Robotics Activities: A Practice of Social Transformation

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Abstract

The general objective of this article is to present the importance of robotics in elementary level school. In addition to discussing pedagogical mediation in this context. The reason for the development of this work centers on the need for studies on Robotics in the educational environment and its networks of relations with a focus on the learning of students and on the need for a change in the culture of the school. The methodology of this work is based on the cartographic method of research and intervention that, instead of seeking a result or conclusion, seeks to follow the process, seeking to establish relationships. Thus, we began mapping the pedagogical mediation between the teachers and students of the municipal schools of Viamão, EMEF Residencial Figueira and EMEF Sergeant Manoel Raymundo Soares. In order to understand the pedagogical mediation of the inventive robot robotics activities for the competitions of the II Municipal Robotics Exhibition of the Viamão Municipality - Rio Grande do Sul. From the results, we can highlight that the students seek to improve their knowledge in related areas, such as physics, mathematics, electronics, programming, and mechanics. Assuming an inventive and active stance, it also enables students to build not only concepts, skills, but also values and ideals in order to contribute to society. Making them autonomous, independent and responsible citizens.

Keywords: Robotics; Education; Inventive Robotics; Robots.

1. Introduction

Our society lives a historical time when the access, production, and availability of information occur at a frenetic speed, provided by Digital Technologies (DT) interconnected by communication networks, which contributes to the emergence of what Castells (1999) calls Society in Network. this new social context causes changes in culture and in the most different areas of knowledge, consequently, in the processes of teaching and learning. Educational institutions, for example, are no longer characterized as the main place for access to information, this space is occupied by the Internet, which provides a world of information, anytime and anywhere, in seconds.

In this networked society, social, educational, artistic, cultural practices are constituted, modifying and expanding into a hybridization between urban and post-urban spaces (DI FELICE, 2009), so that analog and digital mix and coexist. They co-engender to live in contemporary times. This has contributed to the emergence of a new learning subject, which according to Schlemmer (2013, 2014, 2015, 2016a, 2016b, 2016c, 2017, 2018) and Schlemmer, Backes and La Rocca (2016), was born and develops in a world. which is hybrid in terms of spaces (geographic and digital), technologies (analog and digital), presences (physical and digital - social media profile, avatar in virtual worlds, characters in games, telepresence in web conferencing, holograms, among others), cultures (analog, digital - maker, gamer, among others) and for those who make no sense to separate the teaching in person and online. It is in the educational space that these subjects meet us, teachers we were born and developed in an analog world, whose spaces destined for learning were only geographical, the technologies with which we interacted were analogical, the form of presence was only physical, therefore. We learn in an analog world and today our challenge is to teach in a hybrid world where we have a new form of culture, reader, writer, author and, consequently, subject of learning (SCHLEMMER 2009).

This reality requires a new formation of subjects, new skills need to be developed. In this framework we can quote Pierre Lêvy (1998, p.54), "as computerization advances certain functions are eliminated, new skills appear, and cognitive ecology transforms".

These are just a few questions that shape the background of postdoctoral research, entitled "Inventive Robotics & Education," which gives rise to this article. But what is robotics and how can it be present in the educational context? Robotics, in the educational context, basically consists of learning through the assembly of autonomous electronic systems, that is, the assembly of robots. These devices become, in fact, cognitive artifacts through which students explore and express their own ideas, or "an object-to-think-with," in the words of Papert (1986).

> "Therefore, learning takes place by assembling systems made up of models. These models are mechanisms that exhibit some physical activity, such as the movement of a mechanical arm, lifting objects, etc., like current robots. "(BACAROGLO, 2005, p.22)

The pedagogical practice with robotics needs to provide conditions for discussion and promote openness, so that everyone, students and teachers, participate by inventing problems and making suggestions for their resolution, thus developing an inventive attitude (SILVA, 2018). In this context, we can say that all involved in this process are collaborators/mediators of all, so we are developing a practice centered on multiple pedagogical interventions (OKADA, 2008).

In this learning process, where there is openness, exploration, experimentation, and discussion, another important concept emerges, that of inventiveness, which is a process of becoming sensitive to problems, deficiencies, knowledge gaps, and disharmony; which allows identifying the difficulty, seeking solutions and formulating hypotheses about them. (NOVAES, 1977, p.18). The moment the student identifies his difficulties, he is also problematizing an issue to be solved, because this act of "creating problems" is important. According to Kastrup (2004), the difficulties serve to exploit the student's ability.

1.1 Objective

This article aims to highlight the importance of robotics in the educational context, having the development/creation of robots by students and discuss the pedagogical mediation as a way to instigate subjects knowledge in related areas, such as physics, math, electronics, programming, and mechanics. In this context, subjects are urged to seek knowledge, thus enabling the appropriation of concepts. Another important factor is to develop logical thinking more and more, since the student is able to elaborate projects that suit different areas or contexts of robotics, such as engineering, computer science, home automation, among others.

1.2 Justification

This article is justified from the need to develop research on Robotics in the educational environment and its related networks focusing on student learning and the need for a change in the school culture. The relevance is the possibility of mapping the collaborative interventions of inventive robotics in the school field, considering the possibilities of the dynamics of pedagogical practice, such as this interdisciplinary study practice, from the perspective of the aggregation of collaborative learning and inventiveness. Taking into account the social relevance in learning, from the perspective of multiple pedagogical intermediations. In addition, the development of this article is justified by the need for debate on the appropriation of robotics and digital technologies (TD) in school curricula. It is understood that inventive robotics can provide students with the opportunity to put into practice knowledge and skills developed inside or outside the classroom, especially by allowing them to expand value-added concepts, enabling the development of new skills and competences. In this context, knowledge, skills, and competences are understood as processes under construction that occur in the interaction between students, teachers, the cognitive artifact (robot) and hybrid environment (analog and the digital world).

2. Methodological Design

A research is exploratory and descriptive, with qualitative approach methodology for its development and data analysis was used the cartographic method of intervention research proposed by Kastrup (2007; 2008), Passos, Kastrup and Scotland (2009) and Passos, Kastrup and Tedesco (2014). The concept, originally originating from geography, is appropriated and resignified from the intersection of the fields of philosophy, politics, and subjectivity.

According to Kastrup (2007), cartography is a method that aims to follow a process, not represent an object. It is about investigating a production process, without seeking to establish a linear path to an end. “Cartography seeks to ensure the rigor of the method without compromising the unpredictability of the knowledge production process, which is a positive requirement of the ad hoc research process” (Kastrup 2007, p. 19). Its construction on a case by case basis does not prevent us from establishing some clues that aim to describe, discuss and, above all, collectivize the experience of the cartographer. Thus, instead of rules to be applied in the method, Passos, Kastrup, and Escóssia (2009) propose clues to guide the researcher's work. “The clues that guide the cartographer are as references that contribute to the maintenance of an attitude of openness to what is taking place and of calibrating the walk in the very course of the research" (p. 13). Cartographic attention is defined as concentrated and open, characterized by four varieties: tracking, touch, landing and attentive recognition.

The researcher-cartographer will need to establish relationships as he becomes part of his own research territory. The objective of the cartographer is precisely to map a territory that, in principle, did not live, to understand the planes of force - moving plan of the reality of things that act in it - and to produce knowledge along a research path, which involves the attention and, with it, the very creation of the territory of observation (SCOTLAND and TEDESCO, 2009). Because it is intervention research, the analysis takes in the process, that is, in the cartography movement, which makes it possible to perform the intervention while the process is taking place.

It is important to mention that, the cartographic method of intervention research is present in the research developed in the Digital Education Research Group - GPe-dU UNISINOS/CNPq, and has been appropriate not only as a research method but also as a provocative method for the development of new methodologies and pedagogical practices, precisely because of their interventionist characteristic in following the process (along the way), aligned with the need to understand the phenomenon of learning in its complexity - social, political, cognitive, affective and technological (SCHLEMMER; LOPES, 2012). According to the authors, although the method is oriented to the practice of research in the humanities, its power has also been investigated to accompany learning processes in contexts of hybridity, multimodality, pervasiveness, and ubiquity. Enabling the appropriation of the method by teachers and students in their own learning pathways. Thus, the authors' interest has been to explore some elements related to culture and the new regimes of action, participation, and socialization of experience.

We started the process of cartography of the pedagogical mediation between teachers and students, for that, monitoring and observations were made in the municipal schools of Viamão, EMEF Residencial Figueira and EMEF Sergeant Manoel Raymundo Soares. In order to understand how knowledge is present in concrete situations related to inventive robotics in the stages of construction of robots for competition (II Municipal Robotics Exhibition of Viamão Municipality - Rio Grande do Sul). Thirty students from the 5th and 8th participated in this process, during a 10-month period in weekly 4-hour sessions totaling 160 hours. These robots were built by students using a microcontroller board (Arduino Uno) which is a "free" platform for prototyping. In addition, parts from a Creative Kit CT100 school robotics kit and electronic scraps were used.

3. The Robot Construction Process

The construction of the robots began in March 2018 to develop the inventiveness of students participating in the robotics activities of Viamão municipal schools, EMEF Residencial Figueira and EMEF Sargento Manoel Raymundo Soares. Thus, indirectly, we prepare students to participate in the competition of the II Municipal Robotics Exhibition of Viamão - Rio Grande do Sul.

In this process of building, or rather, developing robots, the students came together and decided initially to study the rules of robotics competition, to know what the robot has to do, and what it can and cannot do, how for example, robot size; how many motors it should have, the type of power source (battery, battery or other), among others. After this study, the students organize, with the help of the teachers, a plan to reach the objective of participating in the municipal robotics competition, divided in stages.

In the first stage, the development of robot design, that is, in this stage the students created their conceptions of robots, focusing especially on functionality and physical form so that they would meet the competition rules and perform.

Already in the second, the students performed the resource management, that is, the team separated the available resources to realize their idealizations of robots. At this stage, the students separated the "industrial" components, such as mechanical servos, controller boards, electronic components, among others. In addition to these materials, students also separate electronic scrap and recycling materials, allowing them to create new pieces with the functionality needed to participate in competitions.

Students began to materialize their robots with these features and idealized designs. In this stage four robots were built, two versions developed (with specifications and features) for the Sumo Robot competition (Figure 1) and the other two versions for the Track Follower competition (Figure 2). At the same time as the robot being built the students developed and tested its programming.

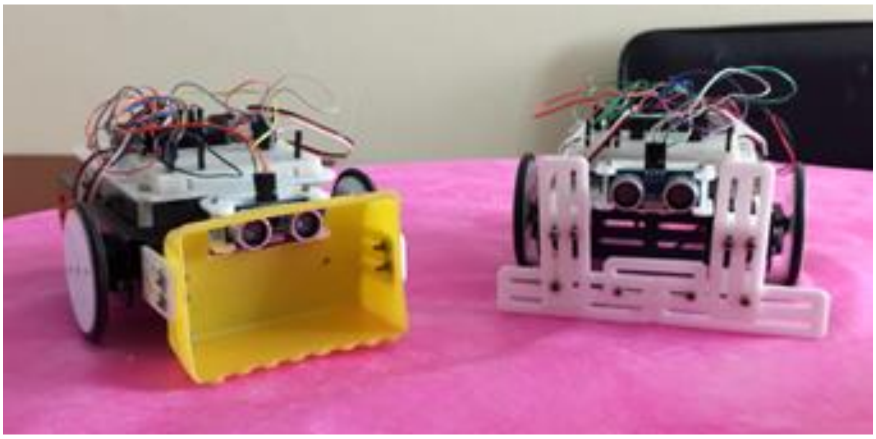

Figure 1 - Robots Developed: Sumo

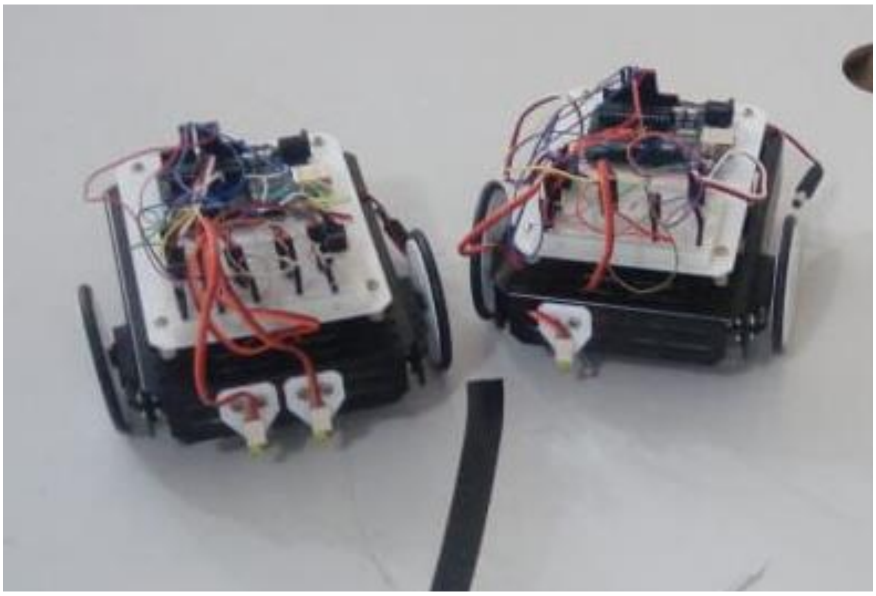

Figure 2 - Robots Developed: Line Followers

The students programmed using the Ardublock program which uses a graphical programming language (blocks) as shown in Figure 3. In this step, the students tested and observed the robot's functioning (Figure 4 and 5). In addition, students requested spaces from teachers and school management to establish a time of competition at school (Figure 6). In these spaces, the groups present and compete with their robots and assist the other groups in detecting and correcting the faults, that is, the students have a collaborative attitude towards each other. At these times, the students co-create, as they discuss the flaws found, or rather, problematize the robot's operation and build solutions together for the problems created. This co-creation process that occurred throughout the process. In addition, this activity works ideals such as companionship, friendship, solidarity, among others that contribute to a transformation of society.

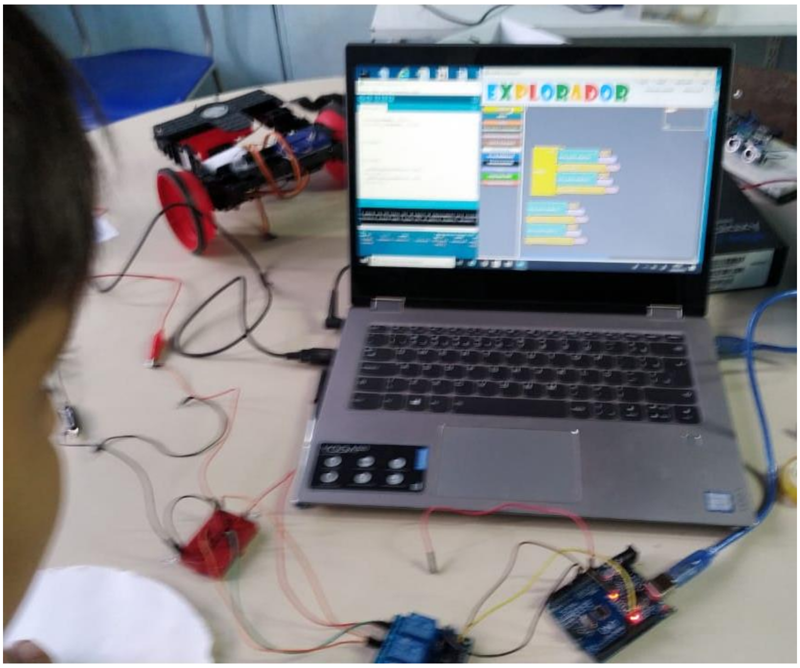

Figure 3 - Students Programming and Testing Robots

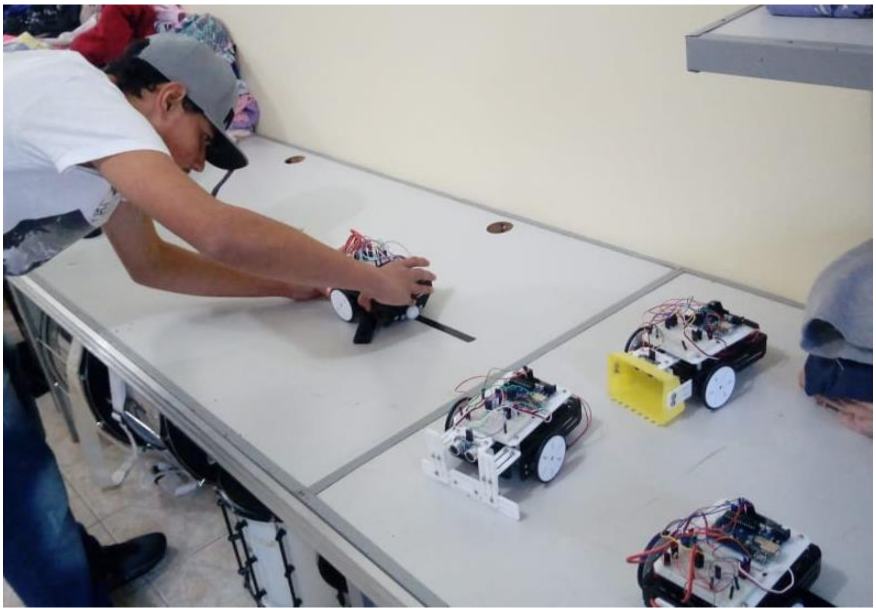

Figure 4 - Robot Testing

Figure 5 - Robot Tests

Figure 6 - Moment of competition at school

Throughout this process of robot development, students were given the freedom to follow their empiricism, allowing students to take into account the experiences lived and learned during the robotics project, that is, to launch and test their hypotheses, so they set up , disassembled, built, and reframed concepts to achieve robot functionality and performance goals.

Team members help each other and express their opinions in the robot design process, thus developing their ability to listen and respect different opinions and reinforcing collaborative ties. In this way, the interaction between the teams allows for collective decision making, always aiming at the best way for everyone. Relationships between students with teachers and students with students in other groups are reliable and partnership, where everyone teaches and learns.

Therefore, in this type of activity allows the learning and socialization among students of knowledge. In addition, it stimulates students' creativity, collaborative spirit, encourages active learning and develops critical, teamwork, leadership, communicative and other skills.

4. Results and Discussion

The results obtained during the performance of the robotics activities indicate that the students presented a change of attitude, showing interest, engagement, and commitment in the process of invention of the robots, evidencing autonomy and authorship when seeking new elements to reach the objectives of the challenges present in each one project. This allowed them to broaden and deepen their knowledge in related fields, such as physics, mathematics, electronics, programming, mechanics, among others, appropriating in practice concepts such as electricity, electrical circuit, resistors, measurement quantities, flat and spatial geometry, sustainability, computational thinking, among others. In addition to instigating the development of autonomy and authorship, the invention of robots has enhanced the development of skills for the 21st Century, presented by the World Economic Forum in 2015: critical cove, problem solving, creativity, communication and collaboration, as well as social qualities such as curiosity, initiative, persistence, adaptability, leadership, and social and cultural awareness (WEF, 2015).

In this way, inventive robotics projects have an interdisciplinary nature, therefore, they allow a practice that goes beyond working with problem-solving, working with the invention, based on the reality/needs of the community, involving the whole school. The development of these projects creates a network that is maintained by the interaction between its members (teachers, students, community, among others). In this network, there is a movement of students in search of knowledge. Generating a teacher-student, student-community tension. From this tension arise activities proposed by the teachers who report their classes with the projects proposed and developed by the students. Reversing the "logic" of planning the class, the themes emerge from the student's projects. Thus, the proposed classroom activities are co-created by teachers and students. These activities also generate community interaction with the school, students seek information from family, friends, merchants, among others. From this search for students' knowledge, bonds are formed between the school and the community that recognize themselves as fundamental actors in the students formation.

Thus, robotics, besides being present in the school curriculum, needs to be appropriate as an ongoing activity, being part of the school, being a liaison with everyone in the school community. Students developing their robotics projects in an inventive context, as well as appropriating knowledge and building concepts, also developed skills, values and ideals in order to contribute to the local community. Therefore, from the perspective presented by Kastrup (2015), these robotics projects cannot be understood as mere objects[1] or as solutions to old problems, but as the basis "of new relationships with information, with time,

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[1] In this concept, these objects are non-human actors, present in the Actor-Network Theory, proposed by Latour (1994, 2002). The nonhuman actor and the human act mutually, interfere and influence the behavior of each other, with the difference that the human cannot be adjusted by the human according to his need. By allowing the connection between other nonhumans and as the main resource of intelligence, or nonhuman, alters the order of human life, setting the pace of thinking and acting. In this sense, the nonhuman can be called a mediator as it defines human interaction at all social levels between humans and the media

with space, with themselves. same and with others". (p. 97). Thus, the relationship between the constituted forms and the present is not one of disruption or discontinuity, but of coexistence, the conditions of cognition being politemporal rather than invariant or historical. The politemporal perspective, brought by Maturana and Varela, is a much more complex field, whose novelty was

> "have evidenced that a living present coexists with historical conditions, which functions as a problematization of historical configurations. The problem is not to understand cognitive functioning as historically produced, but rather how the present is capable of promoting cracks in the historical strata, in the old mental habits, in the established structural couplings, and producing novelty. To think about politemporal conditions it was necessary to unleash the power of the present, untie it from the past, release it from historical constraints .... attention to the present indicates a direction for cognitive studies. reorienting your focus from the study of cognitive forms or structures to your gift tips. " … Is the living present that coexists with the history of structural couplings. Through this notion, Varela introduces in the studies of cognition the possibility of thinking about becoming, becoming that forks history. (KASTRUP, 2015, p. 98-99).

In this context, the understanding of learning is totally resignified, presenting an original conception, when Varela, when approaching the problem, takes the artist as the prototype of the learner. Learning is not then, as proposed by previous theories, adaptation to a given environment, nor obtaining knowledge, but experimentation, invention of self and the world. The invention of the work of art correlates with the production of the artist himself. As a novelty, a theory of action emerges, since for Maturana and Varela the living system is a cognitive system in constant motion, in the process of permanent self-production, that is, autopoietic, which can be understood, according to Kastrup (2015) by the formula TO BE = DO = KNOW. Papert (1986) already mentioned in his constructionist theory that learning consists in creating situations for learners to engage in activities that foster their construction process, making information meaningful, turning it into knowledge. Therefore, learning happens when the teacher is able, through pedagogical mediation, to enable students to take ownership of the concepts of the classroom context, based on what they already know and what is relevant to them. Similarly, from the perspective of inventive robotics, the teacher allows the student to construct ideas and concepts, ie their learning, by assembling / creating / building autonomous electronic systems, ie robots. These devices are actually cognitive artifacts that students use to explore and express their own ideas.

This fact was observed during the construction of the robots for the competitions of the Viamão Municipal Robotics. In this process the students has more autonomy, because during the invention of robots at various times there were flaws in the execution of the project, which required a process of metacognition in the analysis of the whole process built, in order to identify where the problem occurred, This led to the search for new elements to build a solutions. Interestingly, the “flaws” during project development were that students often intentionally died when programming the robot. They “risked” by giving incorrect or

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in relation to other humans.

incomplete commands that they knew would result in failure to “see what would happen,” meaning they tested their schedules and learned from their “intentional mistakes”. Showing how important it is for students to have inventive space and to test their hypotheses and build their concepts from their mistakes and success.

From the perspective of enactive cognition (VARELA, 1990; VARELA, THOMPSON & ROSCH, 1991) "errors" and "failures" can be understood as breakdown's (a disturbance, "problematization" of living structures), which varies from of the couplings with the world, without being able to determine a principle that guides this drift towards the search for a superior balance. This concept of breakdown - break or crack in cognitive continuity is, paradoxically, what ensures the flow of conduct. For Varela, breakdowns are the source of the autonomous and creative side of living cognition and these are "part of the field of cognitive experience, but refer to a pre-subjective field that involves a rich dynamic between elements of the neural network" (KASTRUP, 2015, p. 101).

For Kastrup (2015), the notion of breakdown - disturbance, problematization - appears as a theoretical-scientific formulation for an understanding of cognition that is not limited to problem solving but, above all, the invention of problems. This is why Varela explains the rooting of cognition in the "concrete", facing the previous conceptions that approach cognition from the point of view of logic, of the general mechanisms, of representation, grouped under the name of "abstract" approaches of cognition. (p. 102). Breakdown is a cognitive activity that takes place in the immediate present and that is where concrete actually lives. Varela disagrees with the understanding of what is "concrete", for him, it is not a step for something different, but rather, how we arrived and where we are. "As a virtual background, source of the emergence of sensorimotor correlations, she inscribes the invention in the present. Present that does not appear as a point in the chronological timeline, but as problematization of historical structures." (p. 102).

Therefore, the dynamics of robotics activities are different from the traditional class, as students use their robots to explore, express and construct their own ideas. Changing, thus the focus of where the information is no located in the teacher, it is scattered throughout the learning space. The student in this perspective has autonomy and freedom to look for it in the colleague, in interaction with the robot, the internet, the teacher, among others and, mean it, turning it into knowledge. And the most interesting that this search comes naturally, because the student creates a bond with the robot, creating a bond or a desire to elaborate and materialize the project. Moreover, in this kind of pedagogical practice there is no imposition by the teacher, there is a mediation between the involved, where the concepts, ideas and prototypes are being built as the need and interest of the group arises, there is a collaborative and cooperative construction of knowledge.

Students' commitment to the construction of robots ends up infecting the whole school, because those who do not participate in robotics activities end up changing their behavior, showing interest, improving the participation in class and discipline. This is due to the “desire” of these students to participate regularly in the robotics activities of the school, that is, the students of the robotics activities create an identity, and the other students have the feeling desire to belong, to be part. In this case, robotics activity can facilitate learning and improve socialization, enabling inventiveness, collaborative and cooperative spirit.

5. Conclusion

Robotics in the school environment is a very important topic because it enables students to search and improve their knowledge in various areas, such as physics, mathematics, electronics, programming, mechanics, arts, languages, among others. Therefore, it involves collaborative and constructive practices among all actors involved, especially between student-teacher, student-student, with inventiveness as a predominant factor, thus the creation and solution of problems. These group practices mainly involve multidisciplinary knowledge, a characteristic of a creative and innovative school environment, thus enriching the school curriculum. The focus of the work is to enable students to build their knowledge, actively working on their object of interest, aggregating school content with real practices.

The student actively participates in his process of knowledge building, develops interest in practical content, becoming protagonist in the school and social environment, thus expanding his role as a citizen in the world. The student becomes an active agent in the construction of his or her acquaintance through the creation of their robots, expanding their knowledge during the development of the robot's idealization, construction-programming and testing stages, sharing, discussing and, consequently, reframing ideas and concepts with the large group (students, teachers, parents, among others). Moreover, this student's proactive stance is naturally transposed to his life and added to other values such as companionship, friendship, solidarity, also worked in robotics activities, contribute to a transformation of society.

Collaborative work in robotics activities is of paramount importance, the changes involved in this process promotes debate and analysis from various points of view of the project. This form of work allows the development of reflective and critical thinking. Consequently, there is a change in the student's posture. He is more interested in improving class participation and discipline issues simply because he feels part of the process and empowered. Students feel valued and motivated which contributes to learning. Thus the activities of robotics in the school allows the transformation of school practices.

The inventiveness present in robotics activities is a transformation of school practices. That is, includes the problematization experience, which is revealed through breakdowns. These consist of disruptions or disturbances in the usual cognitive flow, having the creation and solution of problems always present in the learning process that always leads to the "problematization" of the living structures (students, teachers, etc.), which varies from the couplings. with the world. This concept of breakdown - break or crack in cognitive continuity is paradoxically what ensures the flow of knowledge-seeking behavior.

Such conduct is not limited to problem solving, but rather is the invention of problems. This is why Varela explains the rooting of cognition in the "concrete", confronting the previous conceptions that approach cognition from the point of view of logic, of the general mechanisms, of representation, grouped in "abstract" approaches of cognition. Thus, robotics activities are significant practices for students as an objective of their emancipatory development and citizenship.

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