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Dialogue of students during the creation of projects with Scratch in Mathematics classes

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Abstract: The research aims to verify and understand how dialogue occurs in the construction of projects via Scratch programming in mathematics classes based on dialogic acts and theoretical elements. The empirical material included computer recordings from three groups of two eighth grade classes. The recordings show audio from programs, acts, voices and images of students, and were transcribed for analysis of messages that means dialogue. The results show the occurrence of dialogue during interactions characterized by joint work, mutual help, search for consensus, respect for others, being separate and connected. When creating projects in Scratch, it was necessary to challenge themselves, testing possibilities, dealing with the unpredictability of an investigation, so it is necessary to understand perspectives from both sides, position themselves and argue, that is, pedagogical practice has characteristics dialogical in order to build group behaviors related to dialogical processes and theoretical elements.

Keywords: Dialogue. Mathematics Teaching. Project Programming. Scratch Software.

Diálogo de estudiantes durante la creación de proyectos con Scratch en clases de Matemáticas

***Resumen*:** La investigación tiene como objetivo verificar y comprender cómo ocurre el diálogo en la construcción de proyectos vía programación Scratch en clases de matemáticas a partir de actos dialógicos y elementos teóricos. El material empírico incluyó grabaciones informáticas de tres grupos de estudiantes de dos clases de octavo año. Las grabaciones muestran audios del programa, acciones, voces e imágenes de estudiantes, y fueron transcritas para el análisis de mensajes que significan diálogo. Los resultados muestran la ocurrencia del diálogo durante las interacciones caracterizadas por el trabajo conjunto, la ayuda mutua, la búsqueda del consenso, el respeto por los demás, el estar separados y conectados. Al crear proyectos en el Scratch, fue necesario desafiarse a sí mismos, probar posibilidades, lidiar con la imprevisibilidad de una investigación, por lo que es necesario comprender perspectivas de ambos lados, posicionarse, argumentar, es decir, la práctica pedagógica tiene características dialógicas para construir comportamientos grupales relacionados con procesos dialógicos y elementos teóricos.

Palabras clave: Diálogo. Enseñanza de Matemáticas. Programación de Proyectos. *Software* Scratch.

Diálogo de estudantes durante a criação de projetos com o Scratch em aulas de Matemática

Resumo: A pesquisa visa verificar e compreender como ocorre o diálogo na construção de projetos via programação no Scratch nas aulas de matemática a partir dos atos dialógicos e elementos teóricos. O material empírico inclui gravações da tela do computador de três grupos de estudantes de duas turmas de oitavo ano. As gravações mostraram áudios do programa, ações, vozes e imagens dos alunos, e foram transcritas para análise de mensagens que poderiam evidenciar diálogos. Os resultados apresentam a ocorrência do diálogo durante interações caracterizadas pelo trabalho conjunto, ajuda mútua, busca de consenso, respeito ao próximo, estar separado e estar conectado. Quando criavam projetos no Scratch, foi necessário se desafiar, testando possibilidades, lidar com a imprevisibilidade de uma investigação, de modo a compreender perspectivas uns dos outros, posicionar-se e argumentar, ou seja, a prática pedagógica teve características dialógicas de forma a construir comportamentos de grupo relacionados aos atos dialógicos e elementos teóricos.

Palavras-chave: Diálogo. Educação Matemática. Educação Básica. Programação de Projetos. *Software* Scratch.

1 Introduction

The presence of Information and Communication Technology (ICT) has changed the ways people interact, reducing distances between them to share situations and problems. Through these technologies, it is possible to create and share videos, images, audio, or a combination of these, conveying information in oral, written, body language, etc., thereby modifying the construction of knowledge (Coll & Monereo, 2010).

In school, it is possible to interact with the "various elements that make up the educational scenario, such as content, the teacher, other students, the educational institution, etc." (Malheiros, 2008, p.43), expanding pedagogical possibilities while simultaneously making them more complex. One can consider, for example, cognitive development, group work, affective relationships, creativity, problem-solving, the use of ICT, and responsibility in the dissemination of information, as participating in a world with technologies, requires knowing how to use resources and face new problems in pursuit of a harmonious life (Valente, 1999).

ICT enable teachers to plan lessons that consider interaction between individuals, understood as "reciprocal action between two or more actors where intersubjectivity occurs" (Belloni, 2003, p. 58), by assigning roles to themselves and their students in order to mediate the understanding of concepts and build knowledge. Lessons, for example, can occur through the transmission of information, where the teacher typically presents the content and students watch in the hope of understanding it, or through joint exploration, in which questions and reflections are made by both the teacher and the students.

The interaction that occurs in the aforementioned examples has distinct characteristics. In the first case, the teacher tends to dominate the speaking time and presents reasoning or arguments, so it is up to the student to listen to learn. In the second, there is an opportunity for everyone to speak and listen to each other, where the curiosity and questions raised by everyone reveal different directions the lesson may take, as long as an educational environment of acceptance of different ways of thinking is built (Alrø & Skovsmose, 2018).

However, not all interaction can be understood as dialogue, as it requires the individual to, in a conversation, be open to understand the other and to talk without the intention of controlling or manipulating them. For a conversation to become a dialogue, qualities are necessary, that is, characteristics of interactions related to respect and reciprocity, which lead to the construction of meaning among the participants (Alrø & Skovsmose, 2018). This perception allows us to question how dialogue occurs during the execution of tasks in lessons with ICT, as it is a subjective concept that can present different interpretations (Milani, 2020).

This article presents partial results of the master's dissertation written by the first author and supervised by the second author in the Graduate Program of Mathematics Teaching at the Federal University of Rio Grande do Sul/BR, aiming to *verify the occurrence and understand dialogue through dialogical acts and theoretical elements during the programming of projects in Scratch in mathematics classes*. The dialogical acts and the theoretical elements of dialogue are conceptions based on Alrø and Skovsmose (2018), Milani (2015, 2020), and Faustino (2018). The investigation focused on how the dialogue occurred between students while working on projects with free themes using Scratch software, where the research participants were nine students divided into three working groups, all enrolled in the eighth grade of a public school located in the metropolitan region of Porto Alegre.

The pedagogical approach using Scratch, developed in the research, was influenced by the participation of the authors of this article in the research group called "Studies and Research in Mathematics Education and Technologies - MathemaTIC", which carries out extension activities and research in Mathematics Education with Technologies, with an emphasis on authorship expression and the holistic development of individuals. Aspects such as computational thinking, investigative spirit, and artistic expression through the programming of games or stories have been the focus of the group's studies.

2 Dialogue in Mathematics Classes

The possibility of dialogue between teacher and students in mathematics classes affects how learning can be developed. For Milani (2015, p. 202), dialogue in mathematics classes can be understood as "a form of interaction between teacher and students, engaged in a learning activity, where speaking and active listening are shared, ideas are discussed, and understanding what the other says is essential." This means that each participant in the dialogue has the freedom to externalize their ideas through speech, writing, or other forms, aiming to make themselves understood by the other, as well as to consider what the other says through listening, encouraging them, when necessary, to explain their ideas to make them clearer, thus transforming listening into active listening.

It is not a dichotomous judgment about the learning derived from dialogue as good/bad or better/worse, but rather about understanding how interpersonal relationships can occur, as well as the social contexts in which individuals are inserted. Analyzing and describing these elements makes it possible to understand the interaction experiences of group members (Alrø & Skovsmose, 2018).

The dialogue between teacher and student, in turn, can be composed of three ideal elements (process of inquiry, risk-taking or unpredictability, and maintaining equality) related to its concept and, consequently, dealing with the internal characteristics of the subjects involved in the dialogue, and through eight dialogical acts (getting in contact, locating, identifying, advocating, thinking aloud, reformulating, challenging, and evaluating), which are specific actions that help to maintain the dialogue.

Regarding the ideal or theoretical elements of dialogue, both teacher and students need to be willing to be guided by curiosity, assuming responsibility and, consequently, conducting the activity, as dialogue is a way of investigating to discover something not yet known. The *process of inquiry*, from this perspective, can be interpreted as a collective construction of knowledge, with discoveries happening throughout the conversations and lessons.

The promoted investigation makes the process uncertain, unpredictable. Thus, the theoretical element *risk-taking*, refers to the possibility of reflecting on viewpoints that had not yet been considered by each participant. It is possible that questions or evaluations about propositions will be made in order to improve justifications, implying a confrontation or reformulation of ideas (Alrø & Skovsmose, 2018).

The teacher's role in this process is to observe the students and communicate their worldview, assuming a position of equality and promoting the theoretical element of *maintaining equality*. It is likely that the teacher will learn new things, while students realize they are capable of exploring possibilities in a creative world, as everyone in that environment is in a position of equality and shares the same goals. Even while aware of the existing hierarchical differences between teacher and student, it is possible to be "egalitarian on the level of interpersonal relationships and communications" (Alrø & Skovsmose, 2018, p. 123). This theoretical element is a constant pursuit of fairer forms of interaction, respecting each other's differences and ideas (Alrø & Skovsmose, 2018).

Regarding the dialogical acts, these can occur through gestures and speech from one person to another, so both teacher and students can perform them during an activity. They occur between two or more people as a way to maintain the continuity of dialogue (Alrø & Skovsmose, 2018; Milani, 2015).

The dialogical act of *getting in contact* means "creating a connection with a peer and their perspectives" (Alrø & Skovsmose, 2018, p. 95), where the perspective refers to an individual point of view on a specific topic. Therefore, this act marks the beginning of the connection between participants, as one person pays attention to the other's ideas.

The act of *locating* "means discovering something previously unknown or unnoticed" (Alrø & Skovsmose, 2018, p. 96). It is related to becoming aware of others' perspectives, that is, realizing that other ideas may contribute to the ongoing investigation.

The dialogical act of *identifying* refers to the analysis of perspectives and their validation. It involves seeking a deeper understanding of the perspective. According to Milani (2015, p. 22), it "involves efforts to explain, justify, and outline ideas" to explore the reasons behind a perspective and its contribution to the ongoing mathematical investigation.

The act of *advocating* permeates the previous acts, as it "involves making statements or presenting arguments to jointly investigate a subject or perspective" (Alrø & Skovsmose, 2018, p. 102). This act entails presenting a perspective while acknowledging that it is not an absolute truth but something subject to criticism and reflection, leading to defenses, rejections, and arguments about the validity of a perspective.

The dialogical act of *thinking aloud* consists of presenting the "reasoning that the individual used to conclude about a perspective" (Milani, 2015, p. 22). In this process, speech follows the mental construction of individuals regarding the perspectives. While in *advocating*, students try to justify their perspectives more consistently; in *thinking aloud*, the perspective is still in the construction phase. These are hypotheses verbalized to the group that will be tested and may outline the investigative course (Alrø & Skovsmose, 2018; Milani, 2015).

It is considered that in a conversation, participants do not always understand perspectives at first. It is often necessary to explain the original idea again using different means, designating the dialogical act of *reformulating*. Alrø and Skovsmose (2018) present the word paraphrasing as a possible synonym for *reformulating*, as it involves explaining in detail, "focusing on key terms and ideas" (p. 105).

The dialogical act of *challenging* means "trying to steer things in a different direction or questioning already established knowledge or perspectives" (Alrø & Skovsmose, 2018, p. 106), which can occur at any point during the investigation, leading it down paths different from those initially proposed, aiming to better understand a perspective. Finally, the act of *evaluating* occurs simultaneously with task execution and can manifest through positive or negative critiques, supportive or discouraging statements, corrections, or reinforcement of successes, meaning it happens when actions are confronted with initial objectives (Alrø & Skovsmose, 2018; Milani, 2015).

Thus, the dialogue, described by ideal elements and dialogical acts, can be another key element in mathematics classes. The roles of students and teachers, in this case, need to incorporate these considerations, so that the actions taken aim to promote and maintain dialogue throughout the task. This dialogue can occur through the expression of ideas, suggestions, and problematizations by all participants.

3 ICT and the Scratch Programming Software

With the presence of ICT, "new ways of working, communicating, relating, learning, and thinking" have emerged (Coll & Monereo, 2010, p. 2). Initially, the computer was introduced into society with the functions of calculating and storing data. It later became a tool for content creation and, more recently, a means of socialization through the internet and social networks (Santos, 2013), impacting the organization of society.

New media allow for the simulation of objects or phenomena from reality, affecting how knowledge can be represented and disseminated (Lemgruber, 2008), particularly in the school environment . Through ICT, it has become possible to access and transmit information from any physical location and interact with multiple users simultaneously via the internet.

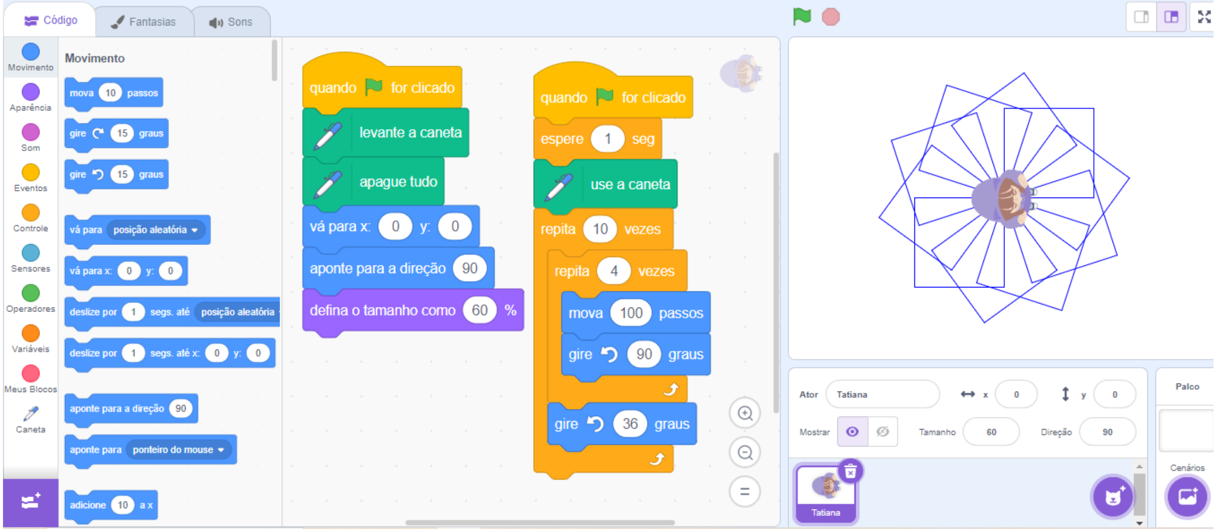
Teachers are now able to plan their classes considering the environment they want to build with their students, contributing to their learning and enhancing their creativity. Creating a classroom environment that recognizes everyone's right to speak and allows students "to follow their interests, explore their ideas, and develop their voices" (Resnick, 2020, p. 147) through the use of ICT is the focus of the proposal presented here.

Scratch software is a way to express and develop creativity, effective communication, critical thinking, and continuous learning (Monroy-Hernández & Resnick, 2008) in mathematics classes. It is an authoring language that allows for the creation of games, animations, interactive stories, among other possibilities, and for sharing them online. Scratch is a visual programming language (Vecchia & Maltempi, 2019), in which users control actions and interactions from/with the media by selecting and combining programming blocks (Santos, 2014; Ventorini, 2015). The blocks are displayed in a visible manner, facilitating the creation of interactive multimedia stories (Ventorini & Fioreze, 2014), allowing users to share what they created, how, and why, as shown in Figure 1.

The official Scratch website allows users to publish their creations and access existing projects, enabling them "to interact with the media or view the programming used" (Bitencourt, 2022, p. 44) or remix the original production. Remixing is a feature that allows users to view or copy programming developed by other users, serving as an exchange of information, whether to suggest ideas or to solve problems, such as programming a specific function (Bitencourt, 2022).

Beyond programming, Resnick (2020), in the book "Lifelong Kindergarten: Cultivating Creativity through Projects, Passion, Peers, and Play," presented an interview about interaction with other Scratch users. When asked, "In what other ways do you interact with the Scratch community?" (p. 111), a user responded: "Instead of just sitting alone and drawing, I can collaborate with others and create something interactive for them to use. They can play with what I created and make their own creations, in addition to offering help and advice" (p. 111). The sharing of ideas among community members becomes a principle of Scratch, providing new learning opportunities through continuous project improvement and fostering learning with others online.

Figure 1: Scratch workspace



Source: Available at: <https://scratch.mit.edu/projects/717535677>. Accessed on: August 22, 2024.

It is possible to identify Scratch as "a creative learning community," with "millions of shared projects" (Wangenheim, Nunes & Santos, 2014, p. 116), where "one group of children *collaborates* on building the *castle*, another group *helps* create the *story*, and both groups *share* ideas with each other. Each new addition to the castle *inspires* a new story and vice versa" (Resnick, 2020, p. 12 – our emphasis). The verbs "collaborate," "help," "share," and "inspire" are possible because the published projects allow other users to interact with the final product as well as view the developed programming. This reflects actions from one individual to another, showing a community-oriented mindset, which serves as key terms in relation to dialogicality in education.

The nouns "castle" and "story" represent people's imaginations. From imagination, a new creation process begins. Scratch can enhance imagination when a user interacts with published projects, as one idea can serve as the foundation for another, whether by expanding the original idea with new elements and new directions for the story, or by showing how to implement specific programming that will be used in a different story.

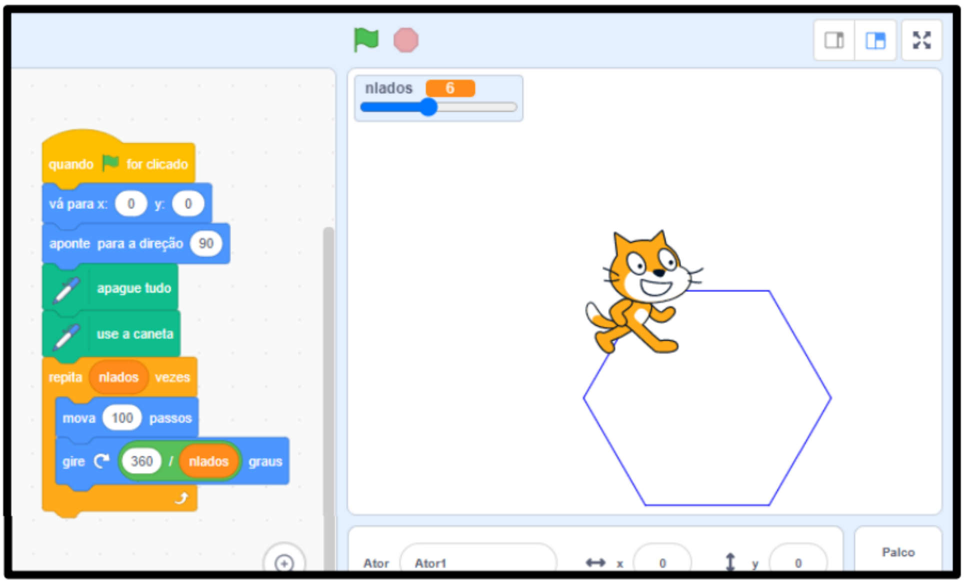
Learning occurs during moments of reflection necessary to achieve the desired objectives in the act of creating (Ponte, 2005). It is essential to test, analyze, or correct during the programming process. One must understand the individual functioning of the blocks and their relationship with others to achieve more complex programming.

In the research by Pereira (2023), Quequi (2021), and Ventorini (2015), the possibilities of learning mathematics and developing creativity stand out. The construction of programming blocks and simulations can lead to experimentation and reflection on mathematical concepts and contribute to the development of reasoning. Figure 2 presents the programming for constructing regular polygons, where geometric concepts and the notion of a variable were applied.

Figure 2 shows blocks that involve Cartesian coordinates because the character is located at a point on the screen and can simulate movements based on specific programming involving coordinates. Thus, direction, sense, distance, and time for executing the movement are incorporated, which are associated with the concept of a vector, for example.

In Figure 2, the use of variables by the {repeat n sides} blocks is visible, utilizing a slider to choose the number of sides of the polygon. The number of sides will be part of the calculation that determines the measure of the external angle, through the relationship between the sum of the exterior angles of any polygon and 360°, simulating the character's rotation and consequent movement in a polygonal shape.

Figure 2: Construction of regular polygons in Scratch



Source: Quequi (2021, p. 26)

In the geometry created with Scratch, the child needs to imagine themselves in the position of the chosen character, defining the distances and rotations necessary to complete its movement. For more complex cases, it is necessary to build programming blocks that present mathematical relationships, so that learning about mathematical concepts occurs simultaneously with the development of programming (Quequi, 2021).

Thus, Scratch offers the opportunity to learn mathematics while simultaneously developing programming logic and "expanding its environment to a collaborative level, enabling not only the sharing of the student's work but also its 'remixing,' exploration, and discussion around the outcome" (Santos, 2014, p. 88). Concepts need to be grasped and mobilized to create projects that require creativity.

4 Literature Review

To understand research related to this work, a literature review on programming with Scratch and dialogue in Mathematics Education was conducted using the Cappes Database of theses and dissertations and the Brazilian Digital Library of Theses and Dissertations (BDTD). This review, conducted in 2022 during the dissertation writing, had no time restrictions, analyzing all the repository results. The initial keyword was "Scratch" in both, yielding 320 results in the Capes Catalog and 431 in the BDTD, excluding duplicates.

The studies belong to postgraduate programs in Education, Science, and Mathematics Education, Professional Master's in Applied Computing, Physics, or Arts and Letters. They address topics such as Game Design and Gamification, Teaching and Learning of disciplinary content, Teacher Training, the use of Scratch to promote Social Inclusion, Computational Thinking, Creativity, and Problem Solving.

Selection criteria aligned with our interest were established: 1) titles related to Scratch and Education, Pedagogical Proposals, Teaching or Learning, resulting in 157 studies; 2) studies related to postgraduate programs in Mathematics Education or in Teaching/Education with a research line in Mathematics Education, reducing the number to 86 studies; 3) reading the 86 abstracts seeking words related to dialogue in tasks with Scratch, such as creativity, relationships/interactions, dialogicity, interaction between teacher and student. After selection, four studies remained: Callegari (2015), Carvalho (2018), Azevedo (2017), and Poloni (2018).

Callegari (2015) sought to understand the sociocognitive processes of 11-13-year-old children in Educational Robotics activities, grounded in Hacker Ethics, Constructivism, and Constructionism, conducting workshops with LEGO®, Scratch, and Arduino. Topics such as speed and force were discussed during the workshops, and it was necessary to understand the mathematical relationship involving the number of rotations of a pointer and a crank in a setup. The author used two data analysis processes: Moraes and Galiazzi's Discursive Textual Analysis for categorization and Piaget's Clinical Method to interpret the categories. As a result, Callegari claims that subjects can actively construct new knowledge, both intellectual and moral, such as respect for others.

Carvalho (2018) explored possibilities and challenges in programming tasks with high school students based on Mathematical Modeling (MM). He concluded that technologies contribute to "a more dialogical and rich programming environment, as they stimulated debate and discussions among students and between students and teachers." (p. 112). The challenge of building a programming model that met students' expectations stimulated interaction between them and the teacher.

Azevedo (2017) researched the construction of mathematical knowledge while creating digital games in Scratch with sixth-grade middle school students. The theoretical framework was based on Constructionism and Paulo Freire's Dialogical Education. The author highlighted the importance of dialogue for understanding mathematical concepts, which began with intuitive notions, were tested in the software, and then formalized. Difficulties in both mathematics and programming were reported, but it was possible to overcome them through joint action and dialogue. The construction of digital games provided the opportunity to create technologies as long as there was an opportunity to "discuss, reflect, and mobilize meanings for what one does and for what one shares with others" (p.183). Thus, mathematical learning also occurs in interaction with others or the environment.

Poloni (2018) investigated possible forms of mediation with high school students in a Scratch workshop. The author used Vygotsky's socio-interactionist theory and Brennan and Resnick's three-dimensional framework. Highlights include moments of searching for published projects or asking the teacher questions when students didn't know a specific programming solution. The researcher states that interventions can contribute to the internal meanings of subjects from external actions, expanding their knowledge networks. In conclusion, Scratch consists of objects, elementary operations, and associated rules that need to be understood by the user during their interaction with the software to build knowledge, not just by reading the information on the screen.

These studies highlight Scratch's potential as a resource for learning mathematics: mathematical concepts can be understood as students imagine a situation, test programming possibilities, and reflect on them. It is possible to break away from pedagogical practices based solely on knowledge transmission, as the path taken during tasks is permeated by students' curiosity, autonomy, and creativity.

The studies suggest theoretical elements of dialogue and dialogical acts during student interaction, as the authors presented connections with dialogicity in education through their interaction. Thus, investigating dialogue in mathematics classes with the Scratch software, where students are invited to build digital projects on topics of their interest, becomes feasible.

5 Metodology

This research is characterized as qualitative, as according to Bogdan and Biklen (1994), it used the natural environment as a data source, with the analyses based on data descriptions to seek their meanings and significance. This article aims to present a research excerpt focused on the occurrence of dialogue when programming in Scratch.

Data collection took place during in-person meetings in regular mathematics classes. Each meeting lasted 1 hour and 50 minutes, in a computer lab equipped with Chromebooks and Wi-Fi connection, in June 2022.

The legal aspects of the research were respected through the Consent Form signed by the students, the Parental Consent Form, and the Voice and Image Authorization, signed by the legal guardians, as well as the School Authorization signed by the acting principal, in order to establish the research participants. Upon receiving the forms, thirteen students aged between 12 and 15 chose to participate, organizing themselves into 4 working groups, named groups 1, 2, 3, and 4. There was no inducement for the group formations to include only the research participants. Each student will be referred to as E1, ..., E13, to protect their identities.

For the recordings, Microsoft Teams' institutional version was used exclusively on the participant students' computers, capturing the screen, showing the actions performed, the program's audio, the students' faces via webcam, and their voices through the microphone. Table 1 presents the recording time for each video produced by the groups during each class.

Table 1: Video files and duration after recordings

Group	Class	Video duration (h:min:s)
1	1	01:03:26
1	2	01:18:27
1	3	01:00:22
2	1	01:01:00
2	2	00:53:52
3	1	01:10:59
3	2	01:11:21
4	1	00:50:27
4	2	01:17:01

Source: Research data

Group 1 used three sessions to complete the project, while the others used two. Group 2 had to be excluded from the analysis for two reasons: one member did not return with the signed legal forms, and the video from class 2 had audio issues for more than 40 minutes.

The recordings were transcribed into 880 messages to be analyzed in search of dialogue meanings. The messages consist of the exact words spoken by the participants, transcribed in direct speech. They were coded (M1, M2, …) to facilitate their location in the general transcription record. Identified frames with the date of the meeting, workgroup, and video file name were used in the first line. Student codes, message codes, the message, and descriptions of the students' actions were organized into respective columns. Table 2 presents the model created for the transcriptions.

Table 2: Record of messages for analysis

Type of record: Oral	Class X Date X	Video file Group X	Workgroup Group X
Student	Message code	Message	Descriptions
E1	M1		

Source: Author's own elaboration.

The conversations were divided into excerpts corresponding to scenes, where a set of actions related to the investigation provided by the dialogue occurs. In each excerpt, it's possible to identify an objective or problem that the group aims to solve, as well as the attempts made through programming. Thus, conversations involving the understanding of how the blocks work and the creation of strategies for using them to build a program are part of these attempts.

In each excerpt, the dialogical acts of *getting in contact*, *locating*, *identifying*, *advocating*, *thinking aloud*, *reformulating*, *challenging*, and *evaluating* were identified, along with ideal elements such as *inquiry process*, *risk-taking*, and *maintaining equality*. The dialogical acts were expressed through words, while the ideal elements could be interpreted from a larger group of messages, as it's necessary to understand the context created by the participants' interactions. According to Milani, Civiero, Soares & Lima (2017), dialogue can be part of the development of pedagogical proposals, presenting distinct meanings during its execution. Excerpts showing verbal interaction between student-student or student-teacher were selected, highlighting their relationship with dialogue and the students' efforts to understand mathematical concepts through media interaction.

6 Pedagogical Proposal

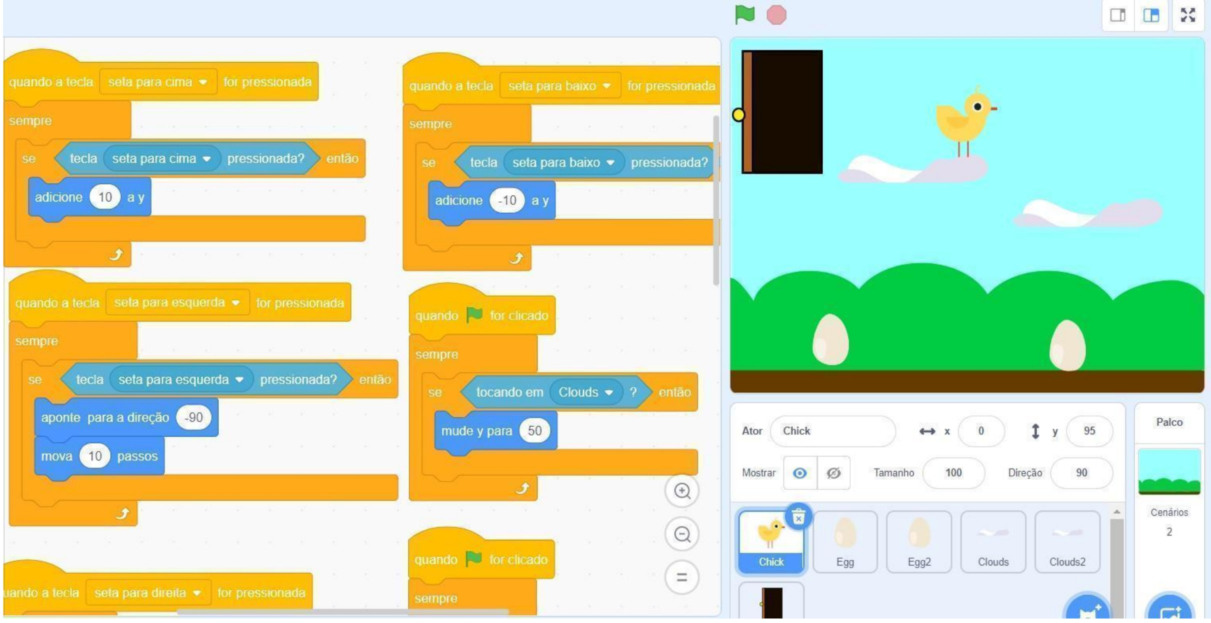
The pedagogical proposal was divided into four stages for better understanding. The first stage was reserved for introducing and familiarizing students with the program through guided tasks. The second stage, qualitatively analyzed here, involved developing a Scratch project with a free theme, allowing for creativity (Resnick, 2020) and learning in mathematics, given that "the distancing from structured content and the alignment of classes with students' daily lives do not necessarily exclude Mathematics from the school environment" (Bitencourt, Fioreze & Búrigo, 2021, p. 160). Mathematical concepts were covered as needed, for example, in order for students to program movements, they had to understand how blocks involving Cartesian plane notions worked.

Studying mathematical concepts during project creation is a way to understand the rationales and procedures of making a Scratch program work, strengthening students' development. It is a way to reflect on things with mathematics (Skovsmose, 2015).

The third stage consisted of presenting the projects developed in the previous stage, and, finally, in the fourth stage, students were invited to complete a questionnaire regarding their participation and learning during the project development.

Figure 3 shows the game created by group 1 along with part of the programming. The game's objective was to guide the character to an open door in the sky, overcoming obstacles along the way. The group managed to program one level of the game during class time.

Figure 3: Group 1 project



Source: Available at: <scratch.mit.edu/projects/705238701>. Accessed on: 06/07/2024.

The programming involved direction commands using keyboard keys, through blocks such as {set y to [10]} or {set y to [-10]}, which use algebraic addition with integers on the Cartesian plane's vertical axis. Right and left movements used the block {move [10] steps}, associated with the block {point in direction [90]} or {point in direction [-90]} in Scratch's symmetry option.

Group 3 developed a project where the user needs to press the left or right keyboard arrows to move the character to the final destination. When the character reaches the right side of the screen, the scene changes, representing a journey.

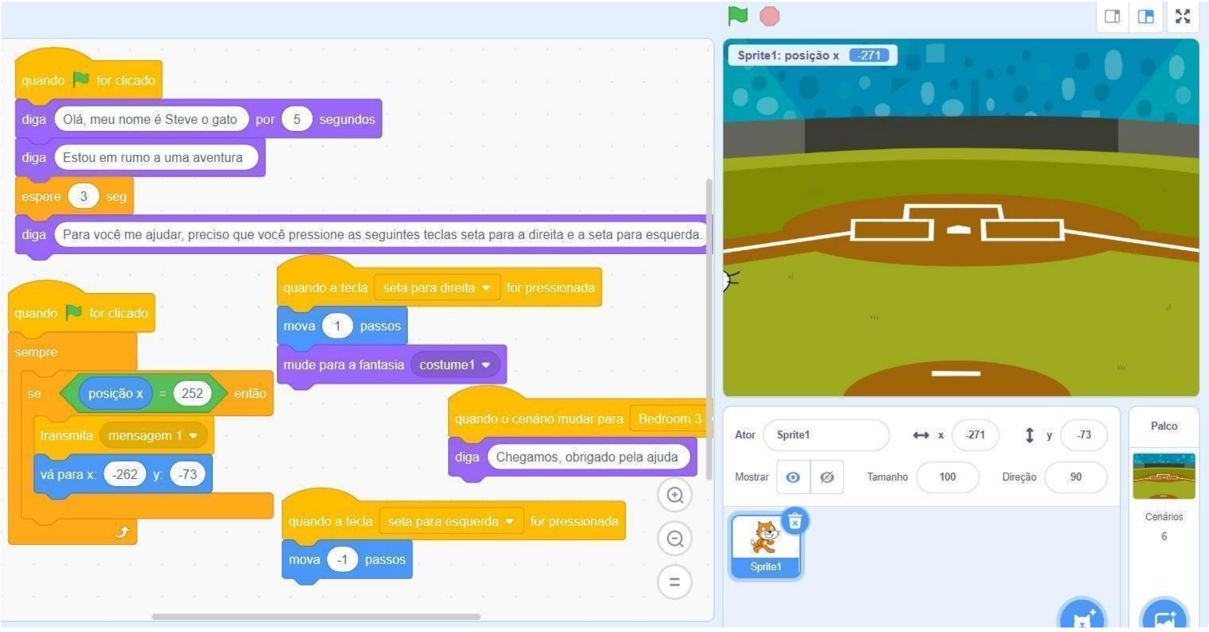
Blocks with coordinates on the Cartesian plane were used in relation to the horizontal axis. The movement of the sprite to the right combined the block {when [right arrow] key is pressed} with the block {move [1] steps}, while the movement to the left combined the block {when [left arrow] key is pressed} with the block {move [-1] steps}. In this case, students worked with positive and negative numbers, associating them with the movements to the right and left on the screen, as shown in Figure 4.

The scene change was programmed based on the ideal position where the sprite should be located. Position 252 on the x-axis was chosen, representing the right edge of the screen for this purpose. When the sprite was at this point, the block {broadcast [message 1]} was triggered, indicating the scene change and returning to the left edge to continue moving through the scenes. The block responsible for this was {go to x: [-262] y: [-73]}, corresponding to the coordinates of the plan.

The project created by group 4 simulates a basketball game with shots at the basket. The programming only involved moving the basketball while the player remained in a fixed position, as shown in Figure 5.

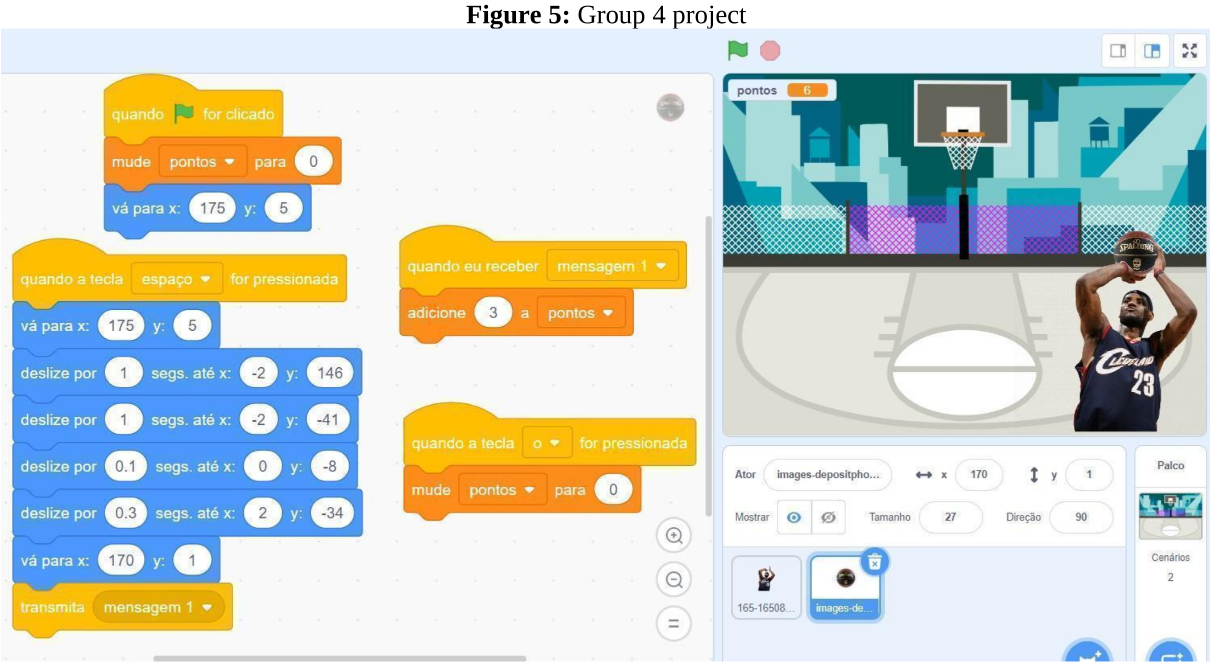
The students repeatedly used the block {glide for [1] secs to x [] y:[]} with different ordered pairs to indicate the trajectory of the ball. Initially, the block {go to x: [175] y: [5]} was used to indicate the starting position, followed by blocks like {glide for [1] secs to x [-2] y:[146]}, {glide for [1] secs to x [-2] y:[-41]}, among others shown in the image.

Figure 4: Group 3 project



Source: Available at: <scratch.mit.edu/projects/708410090>. Accessed on: 06/07/2024.

Figure 5: Group 4 project



Source: Available at: <scratch.mit.edu/projects/709909489>. Accessed on: 06/07/2024.

Based on the projects, all three groups commonly worked with Cartesian coordinate localization involving integers and arithmetic addition of integers for groups 1 and 3, to program the characters' movements on the screen. Recursive sequences were also observed for group 4 regarding the game's scoring system, where each new success added a fixed score to the previously accumulated points.

During the creation and development of the projects, the students interacted with each other and the teacher to ask questions about how to program their ideas. It can be said that the students embraced the proposal and managed to program based on their imaginations, needing to select the programming blocks that involved mathematical concepts for building their projects.

7 Analysis and Reflections on the Data

In the pedagogical proposal implemented, students were invited to create and program their projects, with the researcher-teacher (first author of this article) assisting them in the development process. The excerpt from Table 3 illustrates a conversation related to the beginning of the work, in which the students programmed individually. While Student E1 was *testing* movement blocks, her colleague E2 commented on her intention to create a game in the style of "Super Mario." However, E1 seemed concerned with the movement programming, verbally expressing her doubts, which led the colleagues to join the conversation and offer suggestions.

Table 3: Excerpt from group 1

Student	Code	Message	Description
E3	M41	*This little thing needs to move. Do this part backward.*	*Pointing to something on E1's screen.*
E2	M42	*Ah, for jumping, you need to make it point upwards.*	*Suggesting and pointing at E1's screen.*
E3	M43	*Like it's running. Then, it would jump.*	
E1	M44	*No, but hold on. I need to make it move backward too.*	*Returning to the previous issue of making the sprite move backward.*
E3	M45	*Why?*	
E1	M46	*So the player can go back, see? Will it only move forward forever? Won't it go back?*	*Answering E3*
E3	M47	*Oh, right!*	*Realizing what would happen if the sprite didn't move backward.*
E1	M48	*Hmm. Wait.*	*Searching for blocks in the library.*
E2	M49	*Then, tell it (the sprite) to turn.*	*Suggesting to E1*
E1	M50	*Ah.*	*Searching for blocks in the library.*
E2	M51	*Turn…*	*Thinking aloud, suggesting the use of the {Turn [x] degrees} block.*
E1	M52	*Point in direction. Point in direction.*	*Choosing the block {Point in direction [x]}, dragging it to the construction window, ignoring E2's suggestion.*

E3	M53	*Look, E2. But it (the sprite) wasn't supposed to turn. It's supposed to go back.*	*Explaining to E2 the reason for not using the block {Turn [x] degrees}*
E2	M54	*Got it. True.*	*Agreeing with E3.*

Source: Document with transcriptions of recordings.

It is possible to understand that the students were *getting contact* by completing each other's thoughts, as if in harmony, in M41, M42, and M43. The act of *locating* occurs in M45, where E3 questions the reasoning behind E1's intentions, which she explains in M46, and E3 understands in M47. E1 positioned herself and explained her reasoning in M46.

Such actions were made possible by the element *risk-taking*, which is characteristic of open-ended tasks, where it is necessary to explore and test hypotheses (Skovsmose, 2000; Ponte, 2005). The students *suggested* blocks to program their ideas, selecting one at a time for *testing*.

Gestures pointing at the computer screen accompanied the students' speech, described in the messages M41 and M42, as well as the manipulation of blocks using the computer's touchpad, as observed in M51 and M52. These actions can be associated with the dialogical act of *thinking aloud*. The students then programmed individually on their computers, revealing *collaborative work* since the problem was viewed as a shared challenge, as presented in Table 4.

Table 4: Excerpt from group 1

Student	Code	Message	Description
E3	M86	*Right, I'll try to help.*	
E1	M87	*No, but I've already done this part, look.*	
E3	M88	*The jump part?*	
E1	M89	*Look at these commands. It already jumps with these commands I made.*	
E3	M90	*Look, me too. What do you think of doing it this way: for the jump, slide for 1 second up here, right? I'm still adjusting it.*	*Showing E1 the programming she was creating on her computer.*
E1	M91	*But the jump is kind of slow, right?*	*Evaluating the programming.*
E3	M92	*Yeah.*	
E1	M93	*It's not that effective.*	
E3	M94	*I'll try then.*	
E1	M95	*Look at what I..., the commands I used.*	
E3	M96	*I saw.*	
E1	M97	*This is for going forward and this, look, when your pointer is here, and you press, it goes where your pointer is. It's like it's flying. I can*	*Showing E3 the programming she was creating on her computer.*

		change costumes too. Let's see if there's a flying costume for it.	

Source: Document with transcriptions of recordings.

This moment is marked by the *mutual assistance* offered by the students in presenting how they programmed the "jump" movement for the character. In M89, M90, and M97, there was a sharing of programming, where each student's presentation of their perspective represents the dialogical act of *challenging*, as each student had to understand a new way to achieve the objective. According to Monroy-Hernández and Resnick (2008), this sharing is important for collaborative work.

Group 3 demonstrated other possibilities for dialogue during the early stages of project development. Some students offered suggestions to others, discussing the general theme of the project and elements of the story but without reaching a *consensus*, as shown in Table 5.

Table 5: Excerpt from group 3

Student	Code	Message	Description
E8	M480	*Right arrow. Then, I'll put 'move'*	
E9	M481	*Move*	
E8	M482	*Move…*	
E9	M483	*10 steps*	
E8	M484	*But it will move 10 steps each time...*	*Changes 10 to 1 and tests it.*
E9	M485	*Ok, but it will take too long*	*After seeing the test result*
E8	M486	*Yeah, it will take too long. I'll put 2 steps*	*Alters the block number*
E10	M487	*You have to make the sprite bigger, right! No, 2 is still weak.*	*Referring to the distance traveled by the sprite with the number 2 in the block*

Source: Document with transcriptions of recordings.

In M480, E8 verbalizes her actions, revealing the dialogical act of *thinking aloud*. E9 understands E8's intention and follows her reasoning. In M483, E9 suggests the number of steps the character could take to simulate the distance traveled. After testing, E8 *evaluates* that the number 10 represents a very large distance, changing it to the number 1. Despite their dissatisfaction with the simulation, they continue to suggest and modify values. The suggestions were made verbally or typed into the programming block, showing that typing can also be a way of expressing ideas to colleagues, or, in other words, *advocate* one's perspective.

It seems characteristic of this group to generate a large number of ideas and suggestions while conversing. Their decisions did not seem to be made solely through words like "yes" or "no", however, when they agreed on something, they immediately implemented the programming, and when they disagreed, they offered alternative suggestions.

There was a search for *consensus* since dialogue occurs when "people are united by the common interest of seeking" (Abbagnano, 2007, p. 274). Each student *advocated* verbally or via the computer. The numbers in the blocks representing distances—and consequently, the movement speed—were written, erased, and rewritten in constant *evaluation* by the group members. The computer sometimes replaced, in certain instances, the way perspectives were made explicit: through programming blocks, rather than being spoken, assisting the group in their decision-making process.

In Group 4, dialogue can be interpreted through the lens of teaching programming. One student (E12), who did not know how to program the character's movement, asked for help from a peer (E13), who was in another group, to explain the functioning of blocks related to the Cartesian plane, as shown in Table 6. As the proposal progressed, E13 had already understood the block in question.

Table 6: Excerpt from group 4

Student	Code	Message	Description
E13	M760	*Record this coordinate here (1, 138). Now, you need to do it like this, see. Ah... Movement, slide. No, wait. Now slide. Yes, put it here. Put the position.*	*Talking while E11 searches for the block in the command library. When E11 finds the block, they drag it to the programming area.*
E12	M761	*Okay, it's already here.*	
E13	M762	*It's minus... is it ready?*	*Realizing that Scratch automatically updates the coordinates of the block in the command library.*
E12	M763	*Already here.*	
E13	M764	*Okay. Now press the flag to see.*	*E11 searches for the block {When green flag clicked} in the command library and adds it to the program. Then they test to see how it works*
E12	M765	*Okay. You just have to decrease the time.*	
E13	M766	*Yeah. Then, go...*	
E12	M767	*Okay. Thanks, thanks.*	*E13 leaves, and E11 continues programming.*

Source: Document with transcriptions of recordings.

In the excerpt, it is noticeable that E13 mentions the use of Cartesian coordinates when stating in M760, but does not go into details, as if the information presented on the screen was sufficient for E12 to understand. When E13 begins to detail the numbers in M762, they interrupt their speech upon noticing that Scratch automatically updates the block values when dragging the character in the display window. Thus, he demonstrated a process of programming to his peer by taking advantage of this software functionality. It can be said that E12 understood how to program the desired movement since they followed the same steps, as illustrated in Figure 6.

Figure 6: Programming by Group 4

Source: Research recordings.

Through dialogue, one student impacted the other based on their understanding and viewpoint, causing the other to progress and learn (Malheiros, 2008; Faustino, 2018). However, it is not possible to affirm the comprehension of Cartesian coordinates, as reflection on them was avoided when E13 noticed that the values are automatically updated.

Reflection on Cartesian coordinates occurred at another moment, with the presence of the teacher, who posed questions about the effects caused by altering the coordinates in the animation, as seen in Table 7.

The initial question in M844 *invites* the students to *inquiry* about the block in question. Student E12 admits in M845 that he does not know what is that about, because he hasn't researched it, prompting the teacher to initiate the investigation by suggesting numerical changes in the block via dialogic questions in M846, which tend to evoke dialogical acts. While E12 *is willing* to test, E11 *participates* by offering a response. The testing continues, with the teacher guiding the students through reasoning until they reach a satisfactory conclusion about positive and negative numbers on the horizontal axis.

Table 7: Excerpt from group 4

Estudante	Código	Mensagem	Descrições
Prof	M844	*What is a coordinate?*	
E12	M845	*I don't know yet, I haven't researched it.*	
Prof	M846	*If you put -8 here, what will change? What's the difference?*	
E12	M847	*I don't know, let's see.*	
E11	M848	*It will change the ball's direction or what it does.*	
Prof	M849	*Put -20. Let's exaggerate so we can see clearly...*	*E12 changes the number and tests it.*
E12	M850	*It goes more to the side. It's not centered.*	
E11	M851	*I told you.*	
Prof	M852	*Put positive.*	
E12	M853	*Without the minus?*	
Prof	M854	*Yes.*	*E12 changes and tests it.*
E12	M855	*Then it is wrong.*	
Prof	M856	*In which direction?*	
E11 e E12	M857	*To the left.*	
Prof	M858	*If it's positive, without the minus.*	*E12 changes and tests the teacher's suggestion.*

E12	M859	*It misses even more.*	
Prof	M860	*Which direction did it go now?*	
E12	M861	*To the right.*	
Prof	M862	*So, what is x affecting?*	
E11	M863	*The direction.*	
E12	M864	*The side. Longitude*	*Moves hands horizontally.*
Prof	M865	*Right and left. And y?*	
E12	M866	*It's latitude. It's up and down.*	
E11	M867	*Very good!*	

Source: Document with transcription of recordings.

The statements in M857, M861, M864, and M866, where E12 compares the positive or negative movement with latitude and longitude of meridians, can be considered a case of *reformulating*, as they are viewing the problem from different perspectives, making mental associations to better understand the concept. Student E11's responses in M848, M857, and M863 are more direct, with the first and last referring only to the change in direction.

Here, the dialogue is seen as a debate, where the teacher's questions provide moments for students to speak and reflect (Milani, 2020). For each question, an answer emerges, and for each answer, a new question is posed, gradually building mathematical concepts until the teacher considers the students' statements satisfactory, as in M862 through M867.

During the project creation, relationships with dialogue were observed, as there was an exchange of information where one student was influenced by the other's suggestion while aiming for project improvement (Menezes, Ferreira, Martinho & Guerreiro, 2014, p. 138). There were moments of discovery sharing through the computer, where ideas became visible and perceived, impacting others without imposing will (Malheiros, 2008).

Collaboration occurred, with task division among members, demonstrating co-responsibility without hierarchical attitudes (Fiorentini, 2019). Students showed harmony in their work methods, complementing each other, respecting turns and space most of the time (Resnick, 2020), striving for consensus.

The collaboration and harmony of the students depicted in these excerpts can be related to the theoretical elements of dialogue, such as *process of inquiry, risk-taking, and maintaining equality*. The project gradually took shape, with each suggestion inviting others to participate. Each suggestion needed to be approved, programmed, and tested on the computer, as there was no predefined question to answer. One listened and learned from the other as equals as, for example, with teaching not being exclusive to the teacher (Alrø & Skovsmose, 2018).

Based on the pedagogical practice developed with these students, it is observed that the Scratch environment allowed each group to take control of their actions, testing and developing their ideas through programming and on the stage, thus enhancing both individual and group inventive capacities. In this process of project construction by student groups, three perspectives are identified, as presented by Santos (2013): being separate, being connected, and constructing behaviors. In the first perspective, there was occasional isolation of a group member, as shown in Table 3, who temporarily *separated* himself while building new ideas or testing their logic to verify their point of view. Another observed perspective is the evidence of *being connected* within the group, through close interaction with peers, engaging in dialogue and questioning, with the goal of better understanding one another and seeking to be understood as well. With the fusion of these two perspectives, *behavior construction* occurred, which involved the exercise of *receiving* by listening and understanding the voice and contributions of others, with *offering* through the expression of one's own thinking, reflected in the programming act and in the project.

The quality of learning was thus related to creativity, as new problems needed to be solved for ideas to materialize through programming. Group work showed the importance of interaction with each other to achieve progress (Malheiros, 2008; Faustino, 2018). Exploring the blocks with the teacher's presence provided opportunities to reflect on mathematical concepts, as it was necessary to propose situations, through questions, that aided those concepts formulation (Santos, 2014; Ventorini, 2015, Pereira, 2023). Mutual assistance and collaboration facilitated learning about programming and project development (Resnick, 2020).

8 Final considerations

The results presented in this paper indicated the occurrence of dialogical acts and theoretical elements, as well as the understanding of dialogue through students interaction during the creation and programming of Scratch projects in math classes, restricted to student-student or student-teacher conversations. The theoretical elements of process of inquiry, risk-taking, and equality were evident, along with dialogical acts such as perceiving ideas through programming, reformulating understandings through new software situations experimentation, or challenging peers with new suggestions.

Interactions between students were characterized by terms associated with the dialogue concept, such as harmony, suggestion, collaboration, mutual aid, consensus-seeking, teaching, invitation, willingness, participation, separation, and connection. Since these are modes of being to each other during the work process, and in all three groups, a sense of community was noticeable, where individuals were involved in thoughts, actions, and emotions to decide and to achieve goals with common benefits. (Bitencourt, 2022).

The perception of each other's perspectives was made possible through reading and reflections that occurred during the testing of the programming, as the computer served to show what and how each idea was being created. It can be said that the act of *testing* was a way to evoke dialogical acts among the participants, for example, in moments when students reflected on which numbers should be entered in the blocks or when they questioned and demonstrated their discoveries and constructions in Scratch, supporting the idea suggested by Borba, Silva, and Gadanidis (2014) that ICT modifies the interaction between its users.

The learning process was shaped by the exchange of ideas among group members, as the creative process emerged from collective action, with suggestions exchanged between participants, shaping the programming. In other words, it was not an entirely individual process. Mathematical concepts were explored through the search for programming blocks that best fit the group's objectives, without a predefined approach. Cartesian plane content was present in the projects of the three groups analyzed, due to the need to simulate character movements. There were instances where the teacher played a crucial role in prompting reflection on mathematical concepts, particularly when students were focused on the act of programming and took advantage of the software's features, thus avoiding reflection on the underlying mathematics.

The considerations presented regarding mathematics classes using Scratch indicate the potential for learning and dialogue among participants, as "every learning process involves some kind of 'instrument'; it can be pen and paper or information and communication technologies" (Alrø & Skovsmose, 2018). Since no evidence was provided showing learning through network sharing, further investigation is planned to explore the occurrence of dialogue in this context.

During the construction of the projects, students interacted with each other, exchanged ideas, and reflected on the problems that emerged, enabling the construction of new knowledge and collective progress. Similarly, it was necessary for the research teacher to share a significant portion of the mathematics classes with the students, allowing them to express their ideas and attitudes through choices about what to do and how to do it. The path taken by the students depends on their engagement, participation, and respect for different ways of thinking and learning, guided by the teacher.

References

Abbagnano, N. (2007). *Dicionário de filosofia*. (5 ed.). São Paulo, SP: Martins Fontes.

Alrø, H. & Skovsmose, O. (2018). *Diálogo e aprendizagem em educação matemática* (e-book Edição Kindle). Belo Horizonte, MG: Autêntica.

Azevedo, G. T. (2017). *Construção de conhecimento matemático a partir da produção de jogos digitais em um ambiente construcionista de aprendizagem: possibilidades e desafios*. 2017. 236 f. Dissertação (Mestrado em Educação em Ciências e Matemática), Universidade Federal de Goiás, Goiânia, GO.

Belloni, M.L. (1999). *Educação a Distância*. Campinas, SP: Editores Associados.

Bitencourt. A. L. (2022). *Diálogo de estudantes do ensino fundamental em aulas de matemática com o software de programação Scratch*. 2022. 144f. Dissertação (Mestrado em Ensino de Matemática). Universidade Federal do Rio Grande do Sul. Porto Alegre, RS.

Bitencourt, A. L.; Fioreze, L. A. & Búrigo, E. Z. (2021). Um olhar para o cotidiano dos alunos de um 6° ano do ensino fundamental: reflexões sobre o evento "Show de Talentos" e as aulas de matemática. In: Fioreze, L. A.; & Halberstadt, F. F. *Aprendizagens e Vivências no Ensino de Matemática em tempos de pandemia* (pp. 148-162). Porto Alegre, RS: Editora Fi.

Bogdan, R. & Biklen, S. (1994). *Investigação Qualitativa em Educação: uma introdução à teoria e aos métodos*. Lisboa, PT: Porto Editora.

Borba, M. C.; Silva, R. S. R. & Gadanidis, G. (2014). *Fases das Tecnologias Digitais em Educação Matemática: Sala de aula e Internet em movimento* (1ª ed., E-book Edição Kindle). Belo Horizonte, MG: Autêntica.

Callegari, J. H. (2015). *A robótica educativa com crianças/jovens: processos sociocognitivos*. 2015. 152f. Dissertação (Mestrado em Educação). Universidade de Caxias do Sul. Caxias do Sul, RS.

Carvalho, F. J. R. (2018). *Introdução à programação de computadores por meio de uma tarefa de modelagem matemática na educação matemática*. 2018. 133f. Dissertação (Mestrado em Ensino). Universidade Estadual do Oeste do Paraná. Foz do Iguaçu, PR.

Coll, C. & Monereo, C. (2010). *Psicologia da Educação Virtual: aprender e ensinar com as tecnologias da informação e da comunicação.* Porto Alegre, RS: Editora Artmed.

Fiorentini, D. (2019). Pesquisar práticas colaborativas ou pesquisar colaborativamente?. In: BORBA, M. D.; & ARAÚJO, J. L. A. (Orgs.). *Pesquisa qualitativa em Educação Matemática* (6° ed., e-book Edição Kindle). Belo Horizonte, MG: Autêntica.

Faustino, A. C. (2018). *"Como você chegou a esse resultado?": o diálogo nas aulas de Matemática dos anos iniciais do Ensino Fundamental*. 2018. 232f. Tese (Doutorado em Educação Matemática). Universidade Estadual Paulista, Instituto de Geociências e Ciências Exatas. São Paulo, SP, Brasil.

Wangenheim, C. G.; Nunes, V. R. & Santos, G. (2014). Ensino de Computação com SCRATCH no Ensino Fundamental – Um Estudo de Caso. *Revista Brasileira de Informática na Educação, 22*(03), 115-125.

Lemgruber, M. S. (2008). Educação a distância: para além dos caixas eletrônicos. In: *Revista Sinpro-Rio*, *2*(6), 42-49.

Malheiros, A. P. S. (2008). *Educação Matemática Online: a elaboração de projetos de Modelagem*. 2008. 187f. Tese (Doutorado em Educação Matemática). Instituto de Geociências e Ciências Exatas, Universidade Estadual Paulista. Rio Claro, SP.

Menezes, L.; Ferreira, R. T.; Martinho, M. H. & Guerreiro, A. (2014). Comunicação nas práticas letivas dos professores de Matemática. In: J. P. Ponte (Ed.) *Práticas profissionais dos professores de matemática.* (pp. 135-161). Lisboa: Instituto de Educação.

Milani, R. (2020). Diálogo em Educação Matemática e suas Múltiplas Interpretações. *Bolema: Boletim de Educação Matemática, 34*(68), 1036-1055. Rio Claro.

Milani, R.; Civiero, P. A. G.; Soares, D. A. & Lima, A. S. (2017). O diálogo nos ambientes de aprendizagem nas aulas de matemática. *RPEM Revista Paranaense de Educação Matemática*, *6*(12), 221-245. Campo Mourão.

Milani, R. (2015). *O processo de aprender a dialogar por futuros professores de matemática com seus alunos no estágio supervisionado*. 2015. 241f. Tese (Doutorado em Educação Matemática). Universidade Estadual Paulista, Instituto de Geociências e Ciências Exatas. São Paulo, SP.

Monroy-Hernández, A. & Resnick, M. (2008). Empowering kids to create and share programmable media. *Interactions magazine of the ACM*, *15*(2), 50-53. New York.

Pereira, M. C. (2023). *Histórias contadas por professoras dos 5° anos ao programar no Scratch: Uma possibilidade de ensinar matemática e Pensamento Computacional*. 2023. 147f. Dissertação (Mestrado em Ensino de Matemática). Universidade Federal do Rio Grande do Sul, Porto Alegre, RS, Brasil.

Poloni, L. (2018). *Aprendizagem de programação mediada por uma linguagem visual: possibilidade de desenvolvimento do pensamento computacional*. 2018. 181f. Dissertação (Mestrado em Educação). Universidade de Caxias do Sul, Caxias do Sul, RS.

Ponte, J. P. (2005). Gestão curricular em Matemática. In: *GTI (Ed.) O professor e o desenvolvimento curricular* (pp. 11-34). Lisboa: APM.

Quequi, G. B. (2021). *Programação na Resolução de Problemas Envolvendo Polígonos Regulares por Meio do Scratch: Uma Experiência No Ensino Fundamental*. 2021. 126f. Dissertação (Mestrado em Ensino de Matemática). Universidade Federal do Rio Grande do Sul, Porto Alegre, RS, Brasil.

Resnick, M. (2020). *Jardim de Infância para a Vida Toda: Por Uma Aprendizagem Criativa, Mão na Massa e Relevante para Todos (E-book Edição do Kindle)*. Porto Alegre, RS: Penso Editora.

Santos, A. C. (2014). *Aprendizagem mediada por linguagens de autoria: o Scratch na visão de três pesquisadores*. 2014. 108f. Dissertação (Mestrado em Educação). Pontifícia Universidade Católica de São Paulo, São Paulo, SP.

Santos, V. (2013). *Ágora digital: o cuidado de si no caminho do diálogo entre tutor e aluno em um ambiente virtual de aprendizagem* (1° ed., E-book). Jundiaí, SP: Paco editorial.

Skovsmose, O. (2000). Cenários para Investigação. *Bolema: Boletim de Educação Matemática*. Rio Claro, *13*(14), 66-91.

Skovsmose, O. (2015). *Um convite à educação matemática crítica*. (Ebook. Edição do Kindle). São Paulo, SP: Papirus Editora.

Valente, J. A. (1999). *O computador na sociedade do conhecimento*. Campinas, SP: Unicamp/NIED.

Vecchia, R. D. & Maltempi, M. V.. (2019). O Problema na Modelagem Matemática: determinação e transformação. *Bolema: Boletim de Educação Matemática, 33*(64), 748-767.

Ventorini, A. E. (2015). *Construção de Relações Funcionais Através do Software Scratch*. 2015. 168f. Dissertação (Mestrado em Educação Matemática e Ensino de Física). Universidade Federal de Santa Maria, Santa Maria, RS.

Ventorini, A. E. & Fioreze, L. A. (2014) O software Scratch: uma contribuição para o ensino e a aprendizagem da matemática. In: Anais da *IV Escola de Inverno de Educação Matemátic*a, (pp. 1-14). Santa Maria, RS.