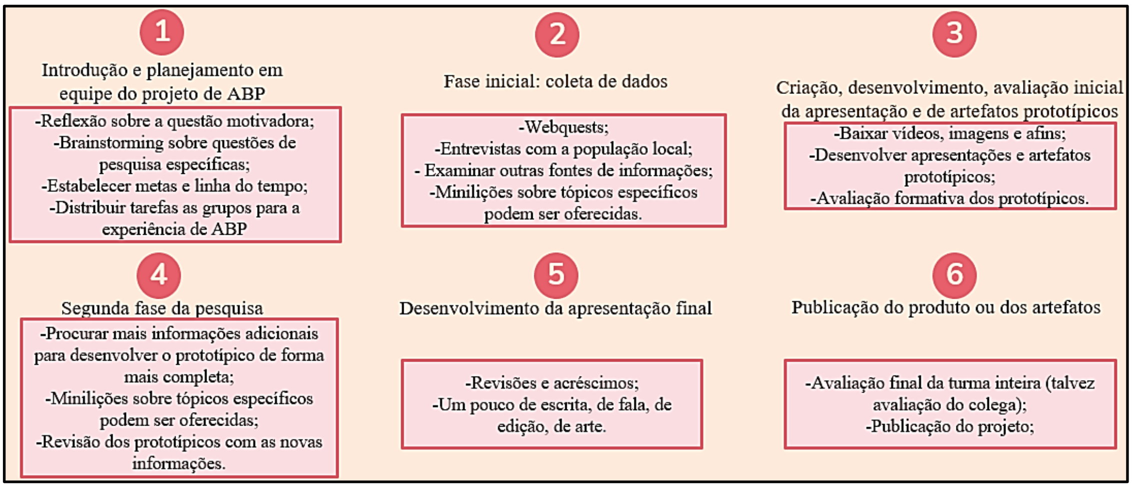
Innovative Educational Strategy	Traditional Educational Strategy
Continuous formative assessment.	Summative assessment out of context.
Focus on active, goal-oriented students.	Focus on teachers and passive students.
Use of multiple and relevant educational resources.	Use of repetitive lectures.
Considers personal qualities and styles. Promotes educational dexterity.	No space for the individual. Passive delivery of information.
Self-learning. Creative self-analysis.	Established programs. Uses existing opportunities. Does not accept alternative programs.
Use of alternatives.	Non-critical, based on the use of memory.
Critical, relevant problem-based, promotes reasoning.	Sequential, disintegrated and imposing.
Integrates transferable concepts, skills, qualities.	Impersonal and individualistic.

Source: Adapted from Venturelli (1997, apud CIPOLLA, 2016)

In this sense, one methodology that has been used for this purpose is Project-Based Learning (PBL). According to Bender (2014, p. 15, our translation), PBL "is an exciting and innovative teaching format in which students select many aspects of their assignment and are motivated by real-world problems that can, and in many cases will, contribute to their community."

Bender (2014) cites that several PBL advocates have identified different reasons for applying the methodology's framework in the classroom, and exemplified it, from the Project on PBL Effectiveness, by highlighting three criteria: the design of a curriculum that involves problems with an emphasis on cognitive skills and knowledge, a learning environment in which the focus is on the student, with small groups and active learning in which teachers act as mediator, and the result of students focused on skill development and motivation for lifelong learning. The author also described the stages necessary to enable the teacher to apply the PBL methodology in the classroom, which are: introduction and team planning of the PBL project; initial research phase: data collection; creation, development, initial evaluation of the presentation and prototypical artifacts; second research phase; development of the final presentation and publication of the product or artifacts. These stages are described in Figure 2.

Figure 2 – Stages of a project in PBL



Source: Adapted from Bender (2014)

It is understood that there is an inversion of roles, in the sense of enabling the student to learn to investigate, to seek solutions to real world issues, to learn by doing, to interact in teams, in order to work on social values and, on the other hand, the role of the teacher, who promotes all the means and resources for the class to be different, innovative and meaningful to the student. Moreover, one of the significantly important steps in the use of PBL methodology is the final assessment in which the project or product is presented and this can occur in scientific events such as Science and Technology Fairs (TERÇARIOL; MORETTI; SOUZA, 2022).

Methodological Approach

The Fair, described in this article, took place at the E. E. Professora Maria de Lourdes A. de Assis Pacheco, a state school, located in the East side of São Paulo. This action included the participation of other schools located in different regions of the city, one more state school and four other technical high schools, totaling five schools involved. It took place on June 24, 2022, during the morning and afternoon periods. The Fair was attended by students regularly enrolled in public educational institutions, partners of the Research Group in Education, Technology and Digital Culture (GRUPETeC/CNPq/Uninove).

As rules for the formation of the participating teams, it was mentioned that each team should consist of a minimum of three and a maximum of six students, each guided by a responsible teacher, who should preferably belong to the same educational institution. The same student was allowed to participate in more than one project and in more than one team. The responsible teachers were also allowed to guide more than one team. The teams could also count, if necessary, for registration purposes, with the support of a responsible teacher as a collaborator, who was linked to the undergraduate or graduate courses at the promoting institution, in this case, the Nove de Julho University (Uninove). Among the types of work exhibited in the Fair, the following stood out: digital games; robotic solutions; computational thinking practices; experiments in Science/Biology, and productions with social media, which mobilized collaborative and creative learning, in a STEAM perspective.

Table 2 shows the schools, the grade levels, and the titles of the works presented at the Fair:

Chart 2 – Schools, education levels and project titles

Achool	Education Level	Project Title
E. E. Professora Maria de Lourdes A. de Assis Pacheco	High School	EscapeClass (Escape Room)
	Elementary School	Robotic Hand
	Elementary & High School	Maze
	Elementary & High School	Astronomy: Solar System
	High School	Biology Project: Optics and Technology Experiments
ETEC Bartolomeu Bueno da Silva – Anhanguera e Escola Estadual Anhanguera	Technical High School	Elas nas Ciências e Tecnologias: Girl's Empowerment and Health at School
ETEC Bartolomeu Bueno da Silva – Anhanguera	Technical High School	- Forca_Fem
ETEC Bartolomeu Bueno da Silva – Anhanguera e ETEC de Poá	Integrated High School Technical Education	- Depression and Anxiety in Adolescence
ETEC Professora Ermelinda Giannini Teixeira	Integrated High School Technical Education	Campeonato de Robótica
ETEC Albert Einstein	Integrated High School Technical Education	GeoQuiz – Brasil x Equador Quiz Paulo Freire

Source: Research data (2022)

After the Fair, a questionnaire was applied via Google Forms, with objective and dissertative questions, to the young participants of the I Interschool Science and Technology Fair. It is worth mentioning that the ethical aspects were contemplated, since the questionnaire itself presented a section in which the respondents were informed that the confidentiality of the data collected would be maintained. There was also a question in this instrument requesting authorization from the respondents to use the information collected for analysis/evaluation purposes of the actions promoted with the respective academic publications, considering the advances in knowledge in the area. Thus, through this collection instrument, 97 answers were returned. Of the young respondents, 51.5% (50) were female, and 48.5% (47) were male. The age of these students ranged from 14 to 18 years old. According to the data collected, 2, 34% (33) of the students indicated they were 17 years old, 33% (32) were 16 years old, 24.7% (24) were 15 years old, 6.2% (6) were 18 years old, and 2.1% (2) were 14 years old.

After this brief characterization of the profile of the student respondents, it is worth explaining that the answers from the objective questions were systematized, statistically, by the Google Forms platform itself, while the analysis of the five open answers of this questionnaire was performed through the Iramuteq software[6]. The texts were purified by removing impermissible characters and joining compound words, such as "escape_room" and "robotics_projects". The software generated tables with word counts, as well as similarity analysis, which indicated the sets to which the terms were grouped. For the analyses, the lemmatization of the terms was used, that is, terms such as "technological" and "technology", "robot" and "robotic", and "rpg" and table_rpg" were considered as similar. The validity of the analyses was evaluated using as a reference the minimum score of 70% (CARVALHO; MOTA; SAAB, 2020). As the text corpus presented the utilization of 139 segments out of 158, the index was 87.97%, proving the robustness of the analyses. It is worth considering that the analyses presented, from the Iramuteq software, were complemented and enriched with the use of the Collective Subject Discourse (CSD)[7].

The information gathered from the questionnaire, indicated above, is presented and analyzed in the following section.

Presentation and Discussion of Results

Next, the results obtained through the content analysis of the answers to the questionnaire are exposed. Regarding the question - Of the PROJECTS presented at the Fair, which one (or ones) did you find most interesting and why? - the results showed that the project considered most interesting was **EscapeClass (Escape Room),** mentioned in 23 answers that contained the name of the game itself or the terms "maze" and "puzzle". Next, the most cited were those involving **Robotics (Robotics Championship and Robotic Hand),** with 16 citations, a count close to the **Biology Project**: optics and technology experiments, cited in 15

[6] Iramuteq (Interface de R pour les Analyses Multidimensionnelles de Textes et de Questionnaires) is a free textual analysis software that uses statistics to raise textual characteristics, such as frequency and structure of words in the text, generating indicators and graphs about the analyzed text. Available at: www.iramuteq.org.

[7] The Collective Subject Discourse (CSD) is a technique applied in qualitative research, focused on opinion polls, which is based on the analysis of the answers given to open questions, developed to know the individual representation of a collectivity or group researched (sum of thoughts). (LEFEVRE; LEFEVRE, 2005).

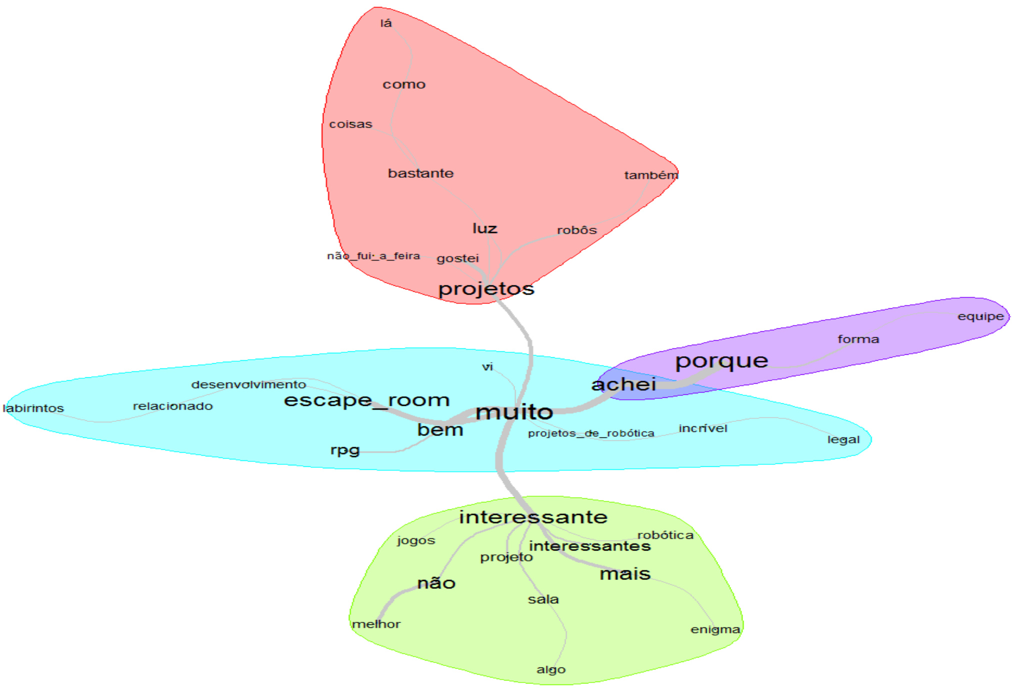
responses, and the **RPG Projects**, with 15 citations. The word cloud (Figure 3) summarizes the frequency of the cited terms.

Figure 3 – Word cloud about the most interesting projects

Source: Research data (2022)

With regard to the reasons, these were raised based on the graph of the similarity analysis in Figure 4, below:

Figure 4 – Similarity Analysis on the most interesting Projects



Source: Research data (2022)

As a complement to the evidence that represents the manifestation of the students about the most interesting projects, next, in Chart 3, the CSD are presented, expressing, in a clear way, the reasons that led the students to indicate the projects highlighted in the Figures above, as the most interesting.

Chart 3 – CSD, most interesting projects and their justifications

Projects	CSD
EscapeClass (Escape Room)	*EscapeClass (Escape Room), because it was very well designed. [...] It was a way for us to learn more about teamwork, development of our ideas. It was very nice to have participated in the Escape Room, a way to work in a team and have fun. [...] it was a project that required a lot of work, but the result was perfect. [...] Modesty aside, not for having participated in the development, but for the stimulation of computational thinking related to the puzzles. The Escape Room, it gave me a lot of curiosity. [...] because I could see my agility and my emotions like: fear. [...] the challenge of figuring out the puzzle. The reason is that these games challenge the players and test their intelligence in general.*
Robotics Projects	*The Robotics Projects, because the projects are very well done. [...] are subjects that interest me a lot. The robotic hand is very interesting, but I don't think it was done in the best way. The mechanical hands can be very useful for the industry itself, if they are improved more and more we can explore resources that [...] still can't be handled. The robotic hands [...] each person thought of something different and creative. I really like robotics and the area that deals with it. I loved the robots that pop bladders too. [...] demonstrated a robot fight where one should burst the other's balloon.*
Biology Project: experiments in optics and technology	*The experiments with the Light, because I found that very interesting. [...] It was a very good and fun experience. [The way that light changes what we see is so interesting. [...] one light that connected to another and turned on, I thought it was cool. [...] in it we could see that the colors are the presence or absence of light. I liked a lot... I won't remember the name now, but the one that showed what the purple light can do with sunscreen. [...] the best one I could see was one related to optics and light refraction. The one about light and photons, because that's where I learned the most.*
The Adventure of Learning with RPG Game Creation	*The proposal of the role-playing games was very interesting. I really liked the Dreamers group and other colleagues who participated there. Even because I also participated in the classes of the course. The RPG Maker games, because of the work and dedication required to develop a project in the program. RPG, because in this way it is possible to develop both creativity and various aspects such as logical thinking or interpretation. I followed the development closely, I saw the effort of the groups.*

Source: Research data (2022)

These results refer back to the argument of Mpofu (2019), when he argues that the STEAM approach favors the development of important competencies, such as knowledge, skills, and values. Many answers escape the scope of the question, as presented in the "Very" group, whose components refer to the idea that the participants characterized their participation in the Fair as something "amazing"; "cool"; "fun", appearing also the words "learning" and "team", which denotes the appreciation and the occurrence of collaborative learning in this process of project developments, aiming at the participation of schools in the event. Such responses indicate that the participating students were eager to demonstrate that they found the experience exciting, corroborating what Bender (2014) says, when he points out that PBL is an exciting and innovative teaching methodology, and it can be noted that this is accentuated when the projects are designed in a STEAM approach.

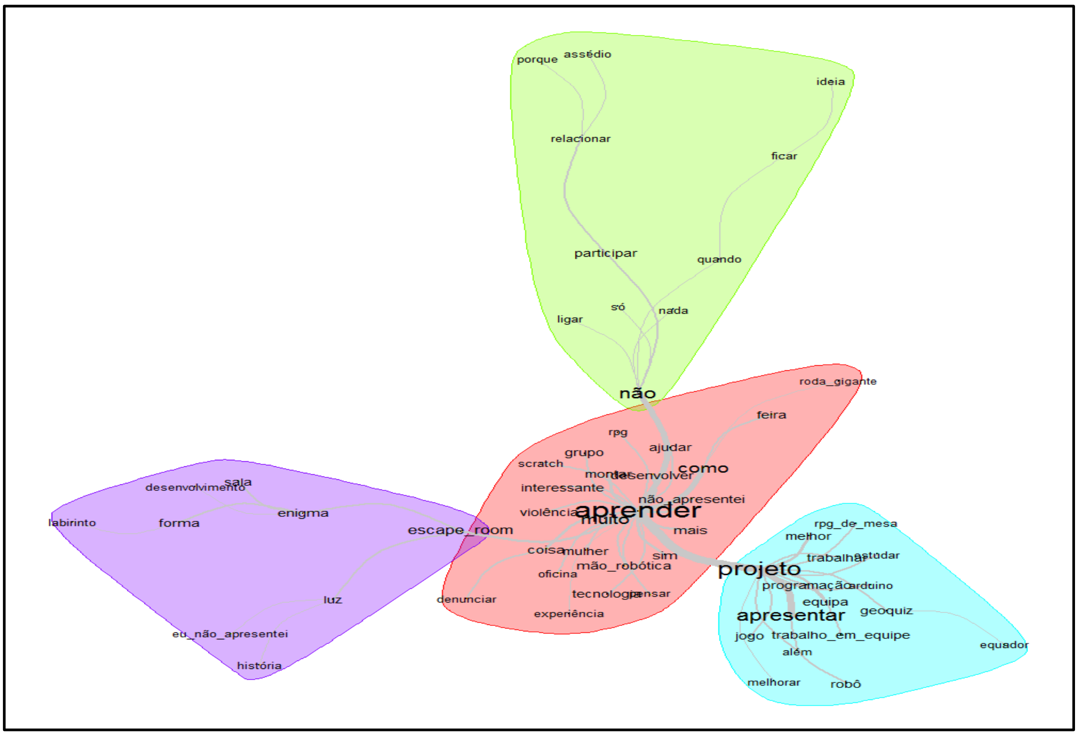
Regarding the second question (Tell us what was your PROJECT and what did you LEARN from its development?), the project with the highest number of respondents was the **EscapeClass (Escape Room),** with 20 citations, followed by the participants of the **Projects with Robotics** (14 citations) and **RPG** (8 citations). The word cloud in Figure 5, below, graphically illustrates, according to the font size, the most frequent projects/words in the students' speeches, from the answers given to this question.

Figure 5 – Word cloud about project you participated in and learning you achieved

Source: Research data (2022)

Through the word cloud, it is also possible to see what was learned during the development of the project. The terms "teamwork", "programming", "arduino", "denounce", "violence", among other words, are in evidence in the answers. To analyze the text segments related to what was learned during the development of the project, the connections present in the graph presented in Figure 6, below, were raised.

Figure 6 – Similarity Analysis on what was learned during the project development



Source: Research data (2022)

Analyzing the sets "learning" and "project", the terms "teamwork", "programming" and "presenting" are in evidence, indicating that learning is mainly related to these terms. In the set "learning", the terms related to the reporting of violence against women are also in evidence, as cited in the answer: "Projects that portray harassment, because it shows the reality". More specifically, in Chart 4 below, the CSDs indicate what the respondents said about their learning from the developed projects:

Chart 4 – CSD, constituted from the statements issued regarding the learning achieved with the projects developed.

Projects	**CSD**
EscapeClass (Escape Room)	*EscapeClass (Escape Room). I presented together with my classmates a maze that had information in the form of riddles to solve a murder, based on that people had 15 minutes to solve 7 riddles and get out of the room. [...] It was a way for us to develop ideas, set up scenarios, think as a team. There were several riddles, developing our intelligence [...], but everything connected to each other. I learned a lot to work as a team and to plan my projects better. I never thought that from such a strange base would come out a very fun project to present. An Escape Room, which is exactly about escaping from a room through puzzles that need to be solved in order to proceed and thus escape from the room. It was a way to improve teamwork and organization. I learned that an interdisciplinary project has many steps that require attention, a lot of dedication, and time to become something cool and interesting. It takes a team that is dedicated and helps in all these steps, both individually, when it is necessary to have ideas and solutions, and as a team,*

	for better communication and agility of the process, and in order not to be difficult for anyone. [...] by stimulating computational thinking related to puzzles [...] and a suspenseful story In it I learned how to deal with organization, teamwork and I learned how to deal with the public. [...] I learned that everyone needs to know how to work together. I learned how to deal better in groups. With this project, I learned to have more patience, I learned to work better in a team, and my development went beyond what I expected, I didn't expect to present a room like that, in developing a puzzle, I think these activities are perfect, because we discover things we are capable of doing that we didn't even know. [...] My group and I presented the labyrinth project, and we did things that nobody thought of doing. I made a labyrinth as a group, and I learned how to assemble a labyrinth. [...] we learned a lot how all effort is worth it for the final result.
Robotics Tournament	*We, alongside the teacher [...], presented a robot. My team's project was the robotics championship, with the [...] robots. I presented the project with robotics in arduino, where the arduino programming was worked to move a robot at a distance, via bluetooth. [...] I learned how to develop a robot in which it moved from one place to another, by an application logged on the cell phone. With this project, I was able to understand more about the embedded systems content in a fun way, absorbing the studied content better. I presented the robotics project, learned how technology offers so many possibilities and how it can be so interesting to see the process and every detail of how it was done. I presented the robots made in class [...] I learned how to assemble a robot with arduino and many others. The learning was great, from teamwork to increasing my interest in robotics.*
Robotic Hand	*My project was a robotic hand and I learned to work in groups and make amazing projects with recyclable materials. A robotic hand, I learned to work in teams and be punctual in my projects. I presented the project on robotic hand, which was interesting for me because I learned a lot about joints and the anatomy of the human hand. My group made a robotic hand inspired by a game, when the idea came up I was a little afraid it would go wrong, but in the end everything worked out and even our group won second place.*
The Adventure of Learning with RPG Game Creation	*The Save The Earth RPG, I learned many things, especially what the RPG itself is. [...] with the project, I was able to learn more about RPGs, both digital and tabletop. [...] story crafting and math. Tabletop RPG, I had to study a lot about environmental impacts and how to prevent them to develop the project itself, and in the course of the project I learned a lot about teamwork and coordinating people. What I learned was teamwork and developing creativity and interpretation. How Tabletop RPGs can contribute to learning, because we improve our logic, problem solving, communication, and depending on the theme, more advanced things like history, geography, human relations.*
Elas nas Ciências e Tecnologias: Empowerment and Health of Girls at School	*Project Elas na Ciências e Tecnologias, [...] I learned a lot from [...] issues related to women, like harassment, violence, and health. [...] I learned about the importance of women in the world, the types of violence, where to report, what empowerment is. My project was related to [...] women in technology, with the main theme of women who suffer or have suffered harassment in places of study. I learned a lot of things related to harassment, like, for example, I learned that there are many ways to harass someone, I learned that you don't have to be afraid to report it, and many other things. [...] I learned a lot about women empowerment, I learned about types of violence, Maria da Penha law, the project of intimate hygiene in schools. [...] I developed a lot of knowledge in this workshop, and cases like abuses, women's difficulties, I learned how to help in this situation. I learned that we should value women and that many of these women cannot afford hygiene products and that we can help them with this. I learned the valorization of women. [...] a lot of information about chauvinism and women's life. [...] anxiety and depression. [I learned several things about female*

	empowerment, ways to protect yourself in cases of violence, and how to report it.
Programming and Creating Games using Scratch	*[...] Scratch games. Scratch matched a lot with what I am studying, it was very interesting. My project was a Scratch game, I improved a lot my logical thinking skills, and I also learned a little more about programming. I presented a game in Scratch [...], I learned logic, programming [...]. A little game to raise awareness about global warming, not to throw garbage on the street, and its consequences. [...] I learned about the preservation of the environment.*
GeoQuiz - Brazil vs Ecuador	*I presented the GeoQuiz project and greatly improved my programming skills while developing it. A quiz application. [...] I was part of the design of the project. The game that connects Ecuador with Brazil, made by Etec's team [...]. I learned a few things about other programming languages, and a little more about Ecuador. The project presented was the mobile application, with the format of a Brazil/Ecuador quiz, and with this project I developed my knowledge in the area of Database and mobile programming. The project was the quiz that presented questions from Brazil and Ecuador, I learned a lot about the culture of Ecuador and important points in their culture that are very interesting.*
Biology Project: experiments in optics and technology	*I presented the homemade microscope, with it I learned several things regarding microorganisms, light and lasers. [...] it was a project with uv light, which only showed what was written when the purple light was turned on. It was about Lights, which in fact we don't see color, but light. I helped in the Biology teacher's darkroom, learned about colors, saw water droplets. I found the experience incredible.*

Source: Research data (2022)

The learning manifested in the CSD presented in the table above refers to the third level of the STEAM framework proposed by Yakman (2010), which cites multidisciplinarity and how the areas of knowledge present in the projects, relate to each other. Although not appearing directly in the students' discourse, the discovery of these relationships can awaken in them, the interest for certain professional careers (YAKMAN, 2010).

Thus, among the analysis of the answers to the questions presented, it could be inferred that the event awakened in the students, the motivation for learning science and technology and generated in them the perception that scientific knowledge is relevant. This result corroborates the arguments of Bacich and Holanda (2020) about the effectiveness of the application of ABP and the STEAM approach in the teaching and learning process, triggered in the projects developed by the students participating in this experience. It is also noteworthy that the event, as postulated by Santos (2012), contributed to the growth of creative potential, cooperation skills and cognitive development.

Final remarks

It can be inferred, so far, that the final evaluation of the event resulted in a positive balance, especially regarding the involvement of participants and the community outside the university, which was a very interesting feature of this Interscholastic Science and Technology Fair. The "inter-school" character was a differential, in that it promoted the interaction between students and teachers from different schools and contexts, offering an opportunity for these actors to get to know new realities and to glimpse future possibilities for other pedagogical practices. It is also worth mentioning the chance that students from the state education network had to get closer, establishing dialogues and bonds with colleagues linked to technical schools integrated to high school (ETEC), considering the continuation of their studies in this teaching segment.

This probably occurred due to the interactive nature of the methodological approach adopted in the unleashing of the projects socialized at the Fair - STEAM associated with the ABP methodology, in view of the steps detailed in Figure 2, such as team planning of the project; data collection; creation, development, initial evaluation, and development of the final presentation with the respective product display. It is worth noting that each shared project contemplated with more evidence one or another area that surrounds the STEAM approach (science, technology, engineering, arts, and mathematics), however, practically all of them, in general, were present. From this approach, learning was student-centered; it occurred in a collaborative way; it promoted students' autonomy, engagement, and protagonism; teachers acted as facilitators or mediators; emerging problems stimulated the search for new information and reflection on them, thus stimulating learning and the development of skills and competences for solving real-life problems.

Thus, Bender's (2014, p. 42, our translation) argument is corroborated when he mentions that "this is an excellent way to engage students, to increase their motivation and achievement, and to differentiate teaching so that all students can participate in a meaningful way." The works presented demonstrated quality, even in comparison with works from fairs on a national level.

Finally, it is possible to recognize the importance of holding this I Interscholastic Science and Technology Fair, in view of the beginning of a process and partnership between the university and basic education schools, which aims to grow and develop an effective dialogue between students, teachers, school managers and researchers, strengthening the creation of networks in favor of teaching, research and extension. In this sense, this category of event proved to be extremely relevant and with a significant potential for the integration and production of new scientific knowledge, as well as pedagogical experiences, in search of a re-signification of the formative processes, in times of Digital Education.

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CRediT Author Statement

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Ethical approval: For data collection, a questionnaire was applied via Google Forms, with objective and dissertative questions, to the young participants of the I Interschool Science and Technology Fair. It is worth mentioning that the ethical aspects were contemplated, since the questionnaire itself presented a section in which the respondents were informed that the confidentiality of the data collected would be maintained. There was also a question in this instrument requesting the respondents' authorization to use the information collected for analysis/evaluation purposes of the actions promoted with the respective academic publications, considering the advances in knowledge in the area. We explained that the Project did not go through the Ethics Committee, because according to RESOLUTION No. 510, OF APRIL 07, 2016, Sole Paragraph: "The following will not be registered or evaluated by the CEP/CONEP system: I - public opinion research with unidentified participants" [...].

Data and material availability: The data is stored in a folder available on Google Drive, under the care of the researcher responsible for the Project.

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