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Electronic Game Creation through Scratch Software: Creative and Collaborative Learning Fostering STEAM Practices

Elenise da Silva Pereira[a]
Leticia Azambuja Lopes[a]

[a] Universidade Luterana do Brasil, Programa de Pós-Graduação em Ensino de Ciências e Matemática, Canoas, RS, Brasil

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ABSTRACT

Background: This research is an excerpt from the master's thesis of the first author, therefore, some perceptions students have of the creation of games using the Scratch software and the teachers' perception will be presented here. **Objective:** This research aims to foster and optimize learning in STEAM practices, using creative and collaborative learning, for the creation of games. **Design:** The research is exploratory qualitative. **Setting and Participants:** The team included 7 students from the final years of a public school in the municipality of Alvorada, RS, Brazil. The research was developed through workshops in the counter shift from the regular school classes. who developed games in the Scratch software and presented them to the school classes of the early years. **Data collection and analysis:** the data collection was based on the responses of students and teachers. **Results:** That students built collaborative learning, took advantage of playfulness and creative thinking to transform realities. **Conclusions:** The development of games provided, besides learning in STEAM practices from creative and collaborative learning, increased self-esteem, affectivity, and collaborative work, movements that are so necessary in communities with high socioeconomic vulnerability, as is the case of the students participating in the research.

Keywords: Creative Learning; Collaborative Learning; STEAM; Scratch Software

Criação de Jogos Eletrônicos através do *Software Scratch*: Aprendizagem Criativa e Colaborativa como Fomento para Práticas STEAM

RESUMO

Contexto: Esta pesquisa é um recorte da dissertação de mestrado da primeira autora, portanto, será apresentado aqui, algumas percepções de alunos sobre a criação dos jogos utilizando o *software Scratch* e a percepção docente. **Objetivo:** Esta pesquisa tem o objetivo de fomentar e otimizar a aprendizagem em práticas STEAM, servindo-se da Aprendizagem Criativa e Colaborativa para a criação de jogos **Design:** A pesquisa é do tipo qualitativa exploratória. **Ambiente e participantes da pesquisa:** A equipe foi composta por 7 estudantes dos anos finais de uma escola pública no

Corresponding author: Letícia Azambuja Lopes. Email: leazambuja@gmail.com

município de Alvorada, RS. A pesquisa foi desenvolvida através de oficinas no turno inverso ao das aulas. os quais desenvolveram jogos no *software Scratch* e apresentaram suas criações para as turmas dos anos iniciais da escola. **Coleta e análise de dados:** A coleta de dados deu-se a partir das respostas dos estudantes e docentes. **Resultados:** Pode-se avaliar que os estudantes construíram um aprendizado colaborativo, aproveitaram o lúdico e o pensamento criativo para transformar realidades. **Conclusões:** O desenvolvimento dos jogos proporcionou, além da aprendizagem em práticas STEAM a partir da Aprendizagem Criativa e Colaborativa, a elevação da auto estima, afetividade e trabalho colaborativo, movimentos estes que são tão necessários em comunidades com alta vulnerabilidade socioeconômica, como é o caso dos estudantes participantes da pesquisa.

Palavras-chave: Aprendizagem Criativa; Aprendizagem Colaborativa; STEAM; *Software Scratch*.

INTRODUCTION

The Programme for International Student Assessment (PISA), a comparative assessment initiative applied by sampling to 7th graders of elementary school, in the 15-year-old age group, prove students' difficulties in science and mathematics.

PISA is coordinated by the Organization for Economic Cooperation and Development (OECD), with the support of national coordination in each country involved. In Brazil, the National Institute for Educational Studies and Research "Anísio Teixeira" (INEP) coordinates the program.

PISA is aimed at producing indicators that contribute to the discussion of the quality of education in the participating countries, to support policies to improve basic education. The evaluation seeks to verify the extent to which schools in each participating country are preparing their youth for citizenship in contemporary society.

According to PISA (2015), students' performance in Brazil is below the average of students in OECD countries in science (401 points, compared to the average of 493 points), reading (407 points, compared to the average of 493 points) and mathematics (377 points, compared to the average of 490 points).

Brazil's average in sciences has been stable since 2006, when the last cycle of PISA with a focus on science was applied (an approximate increase of 10 points in the scores - from 390 points in 2006 to 401 points in 2015 - does not represent a statistically significant change).

In mathematics, there was a significant increase of 21 points on average between 2003 and 2015. At the same time, there was a decline of 11 points if we compare the averages in 2012 and 2015.

According to the OECD results (2019), in 2018, of the 79 countries evaluated, Brazil was among the last, more specifically, in the 57th position in reading (413 points, compared to the average of 487 points), 66th in sciences (404 points, compared to the average of 489 points) and 70th in mathematics (384 points, compared to the average of 489 points), with scores well below the average of the participating countries.

Among the OECD countries, the performance in science of a student with a higher socioeconomic level is, on average, 38 points higher than that of a student with a lower socioeconomic level. In Brazil, this difference corresponds to 27 points, which is almost equivalent to an academic year of learning.

That said, the school where the research was conducted is in a community with high socioeconomic vulnerability, with high levels of violence and unemployment. The revenue from taxes and transfers per inhabitant is only R$ 778.28, placing the city of Alvorada at the (last) 497th position in the southern state of Rio Grande do Sul (TCE, 2018).

As a result, educators have been showing a growing interest in increasing engagement in STEM *(acronym for science, technology, engineering, and mathematics*) practices more broadly, as this is where the greatest learning difficulties are perceived (Martin, 2015).

Besides STEM, STEAM, an acronym that includes the arts, is forefront in this process, as the brain is also fed by art. The acronym STEAM will be used in this dissertation as an effort to reinvent our schools, communities, and nation.

Therefore, not only can computational media be a vehicle for powerful conceptions in mathematics, engineering, and science, but, with the creativity provided by arts, STEAM should be an accessible activity in schools (Halverson & Sheridan, 2014).

Thus, the following question arises: Based on the creative and collaborative learning, how can Scratch software assist in fostering STEAM practices with a group of students attending the final years of a public school located in a community with high socioeconomic vulnerability?

The research was carried out through extra-class science and technology workshops (OCT acronym in Portuguese, STW onwards) developed by the author, where a group of students could have contact with the programming language in an interdisciplinary and autonomous way, developing electronic games using the *Scratch* software.

The research aim was to investigate the development of STEAM practices with students who engaged in the STWs held in a public school in a community with high socioeconomic vulnerability, using the *Scratch* software, applying creative and collaborative learning.

This article is an excerpt from the author's master's dissertation. In this way, only some of the STW students' perceptions of the experiences acquired and some teachers' perceptions of their students' work and development will be treated here.

STEM/STEAM - Science, Technology, Engineering, Arts and Math

The term "STEM" refers to teaching and learning in the fields of science, technology, engineering, and mathematics. It is a set of technical knowledge essential for students to prepare for a good position in the 21st-century job market.

It usually includes educational activities at all levels of education - from pre-school through post-doctoral studies - in formal and informal settings. Federal policymakers have an active and lasting interest in STEM education, and the topic is often raised in debates about science, education, workforce, national security, and immigration policy.

Instead of teaching the four disciplines as separate and distinct matters, STEM integrates them into an application-based learning paradigm in today's world.

Far from being a unique and well-defined experience, integrated STEM education includes several different experiences that involve some degree of connection. Experiences can occur in one or several class periods, throughout a curriculum, be reflected in the organization of a single course or an entire school, or be included in an extra-school activity (Honey, Pearson & Schweingruber, 2014).

The integration of STEM concepts and practices promises to lead to an increase in conceptual learning within the disciplines. For both science and mathematics, the impact on learning and achievement depends on the approach to integration and the types of support that are embedded in the experience and provided through instruction. Integrated STEM education also shows the promise of supporting knowledge gains in engineering and technology (Honey et al., 2014).

What separates STEM from traditional science and mathematics education is the mixed learning environment, showing students how the scientific method can be applied to everyday life. It also teaches computational thinking and focuses on today's problem-solving applications.

As society becomes aware of the need for creative and innovative workers who can compete in the current job market - new thinking skills - it was necessary to shift the current emphasis on STEM to STEAM (science, technology, engineering, arts and math), ensuring that every brain is "fed" through arts (Eger, 2013).

STEAM, including the arts and art integration, has become the limit issue in this effort to reinvent our schools, communities, and nation. To achieve the objectives, however, it is necessary to be available to reinvent schools and the very concept of education, facing all the recurring challenges (Eger, 2013).

Today's multifaceted issues and complex problems require professionals who go beyond disciplinary content and creative thinkers who can work across disciplines (Mishra, Terry, Henriksen & Research Group, 2013).

The future of innovative thinking in the STEAM disciplines is based on breaking the distinction between discipline traditionally seen as "creative", such as arts or music, and the STEM disciplines, usually considered to be more rigid or logical-mathematical (Catterall, 2002).

According to Silva and Groenwald (2018, p. 4) "the idea behind STEAM in education is to break barriers between disciplines. It is about interdisciplinarity par excellence." Besides the technical part, the STEAM methodology allows you to learn and develop

characteristics such as imagination, creativity, critical thinking, adaptability, collaboration, communication, emotional and social structure, cultural and social skills.

Thus, STEAM has become an essential paradigm for teaching and learning, creative and artistically infused in the STEM disciplines. In this regard, Silva et al. (2018) add that

> There is an emphasis on working together that encourages each student to perform functions and activities that use and develop their skills and competences, contributing to common learning. It also fosters the development of critical thinking and provides students with a better ability to face the complexity of the world. (Silva et al., 2018, p. 4)

Arts-based teaching leads to more motivated, engaged, and effective disciplinary learning in STEM areas. In former studies, student achievement has been increased through these arts-based practices. Most importantly, students have not only strengthened their learning within disciplines but also across disciplines, through being able to explore and make connections between art, music, mathematics, science, and more (Henriksen, 2014).

COLLABORATIVE LEARNING

The concepts of collaborative learning and cooperative learning are often confused. The differences and similarities between the concepts arise a wide discussion and are subject to several interpretations in the current academic environment.

Collaboration is a philosophy of interaction and a personal lifestyle, while cooperation is an interaction structure designed to facilitate the achievement of a goal or a final product (Torres & Irala, 2014).

We use collaborative learning in this research. In collaborative learning, the process is more open, and group participants interact to achieve an objective they share. In cooperative learning, the process is more centered, directed, and controlled by the teacher (Matthews, Cooper, Davidson & Hawkes, 2004).

In this case, it is a form of learning in which two or more people learn something together. In a broader view, it can be said that learning is expected to occur as a side effect of an interaction between peers who work in an interdependence system to solve problems or perform a task proposed by the teacher.

Group interaction enhances learning more than individual effort. Rather than competitive and isolated, more efficient learning (as well as more efficient work) is collaborative and social (Torres & Irala, 2014).

It is not enough for the teacher to simply place students in a disorderly manner, but rather to create learning situations in which significant exchanges between students and between students and the teacher can occur (Torres & Irala, 2014).

It is in exchange with other subjects and with oneself that knowledge, roles, and social functions are internalized, allowing the constitution of thoughts and the very consciousness. It is, therefore, a process that moves from the social plane (interpersonal relations) to the individual internal plane (intrapersonal relations) (Vygotsky, 2001).

This process involves a whole complexity and human subjectivity, which differs according to the reality of each person. It is noteworthy that this process is in opposition to the dominant education system, based on an authoritarian, hierarchical, and linear pedagogy.

The practice of collaborative learning encourages socialization in the teaching and learning process, in which individuals in groups solve problems and, above all, build socially relevant knowledge together (Irala, 2005).

CREATIVE LEARNING

Today's children will face a continuous flow of new problems and unexpected challenges in the future. Much of what they learn today will fall out of favor tomorrow. To be successful, they must learn to develop innovative solutions to unforeseen problems that will undoubtedly arise in their lives. Your success and satisfaction will be based on the ability to think and act creatively.

According to the World Economic Forum, the 10 skills that every professional will need to master by 2020 are complex problem solving, critical thinking, creativity, people management, coordination, emotional intelligence, judgment and decision-making skills, guidance to serve, negotiation, and cognitive flexibility. Thus, knowledge alone is not enough: students need to learn to use knowledge creatively (Resnick, 2009).

According to Ibáñez (2001), this idea of creativity, founded on the principle of market competitiveness, results in the basic school's objective in detecting and developing creative potentialities.

We consider, then, that the creative product of learning corresponds to the students' personalized connection to the differentiated works they build, from written production, questions, identification of contradictions, and criticality, including to unusual solutions found in the process.

Martínez (2006, p. 90) argues that creative learning implies a "personalized transformation of the contents to be learned, a process in which subjective meanings emerge that recursively feed the process of learning creatively."

Those changes, although difficult, may be possible from the action as subjects and from the subjective senses that take place in a new and potentially exciting situation: contributing to differentiated learning.

As a result, a research group from the Massachusetts Institute of Technology (MIT), the *Lifelong Kindergarten*, at the MIT *Media Lab*, has developed new strategies to involve young people in creative learning experiences, so that they can develop as creative thinkers.

According to Resnick (2014), the main approach is based on four fundamental factors, called "Four Ps of Creative Learning" - Projects, Partnerships, Thinking while Playing, and Passion.

Those four Ps emphasize the value of creativity by creating projects that are meaningful to students playfully and collaboratively, and are inspired by the constructionist approach to education.

Therefore, the *Lifelong Kindergarten* group used the Four Ps of creative learning as principles for designing the programming language of the *Scratch* software.

THE *SCRATCH SOFTWARE*

Created by Resnick, an MIT professor, *Scratch* was developed aiming to teach programming to children. Since its launch in 2007, millions of young people from around the world have used *Scratch* to program with their ideas and to share those creations with others *online*.

Scratch had a great influence on the *Logo* programming language, created in the 60s, in the same space at MIT, by Seymour Papert. It was one of the first programming software used in education projects, and goes beyond it, making programming more manipulable (through blocks), more meaningful (supporting various projects) and more social (allowing users to share, recreate, comment and collaborate with each other's projects) (Resnick, 2014).

Thus, *Scratch*, through a visual, multimedia, and interactive programming environment, can enable STEAM practices, which are used intentionally and perceived as a source of power to achieve personal projects, through intrinsic motivation and search for the development of creative thinking.

This software seeks to master the logical language, bringing benefits not only to the project to which it belongs but also in the classroom, helping to establish relationships that are important in all school subjects.

METHODOLOGY

This research was developed through science and technology workshops (STW), in the science and technology laboratory (STL) of a public school in the municipality of Alvorada, located in the metropolitan region of Porto Alegre, RS, Brazil, where 7

students participating in the STWs had contact with the programming with the help of the *Scratch* software.

Scratch was chosen because it is free software, it is popular and provides the practical application of electronic language and programming logic (Duarte Silveira & Borges, 2017).

The project began with the presentation of *Scratch* to the group in the school's *netbooks*, letting students free to explore and learn through explanatory videos on the *YouTube* website. The group worked on the games for about 4 months, until some games were completely ready.

After that, there was a moment when the games were introduced to their colleagues from the school's early years, fostering their interaction with the STW participants. This day was called "Socialization Day with the Early Years".

This moment was organized with the supervising teacher of the early years, so that all 8 classes of the morning shift, from the 1st to the 4th grade, could participate in the presentation, entitled to 30 minutes for each class to play and talk with the participants of the STWs.

In the course of the investigation, we conducted oral interviews, so that STW participants were allowed to take a stand regarding how they perceived their experiences with the creative and collaborative learning, as well as the perception of the teachers involved.

To analyze the perceptions of STW participants of the creation of electronic games and experimentation with creative and collaborative learning, the question we posed in the oral interview was: How were your experiences with the creative learning in the creation process and the presentation of the games?

To verify the curricular teachers' perceptions of the STWs in school and the participants' development, the question was: What is your perception of both the STW's work in the school and the students' development?

To verify the teachers' perceptions of the STW at school and the Socialization Day with the Early Years, the question asked was: What is your perception of both the STW's work in the school and the Socialization Day?

Respondents were given a week to answer through different means: *WhatsApp, Messenger,* audio, voice recording, or in writing on paper, at the discretion of the participant.

Subsequently, the answers were transcribed and studied by data thematic analysis, aiming at the meaning of the perceptions of the research participants concerning the theme addressed.

According to Minayo (2001, p. 316), from this type of analysis it is possible to unveil the "meanings that make up a communication whose presence or frequency means something for the analytical objective sought."

Summary of the main points of the methodology:

- To learn game programming from creative learning;
- Create electronic games using *Scratch* software;
- Apply basic STEAM concepts in the science and technology workshops (the STWs);
- Analyze how students participating in the research perceived the creation of electronic games;
- Verify the perceptions of the teachers who followed the process.

The activities developed by the students were guided by the author, who is the leader of the Science discipline, from the perspective of the creative and collaborative learning methodology, which proposes the process of creativity as a spiral, where the research participants are involved in all the creative aspects: imagination, creation, playfulness, sharing of ideas, reflection on what was created, imagining new possibilities (Resnick, 2017).

The approach of this research was qualitative exploratory, the main characteristics of which are the attention to the context, the interpretative character of the discourses produced and the experience of the very researcher, who, in this type of investigation, presents herself as the main instrument of data collection through interaction (Esteban, 2001).

RESEARCH PARTICIPANTS

The group included 7 students, 1 girl and 6 boys aged from 12 through 15 years old, divided between the 6th and 9th grades of elementary school, from 6 different classes.

We chose the participants based on the student's interest in the theme, responsibility, and commitment in the regular classes. Teachers were also asked about the behavior and performance of pre-selected students in their classes.

When presented with the challenge of creating games using the *Scratch* software, all of them accepted, making them part of the research. The group was heterogeneous, formed by 4 students of the 6th grade, and 1 student of the 7th grade of several classes.

The regular teachers of the STW participants got also involved in the research, together with the school's management team, with their perceptions about the STW and the performance of students in their classes after entering the STW.

Teachers from the early years also participated with their perceptions about the "Socialization Day with the Early Years".

As for the ethical aspects of the research, as they are minors, the responsible the students signed a Free and Informed Consent Form, authorizing their children (or minors under their custody) to participate in the research.

Students authorized by their guardians and who chose to participate signed an Informed Consent Form. This research was approved by the Human Research Ethics Committee of the Lutheran University of Brazil, via the Brasil platform, under the CAAE number: 91215018.0.0000.5349.

For the participants' identity guarantee of confidentiality in the transcription of their speeches, each student and teacher was identified with a number. In this case, for the transcription of the speeches (responses to the interview) in the analysis and discussion of the results, the students were identified by a corresponding number, the participating teachers were also identified by a corresponding number.

SCIENCE AND TECHNOLOGY WORKSHOPS (STW) - JANGOTECH

The *Science and Technology Workshop* (STW) was called *Robotics Workshop* when it started in 2014, lasting 2 years, when it was terminated for a lack of funds and free hours of the teacher responsible.

When the researcher became aware that this project existed in the school where she works, she told the board she was interested in reactivating it, which she could also use as an object of study for her master's dissertation. In September 2018, the workshops appeared again, once a week, in the evening shift (regular classes are in the morning and afternoon).

Initially, after the members had contact with the logical language through the *Scratch* software, they asked permission to disassemble the netbooks, due to the curiosity raised by computers with malfunctions left in a spot in the laboratory.

With the authorization of the school principal and by removing and writing off the boards from the heritage system of the state of Rio Grande do Sul, the team began to disassemble them and perceive the simplest initial problems, which involved exchanging keyboards and buttons. The group observed that there were devices in very bad conditions, beyond repair, serving only for the use of their parts. On average, of every 5 computers, 3 achieved full operation.

As many parts remained unused from the repairs, the students themselves had the idea of building robots with them. Thus, they went to their classrooms asking their colleagues and the whole school community to bring damaged electronic pieces to school that they might have, aiming at reusing them.

Themes related to ecology and the environment emerged during this process, bringing out responsibility and social and environmental protagonism. Some plans started to be studied, such as a site for the collection of electronic waste in the school, due to the perception that in the neighborhood there were many residues of this type improperly discarded in vacant lots and sidewalks.

Currently, the STWs are fixed at 2 class counter shifts (morning and afternoon) per week, however, the research was carried out over twelve months, with weekly 4-hour-long meetings in the morning shifts, respecting the schedule of the regular classes, from September 2018 to September 2019.

RESULTS AND DISCUSSION

Table 1 shows the frequency of occurrence in the speeches of STW participants in which there were ideas regarding the research topics: STEAM, creative learning, and collaborative learning. The ideas that emerged in each answer may constitute more than one occurrence.

Table 1
Terms found in STW participants' responses

Themes	Emerging ideas	Frequency of occurrence
STEAM	Calculations	4
	Commands	4
	Art	2
	Sciences	3
	Technologies	3
	Mathematics	3
	Logical reasoning	2
	Total	21
Creative Learning	Projects	9
	Partnerships	12
	Passion	14
	Thinking while playing	6
	Creativity	8
	Total	49
Collaborative Learning	Teamwork	12
	Thinking in groups	4
	Total	16

- Perceptions of STW members

After the creation and preparation, the STW participants finished the games and answered the question asked by the researcher: How were your experiences with the creative and collaborative learning, in the process of creating and presenting the games? Figure 1 presents excerpts of some answers.

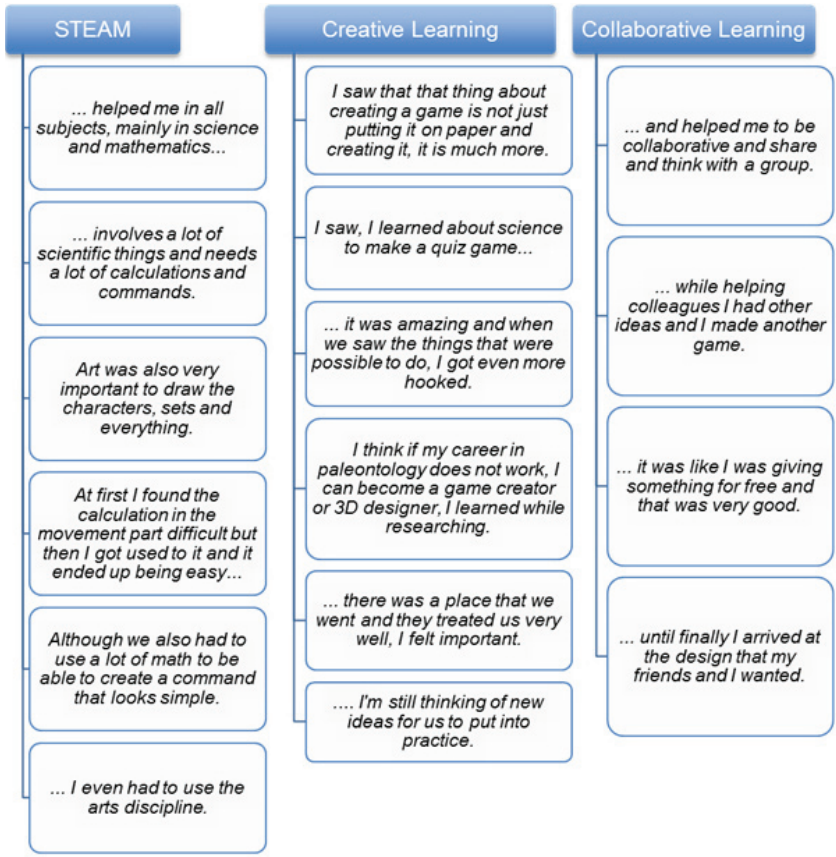

Figure 1. Excerpts from the STW participants' answers.

In analyzing the results, we concluded that the STW and the game creation process through *Scratch* helped students in STEAM practices. Through their difficulties, it was possible to acquire various skills, such as collaborative work, logical-mathematical thinking, development of interpersonal and intrapersonal relationships, including research criteria, investigation, and understanding of the situations encountered.

The participants also reported that the learning was constant from the development of new stages, where they could learn more and improve the games based on their experimentation, so the idea of creative learning was validated.

These results are in line with other research that involved *Scratch* as a learning enhancer (Sápiras, Vecchia & Maltempi, 2015; Farias & Rivera, 2017; Uchôa & Santos, 2018; Poloni, Soares & Webber, 2019).

This possibility brought by the digital technologies to reflect, interact, invent and build knowledge is successful when it accompanies the student beyond the school, making thinking about new ideas a part of their daily lives (Valente, 2017).

Through the *Scratch* software, they also demonstrated skills to have access to their feelings and ideas when a command or game presented an error, in solving the problems encountered, favoring logical reasoning, placing them in pleasant situations throughout the organization of the commands and games (Zilli, 2002).

The collaborative learning practice encouraged socialization in the teaching and learning process, in which all STW participants, together solved problems and, above all, built knowledge together.

Perceptions of the Teachers of the Early Years

Some excerpts from the accounts of the teachers of the early years on the "Socialization Day with the Early Years" the STW participants developed will be presented below (Figure 2).

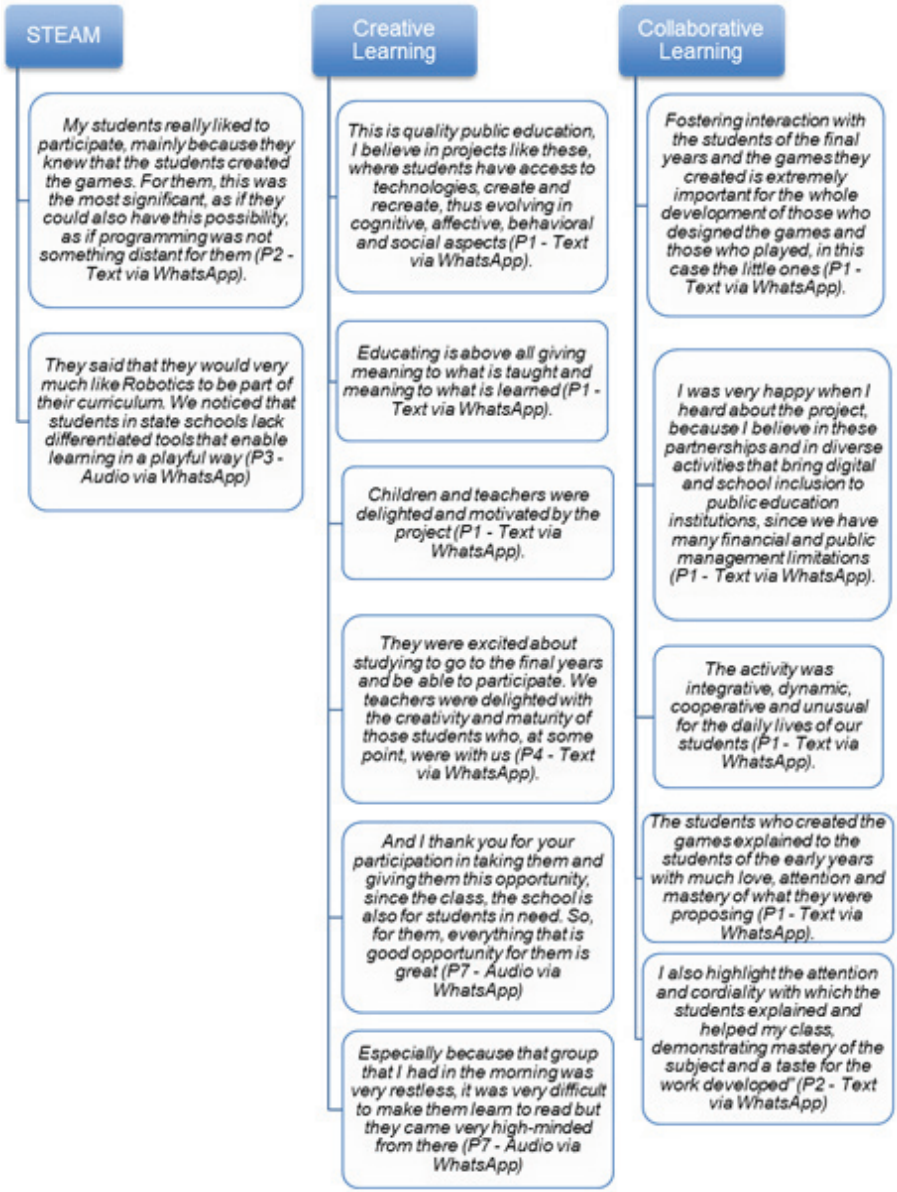

Figure 2. Excerpts from the perceptions of the teachers of the early years about the Socialization Day.

The teachers pointed out that the participants of the STW worked dynamically and collaboratively during socialization. During the construction of the games and in

the presentation, the students of the early years were able to enjoy a digital environment, something unusual for the participating students, as reported.

The analysis of these results reveals that collaboration is certainly an effective means of producing knowledge, transcending content learning, with the constitution of thought and the very consciousness.

The development of creativity and the ability to work in a team were some of the aspects the teachers highlighted the most.

- Perceptions of curricular teachers

To verify the perceptions of the curricular teachers of the STW participants of the work done and the students' development, an interview was conducted containing the following question: What is your perception of the STW and the development of the students involved? Here are some excerpts from their responses (Figure 3).

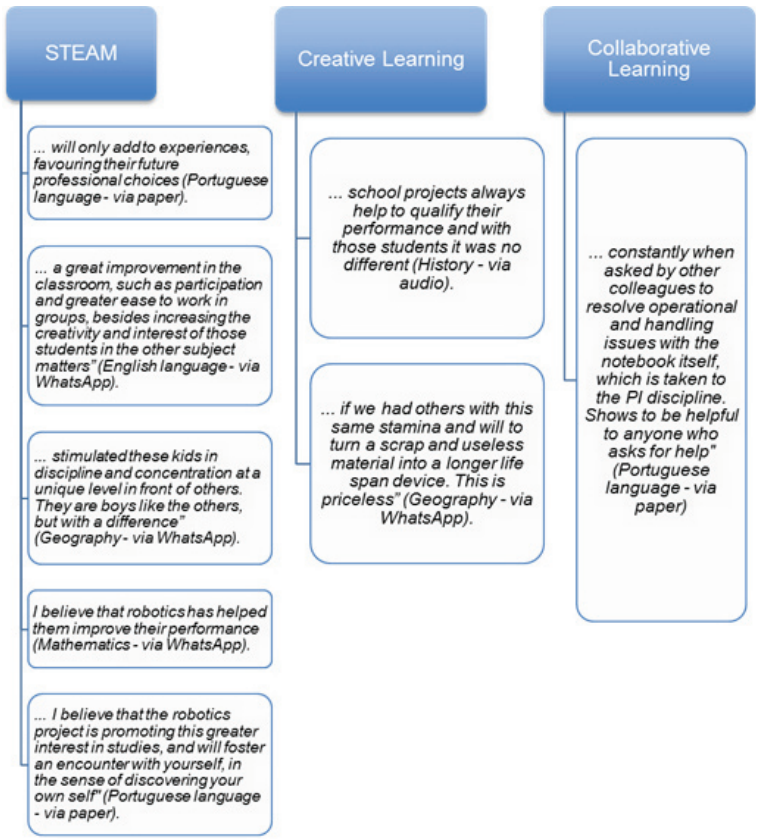

Figure 3. Excerpts from the perceptions of curricular teachers.

Through the perceptions the curricular teachers showed to have of the participants of the STWs, the progress and evolution in the classes were very noticeable, being clear that they made the workshops part of their lives, taking and bringing activities from their homes, breaking with the home-school barrier, in that knowledge is confined to the school environment.

According to these results, the *Scratch* software was found to be a vehicle for powerful ideas in STEAM, an important type of scientific and social literacy, also stimulating logical thinking, concentration, and commitment in the disciplines.

It was also possible to verify the collaborative learning of the participants of the STWs with the other colleagues in the classroom, a factor that was developed and improved during the workshops and in the socialization of the knowledge acquired, encouraged by their experiences.

It could be seen that the methodology used in the research is capable of developing and enhancing interdisciplinarity, helping participants to establish connections. The knowledge exchanges were quite important and a major step towards increasing interest in studies.

The results showed that creative and collaborative learning, with the use of the *Scratch* software, enabled a greater performance, both in STEAM and in other areas, such as Portuguese language, history, and geography.

CONCLUDING REMARKS

In their first contacts with the *Scratch* software, the STW participants maintained an individualistic position, with some showing to find it easier to work with commands than others. Thus, those who had difficulties always asked for help.

A challenge in the collaborative learning process was the creation of opportunities for collaboration without their being "ordered" to do something, in a subordinate way. Faced with this situation, they were encouraged to help each other, and so, after some classes, they were already helping each other voluntarily and building the games collaboratively, even though only one author per game.

In this sense, mediation was essential. While there were doubts, the first teachers' thought and behavior in a traditional class would be to answer those questions. Thus, we had to be patient and wait for them alone and with the help of colleagues to find solutions to their problems, fostering the collaborative learning process.

As collaborative learning and creative learning were one of the objectives of this research, we avoided as much as possible to provide ready answers. We proposed, at all times, that those who had already carried out a certain command helped those who had not yet succeeded, a mediation work highly relevant to the progress and success of collaborative learning.

This research, by creating and presenting games, combined playfulness with creative thinking, to transform/create realities, since such task provided learning in STEAM practices based on creative and collaborative learning, increased self-esteem, affection and collaborative work, actions that are extremely necessary in communities with high socioeconomic vulnerability, as is the case of the school where the research was conducted.

Win the students' attention, arising their interest in wanting knowledge, becomes one of the challenges that faculty faces nowadays because the "outside world" seduces them to the point that they see the school as outdated, as well as everything that is done inside it.

Throughout the research, the STW participants were gaining resilience in the face of difficulties and cultivating ties with each other. They learned from the mistakes by researching, raising hypotheses, testing, sharing discoveries, and information.

A transformation resulting from the practices of creative and collaborative learning was a greater engagement of the participants. Through the emotional and affective connection of the construction of the very idea, the students became actively involved with the knowledge, behaviors, and habits related to the process.

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AUTHORS' CONTRIBUTIONS STATEMENTS

This article was prepared and organized by both authors. E.P. developed the theoretical framework and collected the data. E.P. and L.A.L. developed the methodology, analyzed the data, and worked on the general construction of the article. L.A.L. advised the dissertation.

DATA AVAILABILITY STATEMENT

The authors agree to make their data available at the reasonable request of a reader. It is up to the authors to determine whether a request is reasonable or not.

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