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Robotics in the elementary school and sicence and mathematics curriculum: reflections based on a concrete experience[1]

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ABSTRACT

This qualitative study analyzes possible articulations of the science curriculum with an educational robotics project developed in Elementary School based on document analysis and interviews with teachers who are part of the project. The results indicate gaps in information in school documents, especially with regard to evaluation, both in the Robotics Project (RP) and in the Pedagogical Proposal. Even though there is a partial articulation of the prescribed curriculum of the National Common Curricular Base in Brazil with the RP, the data show that there is no reconfiguration and re-signification of this curriculum in the local context. The study points out that educational robotics can be a promising resource for pedagogical activities that favor the development of logical thinking, criticism and perception of the relationship between curricular content and society , as long as the educational actions have pedagogical intentions and are clearly articulated both to the prescribed and experienced curriculum.

KEYWORDS: Robotics. Science and mathematics curriculum. Digital Technologies.

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Robótica na educação básica e o currículo de ciências e matemática: reflexões baseadas em uma experiência concreta

RESUMO

Este estudo qualitativo analisa possíveis articulações do currículo de ciências e matemática com um projeto de robótica educacional desenvolvido no Ensino Fundamental I e II a partir de análise documental e entrevistas com docentes integrantes do projeto. Os resultados indicam lacunas de informações nos documentos escolares, sobretudo no que se refere à avaliação, tanto no Projeto de Robótica (PR) quanto na Proposta Pedagógica. Ainda que ocorra a articulação parcial do currículo prescrito da Base Nacional Comum Curricular com o PR, os dados evidenciam que não há reconfiguração e ressignificação desse currículo no contexto local. O estudo salienta que a robótica educacional pode ser um recurso promissor para atividades pedagógicas que favoreçam o desenvolvimento do pensamento lógico, da crítica e da percepção das relações entre os conteúdos curriculares e a sociedade, desde que as ações educativas tenham intencionalidade pedagógica clara e estejam claramente articuladas tanto ao currículo prescrito quanto ao experienciado.

PALAVRAS-CHAVE: Robótica. Currículo de Ciências e Matemática. Tecnologia Educacional.

La robótica en la educación básica y el currículo de ciencias y matemáticas: reflexiones a partir de una experiencia concreta

RESUMEN

Este estudio cualitativo analiza posibles articulaciones del currículo de ciencias con un proyecto de robótica educativa desarrollado con estudiantes de primaria y secundaria a partir de análisis documental y entrevistas a profesores que forman parte del proyecto. Los resultados indican vacíos de información en los documentos escolares, especialmente en lo que se refiere a la evaluación, tanto en el Proyecto Robótica (PR) como en la Propuesta Pedagógica. Aunque hay una articulación parcial del currículo prescrito de la Base Curricular Común Nacional brasileña con el PR, los datos muestran que no hay reconfiguración y resignificación de este currículo en el contexto local. El estudio apunta que la robótica educativa puede ser un recurso prometedor para actividades pedagógicas que favorezcan el desarrollo del pensamiento lógico, la crítica y la percepción de la relación entre los contenidos curriculares y la sociedad, siempre que las acciones educativas tengan intenciones pedagógicas y estén claramente articuladas tanto al currículo prescrito como experimentado.

PALABRAS CLAVE: Robótica. Currículo de Ciencias y Matemáticas. Tecnologías digitales.

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Introduction

The discussion about the renewal of educational practices is increasingly present in schools, especially considering the potential and limits of Digital Information and Communication Technologies (DICT). Demands for less rigid curricular structures and more articulated with the use of these technologies move the debate and promote the search for pedagogical practices that consider multiple forms of learning. Educational robotics makes up this scenario and has been used as a structural part of a broader movement that has been introduced in the school context, the maker movement – an English term associated with the idea of creating, realizing and which derives from the North American movement "Do it yourself". Which, in turn, has been promoted since the first decade of the 20th century (DOUGHERTY, 2016), but gained new impetus with the democratization and advancement of digital technologies.

Robotics in the school environment has been associated with promoting student protagonism and the development of problem-solving skills using critical thinking to produce knowledge. According to César (2018, p. 55, our translation), it is a "[...] set of processes and procedures involved in teaching and learning proposals that use robotic devices as a mediation technology for the construction of knowledge". This idea would entail changes in the social, cultural, scientific, and technological spheres, in which the protagonism would be linked to the act of creating an artifact, understanding all the stages of the processes involved in its production, as well as the effects that the created device could have on society, in other words, it is a broader understanding of the creation of the object. In this direction, in Brazilian schools, robotics is gaining ground as a representative of innovative pedagogical practices to improve teaching and learning processes. Furthermore, it is usually associated with a certain revival of students' love for learning (RAABE; GOMES, 2018).

On the other hand, an elementary part of this type of educational proposal should encompass the problematization of the didactic-pedagogical relationship between the school curriculum and the activities developed in maker spaces and/or robotics projects. In other words, these contexts should act as a means for developing curricular content, in a critical and articulated way, seeking links with the different areas of knowledge covered by formal basic education. On this interest, Blikstein, Valente, and Moura (2020) warn that many educational institutions carry out these activities without a clear connection with school content.

Amid this more critical discussion, linking robotics activities to the curriculum without losing sight of contextualized and meaningful learning is a challenge, since they become useless if the school is not clear about how they relate to the curricular and pedagogical proposals, what purpose they serve and why they are part of the pedagogical proposal. In this sense, robotics cannot be merely applied as a "modernization" or marketing prop to achieve commercial goals supported by promises of educational innovation.

Considering this context, this article presents an excerpt of the results of a broader qualitative research, developed within the scope of a master's degree at a Brazilian public university, and aims to: analyze the possible articulations of the Natural Sciences and Mathematics curricula with the activities of robotics developed with students from Elementary and Middle School equivalents at a private school located in the countryside of São Paulo.

Theoretical Foundations: between the prescribed curriculum, the experienced curriculum, and teaching intentionality

The term curriculum refers both to a sequencing of experience in the educational context and to the idea of a learning plan (LOPES; MACEDO, 2015). In other words, the meaning of curriculum is associated with the structural organization of the educational experience that revolves around subjects, curricular matrices, teachers' teaching plans, students' daily activities, etc.

From a theoretical-conceptual point of view, Jesus (2008) highlights the existence and organization of three levels of the curriculum: formal, real, and hidden. In this organization, the formal – also known as prescribed, as Gimeno Sacristán (2000) – it consists of the curricular guidelines, the contents to be covered, the planning of activities and assessments, etc. In turn, the real, or experienced (GIMENO SACRISTÁN, 2000), is the curriculum recontextualized in the classroom as a result of the actions, interactions, and practices of teachers and students. Finally, the hidden curriculum represents the experiences that students draw from their observations, their behaviors, and their perceptions of the social and school environment in which they live. The term "hidden" refers to the absence, in teaching planning, of the many possible practices and experiences when the prescribed (formal) curriculum is materialized in everyday school life.

Considering this breadth of aspects covered by the curriculum, Gimeno Sacristán (2000) states that the concept is linked to the union between school and society. It is configured as a complex practice that is made up of both experiences and memories and content, didactic sequences, and methods. Therefore, for the author, the curriculum is related to a cultural construction associated with the traditions of each educational system. afirma que o conceito está atrelado à união entre a escola e a sociedade.

Topics such as the selection of curricular content; the consolidation of learning by the student and respect for their individuality; the role of the teacher; managing the classroom routine; the relationship between school and curriculum in the social construction of knowledge; and the training of citizens to act in a democratic society became part of Brazilian educational debates during the period of the so-called New School and, even today, remain current and under discussion (LOPES; MACEDO, 2015). As Arroyo (2013) points out, the curriculum is a permanently contested territory.

In the materiality of the school space as a place where different cultural groups meet, the development of curricular contents prescribed in legislation and guidelines will meet (and often clash) with the interests and conceptions of each social group. The school cannot ignore the diversity of beliefs, customs, practices, knowledge, and identities that make it up, nor can it fail to address it when choosing curricular content. Of course, this is not an easy task (GIMENO SACRISTÁN, 2000), and the curriculum, therefore, must be a field of critical production and cultural policy always under (re)construction in dialogue with society.

Combined with this reflection, we emphasize the indispensability of considering the social reality and cultural background of the student in the teaching and learning processes and curriculum construction, especially considering the spheres of the prescribed curriculum and the experienced curriculum. In this sense, it is undeniable that our society has experienced significant scientific and technological changes. One of them corresponds to the DICT, increasingly present in the daily lives of teachers, parents, and students. If digital technologies are part of the

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routine of most students outside of school, they therefore become a cultural asset to be considered for approaching and appropriating knowledge in the school context. Therefore, curricular construction that considers, problematizes, and integrates these technologies seems necessary in current times with a view to critical training and civic action in the society in which we operate.

Escaping from salvationist and/or merely instrumental perspectives, the presence of DICT in education can enable the development of multiliteracies (ROJO, 2013), critical thinking, and authorship (RODRIGUES, 2019, 2021). Contemplating the diversity of languages (as forms of representation of thought) and curricular paths means enabling learning for different cultural groups, and democratizing access to knowledge in space and the school curriculum. However, DICT are not easily integrated with intentionality and meaning into pedagogical practices, nor does this happen immediately or "by decree". Its presence requires reflection and praxis on the part of the subjects who construct the school curriculum daily (RODRIGUES, 2017) – as evidenced in the emergency remote teaching experiences developed during the COVID-19 pandemic (CETIC, 2021).

Furthermore, it is important to highlight that it is the school's role to provide access to knowledge, in the scientific, technological, social, and cultural spheres. Especially in the field of technology, pedagogical strategies need to be linked to reflective dialogue with students, to promote critical awareness about what constitutes expressive knowledge and what potentially will just be alienation and unnecessary consumption. In this sense, school robotics should go beyond the idea of preparing students for the job market towards promoting a broad understanding of processes that involve the construction of artifacts and science and technology solutions in favor of the construction of a more just, equitable, and democratic society.

In this direction, Blikstein (2015) argues that not every child will have ease in a robotics project or a maker space and highlights the fundamental role of guidance and monitoring by teachers. The author also highlights that teaching robotics is not about promoting competition, but about valuing cultural artifacts and fields of knowledge. Finally, he warns about the issue of access for families who are unable to sustain the costs of these activities, because, as previously stated, the social context of education cannot be isolated, since not considering it is making educational processes superficial.

Movements such as educational robotics currently present themselves as promises to improve teaching and learning processes. However, as stated by Rodrigues and Almeida (2019), understanding the pedagogical intentionality in the curricular construction of these movements is essential for their reframing (beyond miraculous and, therefore, fantasy promises, in the complexity of the educational field). Blikstein, Valente, and Moura (2020, p. 539, our translation) corroborate the authors' ideas, highlighting that

> Without pedagogical intentionality, without educational theories that act as guides for the creation of activities, without concern with the democratization of opportunities, without an understanding of the mediating and amplifying role of technologies, [...] [the maker] runs the risk of becoming a brand as generic as it is empty, an element of marketing rather than emancipation, a domain of "consultants" rather than educators.

For educational activities with robotics to contribute to more meaningful learning and citizenship training in contemporary society, they must be reflected in the curricular dialogue mediated by pedagogical intentionality and the critical-reflective training of students.

Methodological perspective: between documents and voices

This research is configured as a qualitative study (LÜDKE; ANDRÉ, 1986). The study's locus was a private school, created in January 2018, located in São Paulo tate. In 2022, when the research was carried out, it had 530 students and a teaching staff of 69 teachers, 25 from Middle School, 14 from Elementary School, and 30 from High School. The school is one of the pioneers in the city and region to introduce Robotics as a curricular subject.

Data collection took place in two stages: documentary survey and semi-structured interviews. Data were collected from the following documents: Pedagogical Proposal (PP) and School Regulations (SR), Robotics Project (RP), Curricular Matrix (CM), as well as the Curricular Contents (CC) for Elementary and Middle School of the subjects of Science, Physics, and Mathematics. The analyses of the documents sought the following information, in addition to points of convergence and divergence between them: teaching objectives, lesson plans in teaching activities, educational intentions, evaluation methods, and records made by teachers regarding the activities proposals, and curricular content involved in robotics activities.

Semi-structured interviews were carried out with seven research subjects, chosen because they were directly involved in the RP. Table 1 presents a summary of the interviewees' training, as well as their actions and responsibilities in the Robotics Project.

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TABLE 1: Research subjects.

Education	Job	Code	Actions and responsibilities
Degree in Psychology, specialization in Psychopedagogy and School Management. Master's in Human Development.	Principal	D1	Works at the school since its creation, constantly supervising the pedagogical actions developed in the Robotics Project.
Degree in Law and Pedagogy.	Coordination assistant (Elementary School)	C1	Advises the educational activities of robotics classes, organizes and provides materials, in addition to participating in classes in order to assist students during the activities.
Degree in Pedagogy and Biology. MBA in Project Management and Master's degree (currently studying) in Educational Projects.	Coordination (Middle School)	C3	Active in the Robotics Project since its creation, he helps in planning the contents of the Robotics Project and selects the professionals involved in the Project.
Degree in Biology and Pedagogy (studying).	Coordination assistant (Middle School)	C2	Certifies the functioning of materials for the robotics class and is responsible for recording student attendance.
Computer Technician, degree in Mathematics, master's degree (studying) in Education and Projects.	Mathematics Teacher (Elementary School, 4th and 5th grades)	P2	Responsible for regular Mathematics classes in Elementary School for 4th and 5th grade students. Teaches all Project classes in this segment. Their classes receive, in addition to coordination and principal support, assistance from the Middle School teacher-coordinator and their role consists of carrying out, together with the coordinator-teacher, lesson planning and teaching the proposed robotics content to students.
Degree in Physics.	Physics Teacher (Middle School, 8th and 9th grades)	P1	Responsible for regular Physics classes in Middle School for 8th and 9th grade students.They also prepare the content that will be presented in classes.
Computer Technician, degree in Physics, master's degree (studying) in Science	Physics teacher and Robotics Project Coordination	P3/CP	They have extensive experience with maker and robotics projects applied in other schools. Helps with content planning, the selection of teachers who are part of the project, and the materials used. Their role is seen as professor-coordinator, as advises on the preparation, execution and evaluation of all stages that take place in the Project.

Source: Own authorship. Research data.

Using the interview data, we sought to understand elements of everyday pedagogical practice in RP, such as structure and organization of classes, details of the development of activities carried out; frequency and duration of activities; assessment guidelines, pedagogical intentionality and relationship with curricular subjects.

To organize and process the interview data, the transcriptions were fragmented into excerpts and then grouped into five emerging categories, as instructed by Cardoso, Oliveira, and Ghelli (2021). The final categories were: 1) understanding of the curriculum and its elements; 2) active methodologies and technologies; 3) pedagogical intentionality; 4) limitations and aspirations for improving the educational process and; 5) possible connections between the curriculum and robotics activities (GONZAGA, 2022).

In this article, discussions of the results are focused on the school's curricular documents and possible connections between the curriculum and robotics activities (5th category) arising from the interviewees' statements.

Results and discussion

A look into the prescribed curriculum documents

The general analysis of the documentary data allowed us to identify that two aspects are the main focuses in the Robotics Project: research and project development, which appear as competencies, the first being also placed in the Pedagogical Proposal as a scientific foundation to be developed throughout the school trajectory. In the PP, interdisciplinarity also appears as a fundamental point, and in RP it is presented in the integration of knowledge of Mathematics, Science/Physics, and Computing. However, in the Curricular Matrix, IT is not a subject offered to all students, only for the initial years of Elementary School. In this document, Mathematics is the only subject highlighted and is linked to the National Common Curricular Base

(NCCB). The CM text recognizes that “other disciplines” make up the RP; however, it specifically mentions the subjects of Science, Physics, Computing and their contents.

In the Pedagogical Proposal, it is described that the knowledge, activities, and development of teaching and learning “are organized and systematized”, however, the RP description does not present how the organization or planning of project activities is carried out. There is no clear proposal, in any of the documents, for the planning of robotics activities – which prevented the analysis, through documents, of a possible articulation between the curricular contents and the robotics project developed at the school.

Considering the students’ prior knowledge and relating it to scientific knowledge contributes to the understanding of the contents and also to the student’s performance in school activities (LOPES; MACEDO, 2015) and society. Furthermore, the school/society approach is usually a highlighted aspect in maker or school robotics actions and proposals. However, in the RP document, there is no detail on how it is intended to instigate student participation/action and integrate project activities with curricular content.

The equipment used (electronic boards and components, computers, mobile devices, interactive whiteboard, etc.) is also not described in the RP. Nonetheless, Gimeno Sacristán (2000) emphasizes that teaching aids are the most direct regulators of pedagogical content and methods and also need to be part of the prescribed or formal curriculum (JESUS, 2008).

In general, when checking the points that were similar in all the documents analyzed, it is worth noting that in both the Pedagogical Proposal and in the School Regulations, in the Robotics Project, and the Curricular Contents there is emphasis on the use of “problem situations” during the teaching and learning processes. When placed in the perspective of the student’s reality, problem situations can contribute to the construction of knowledge (VALENTE, 2016). It is also important to note the presence of the words “curriculum” and “innovation” in the institution’s educational proposals, as well as the constant presence of terms such as “investigative spirit”, "curiosity and interest", "autonomy" and "collectivity". This is a positive aspect since there is a convergence between documents in this regard, which can provide greater direction for pedagogical practice. However, there is no detail or description of how these terms can be understood in the school space nor how they can be developed in the curricular context.

We also highlight that the lack of information in curriculum documents can create an obstacle to the recontextualization of the curriculum in pedagogical practice; in addition to making it difficult to apply the Robotics Project. Having clear documentation of the school's intentions means having a firmer foundation for implementing the real curriculum.

In Table 2, we present a summary of the points of rapprochement and separation identified in institutional documents.

TABLE 2: Document analysis – rapprochement and separation.

Documents	**Approach points**	**Points of separation or gaps**
Pedagogical Proposal (PP) and Curricular Matrix (CM).	Perspective of technological training and presence of disciplines in CM that allude to this perspective.	Cross-cutting themes are described in the PP, but do not appear in the CM.
School Regulations (SR) and Pedagogical Proposal (PP).	Offering extracurricular activities and developing multiple skills.	Assessment forms not detailed in both documents.
Curricular Contents (CC) and Robotics Project (RP).	Problem situations as practice indicated in both documents.	Low frequency of discussions about technology in CC and item cited too much in RP.
Robotics Project and all cited documents.	- Research and development of projects as skills to be developed in class. -Emphasis on the subject of Mathematics. -Emphasis on the use of problem situations.	-Lack of information for carrying out applied projects. -There is no mention of other subjects; just Mathematics. -Lack of information on how robotics activities are organized.

Source: Own authorship. Research data.

On PP, technology is considered fundamental to the institution, but, in fact, at CM, we observe only two subjects, described as curricular components, that address the topic of technologies: Robotics and Computing.

As already stated by Almeida and Silva (2011), Jesus (2008), and Gimeno Sacristán (2000), the choice of curricular contents must awaken critical reflection, since curricular choices are not neutral and the curriculum reflects the character that the school assumes.

Regarding cross-cutting themes, the PP states that they are covered in all subjects and also in special projects, such as RP. However, in the CM these themes are not presented. The offering of extracurricular activities, mentioned in the SR and PP, aims to "develop multiple skills". However, in both documents gaps were identified regarding how extracurricular activities were carried out and evaluated. In the CC and RP, problem situations are mentioned, but with a low frequency of discussions about technology in the CC, an item highlighted in the RP.

In general, about the RP and all other institutional documents analyzed, we identified the expression of interest in developing projects, highlighting the subject of Mathematics and the resolution of problem situations. On the other hand, the documents claim to develop interdisciplinary projects, but only the subject of Mathematics is mentioned. Another gap identified in the RP corresponds to information about the organization of robotics activities, that is, lesson planning, content or themes defined according to a schedule, and evaluation of activities for a final concept, which appears in the CM.

Between the prescribed and the real: where is the robotics project?

In this section, we present and discuss the perceptions of research subjects on the topic under analysis. We start with P3/CP, which indicates the use of NCCB to build knowledge that guides RP, but also highlights the concern with what it calls "training objectives":

"So, planning is based on the material used by the school, also on NCCB, which has the computational thinking part, technological operations,

we think about the objectives we have for student training at school and we align what we will fit there [in the Robotics Project]" (P3/CP).

P3/CP seems to be clear about the indispensability of the prescribed curriculum for teaching in RP. As already described in the documentary analysis, the clarity of the curriculum prescribed in school documents helps to guide the pedagogical actions that will be carried out at the school. As there is no systematic introduction of robotics in the Brazilian curriculum (CAMPOS, 2017), using school documentation as a basis for robotics projects contributes to a curricular organization that is closer to school realities, guiding the actions of the teachers involved. However, the only document cited by P3/CP is the national one (NCCB), although the students' training objectives are present in the Pedagogical Proposal.

C2 also mentions the NCCB and demonstrates its understanding of the objectives of the content proposed in robotics activities and its relationship with the same document cited by P3/CP:

"We strive to approach robotics content more directionally, so we use the specific material, which is based on the NCCB proposal, and since last year we have had the intention of adapting some content, skills, and abilities with robotics activities" (C2).

We emphasize, based on C2's speech, that, on the one hand, the use of the NCCB can collaborate with the planning of robotics classes, as it is a general normative reference; on the other hand, it is necessary to point out that this document must be a secondary source. Blikstein (2015) states that the primary source should be institutional documents that, as they contemplate the local conditions of the school and the community, have greater possibilities of promoting critical reflection and emancipation by problematizing the context of life.

In the same direction as C2, D1 comments on aspects of the prescribed curriculum and its relationship with robotics:

"In this Mathematics, Physics, and Robotics group, along with the pedagogical part, we sat down and talked about the possibility of combining

robotics knowledge into the curriculum, so this project was never ready, it was always under construction and ongoing. [...] Robotics classes began to be better planned and became more structured, using the curricular base, although it is still under construction, that was the starting point" (D1).

The excerpt from D1 can be associated with the propositions of Blikstein, Valente, and Moura (2020) about the link between curricular content and technological activities offered by a pedagogical institution. According to the authors, the definition of curricular content must be aligned with the activity intended to be carried out, for example, in maker or robotics projects, based on clear learning objectives. In this sense, content planning is carried out together with other teachers who are directly involved in the RP, but again the documents closest to the specific school reality do not seem to have the same weight as the general document (NCCB).

Still, regarding the planning of robotics activities at school, which occurs through conversations between teachers, we highlight that this can, in a certain way, limit the participation of the broader school community – which could, at the same time, on the contrary, be enhanced by projects of this type. Broader planning that adheres to school reality would involve permanent dialogue between teachers, parents, and students seeking to encompass local needs, knowledge, and cultures in the construction of the curriculum as culture (GIMENO SACRISTÁN, 2000). In this sense, the RP could encourage actions that involve contextualized discussions and democratic participation, contrary to merely technical training (SILVA, 2015) associated with technologies.

In this sense, the use of NCCB as the main, and sometimes only, base tool for teachers' planning may indicate vulnerability in the RP, as the curricular construction must also be rethought about content, seeking, in a collective construction, to bring together teaching demands, student and parent manifestations, and everyday knowledge in its diversity and particularities (GONÇALVES; MACHADO; CORREIA, 2020). Even though the NCCB offers support in the guidelines aimed at the right to education, care must be taken, as it is a prescribed curriculum document that seeks to standardize skills and abilities, often disregarding school diversity.

There is no reference from the interviewees to school documents that cover contextual elements of the institution. Even so, P2, C2, C3, and DI explain their view that the curricular contents are covered in the RP. For C3, this occurs due to the association between theory and practice in RP activities, and, for C2, the association occurs due to the similarity between cognitive actions required in both mathematics and programming:

"I think that, for example, in the practical activity, the LED connected to the board was used, and so when they see the result they know that it works, they understand the concept of what is being conveyed [...]" (C3).

"I see uses of logic within Mathematics and programming logic; this year, for example, teachers are working with colors from the physical spectrum of colors and how this relates to the sensory organs" (C2).

From the point of view of teaching actions in the RP, P2 claims to use the STEAM methodology in his robotics classes and indicates that his practice is based on systematized knowledge, a pedagogical approach supported by projects, and that their classes are based on subjects that appear in the CM such as Science, Mathematics, Technology. P2 states that they apply the organization of thought in class dynamics, as they highlight that students have difficulty solving a Mathematics exercise due to the difficulty in guiding the beginning, middle, and end, that is, fragmentation of the exercise. The Mathematics classes in the initial years of Elementary School are taught by P2 and from their speech, it is possible to identify that P2 has detected this difficulty in students during the subject's classes. Therefore, in robotics classes, they exercise the organization of thought. P2's actions indicate a link between the classroom, more specifically the Mathematics exercises, and the robotics classes. However, this link seems to be more associated with teaching intentionality than with the clarity of the prescribed curriculum.

P3/CP's report, based on their experience in the classroom with robotics, also indicates that this subject establishes relationships between the science curriculum and the RP: *"For example, the concept of Energy, which is an almost immediate concept, when you deal with batteries, power supplies, circuits, and engines, you have the opportunity, instead of talking about the formula and what is in the book [handout], talk about the concept of Power"* (P3/CP).

P3/CP's speech sheds light on the use of handouts in the school context, as the teaching material provides a structure of pre-determined content with a defined time for its implementation, making the teacher feel worried about adapting their class time to complete the handbook material. In this context, treating the implementation of new pedagogical practices as being solely the responsibility of the teacher, or even associating it exclusively with their will, means ignoring the broader curricular issue. Since robotics presents itself as a subject in the school's CM, providing opportunities to experience the curricular content present in the materials provided in RP activities can contribute to a more meaningful curriculum experience, but again we emphasize the need for this not to be linked solely to the making and the intentionality of the teacher.

P1, in this sense, adds: *"[...] we can work on the concept of energy transformation, electrical or mechanical, to connect an engine, an LED, we always link the classes, so that they can see that it is possible to use mathematical and physical concepts in practice"* (P1).

The excerpts from subjects P3/CP and P1 demonstrate a link between the content covered in the classroom and the activities proposed in the RP. P1 also adds that, according to their view, it is possible to combine concepts of Mathematics, Physics, and other subjects with robotics, as students can live with the experiences developed in the Project: *"Another objective is to enable students to come into contact with Physics before starting high school and therefore* *remove the labels that Physics gets, that it is difficult and boring. In addition to developing manual cooperation skills"* (P1). By what P1 mentions, it is possible to observe the idea of instigating the student's interest so that they can be the author of their learning, understand the meaning of what they are learning, and associate it with their routine.

Regarding the planning of activities, P2 says they talk to P3/CP to define the contents of the semester, and the NCCB curricular guidelines related to technologies are mentioned again by P3/CP as guides of this planning. However, in the interviews, participants also mentioned elementary aspects of the curriculum related to teaching planning, such as class time and proposed activity, objectives, structure, and resources.

Along with the pedagogical team, D1 says they participate in the planning and again highlights the aim of combining robotics knowledge with the curriculum, but without reference to what type of curriculum. D1 states that the RP is under continuous construction:

"The Mathematics teacher used the Mathematics curriculum to include robotics in classes, the IT teacher used technological knowledge, and the Physics teachers in the same way, they surveyed the curriculum for the high school years of Science and Physics and aligned it with robotics. This idea is still in planning and is being structured, these were the last steps we have taken of robotics at school so far" (D1).

In the analysis of the document referring to the RP, there was no identification of how class planning is carried out. However, the excerpt from D1 shows that teachers use the Mathematics, Physics, and Science curricula to think about robotics actions. Even though they do not use the word "curriculum", in the statements it was possible to detect the presence of curricular contents consistent with the segments of Elementary and Middle School. D1 adds that the fact that RP teachers also teach Mathematics and Physics subjects contributes to the functioning of the project, as in this way, they can combine knowledge with robotics. However, such articulation, according to the interviews, is made only by a general document, the NCCB, dispensing documents from the school itself. Furthermore, the RP does not seem to dialogue with other subjects or areas of knowledge; being closely linked to each teacher's understanding of the curriculum/project relationship; and not fulfilling its multidisciplinary function.

The interviewees appear to have no ingrained knowledge about the institution's prescribed curriculum and, as seen in the document analysis, there is a lack of relevant information in these documents. The presence of regular subject teachers in the RP provides the opportunity to expand curricular content in a way experienced in the project, expanding classroom learning. However, it also seems to generate a certain fragmentation of actions, repeating in the RP the disciplinary logic established in the traditional curriculum. Finally, the interviewees expressed concern about the project not being considered a recreational activity – which can be understood as a positive aspect for them to continue reflecting on the functions of this type of project in the school context.

Final Remarks

With this study, it was possible to conclude that there is no full articulation of the Natural Sciences and Mathematics curricula to the Robotics Project of the analyzed school, with only a partial articulation being carried out, which occurs especially from the search, by the teachers, of linking activities to the NCCB and some specific content covered in the courses. In other words, articulation depends on teaching intentionality. We also highlight the lack of reference to local curricular documents by the subjects involved in the RP and we confirm that the NCCB should not be understood as the curriculum itself, but rather as guidance for the construction of local curricula. Only the theoretical support of NCCB does not provide sufficient support for the teaching practice in the Robotics Project and even indicates a certain vulnerability in project planning.

Regarding content, teachers use Mathematics, Physics, and Science curricula as a basis for planning RP actions. Even though they do not use the word “curriculum”, it was possible to detect the presence of curricular content referring to these subjects in the project. The fact that the project’s teachers also teach the subjects of Mathematics and Physics seems to facilitate the articulation of knowledge of these areas in robotics classes. But it can also cause the fragmentation of activities and the repetition of disciplinary logic (which traditionally guides the curriculum) in the RP.

This study suggests that the lack of clarity and direction in school documents contributes to the RP/Curriculum Content articulation being left to teachers. As there are no Biology and Chemistry teachers in RP, these subjects, which also make up the natural sciences, are not covered (as are other areas of knowledge). The project therefore does not fulfill one of its main possibilities: that of being a space for the unifying and interdisciplinary construction of the school curriculum.

For full articulation to occur, we understand that it is essential that the prescribed curriculum is aligned with the practical actions of teachers and the characteristics of the school community. Furthermore, school documents must be the result of collective constructions, being permanently updated and widely disseminated so that they do not present gaps and can support the construction of curricula experienced in everyday school life.

The insertion of robotics in the school context requires caution, firstly, because the curriculum is a field of tensions and interests. Furthermore, if there is no link with the school curriculum, robotics can become just a distraction, a moment of recreation for students, or a marketing tool serving purely market interests. In this sense, we highlight the need for critical-reflective teacher training so that school robotics does not become another “fashionable” activity without contributing much to the education of our young people. Finally, we emphasize that robotics at school is not an accessible reality for most school contexts in Brazil, despite the possibilities it can present for the development of critical thinking, creativity, and understanding the school/society relationship with a view to a world in which technological solutions can translate into social justice, equity, and citizenship.

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