A DISCOURSE OF TEACHERS WHO TEACH MATHEMATICS ON PROJECT-BASED LEARNING METHODOLOGY AND DIGITAL TECHNOLOGIES

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Abstract: The research aims to understand how a closed network of conversations held by teachers who teach mathematics in Basic Education, and who participated in a continuing education course, are structured around training for the understanding and planning of classes involving the methodology of learning projects and digital technologies and contour with the participation of 15 teachers who teach mathematics. The data were analyzed using the collective subject discourse technique. To identify the group's understanding of the methodology and its interconnection with technologies, as well as the imminent demand for training.

Keywords: Digital Technologies; Learning Project Methodologies; Collective Subject Discourse

UM DISCURSO DE PROFESSORES E PROFESSORAS QUE ENSINAM MATEMÁTICA SOBRE A METODOLOGIA DE PROJETOS DE APRENDIZAGEM E TECNOLOGIAS DIGITAIS

Resumo: A pesquisa objetiva compreender como uma rede fechada de conversações constituída por professores(as) que ensinam matemática na Educação Básica, e que participaram de um curso de formação continuada, estruturam-se em torno da formação para o entendimento e o planejamento de aulas, envolvendo a metodologia de projetos de aprendizagem e tecnologias digitais e contou com a participação de 15 professores(as) que ensinam matemática. Os dados foram analisados por meio da técnica do discurso do sujeito coletivo. Identificam-se as compreensões do grupo sobre a metodologia e seu imbricamento com tecnologias, bem como a eminente demanda por formações.

Palavras-chave: Tecnologias Digitais; Metodologias de Projetos de Aprendizagem; Discurso do Sujeito Coletivo.

DISCURSO DE DOCENTES QUE ENSEÑAN MATEMÁTICAS SOBRE LA METODOLOGÍA DE LOS PROYECTOS DE APRENDIZAJE Y LAS TECNOLOGÍAS DIGITALES

Resumen: La investigación tiene como objetivo comprender cómo una red cerrada de conversaciones realizadas por profesores que enseñan matemáticas en Educación Básica, y que participaron de un curso de formación continua, se estructuran en torno a la formación para la comprensión y planificación de clases involucrando la metodología de proyectos de aprendizaje y tecnologías digitales y se conforma con la participación de 15 profesores que enseñan matemáticas. Los datos fueron analizados utilizando la técnica del discurso del sujeto colectivo. Es posible identificar la comprensión del grupo sobre la metodología y su interconexión con las tecnologías, así como la inminente demanda de capacitación.

Palabras clave: Tecnologías digitales; Metodologías de Proyectos de Aprendizaje; Discurso del sujeto colectivo.

1 INTRODUCTION

Digital technologies are instruments that are in a constant process of transformation and are widely used in the daily lives of a large part of the people in our society. Such factors contribute to making perceptible the changes in our ways of being and existing, in social coexistence, mobilized by the most diverse technologies.

Changes occur, adaptations happen, but as teachers, we increasingly need to understand that technology alone is not capable of producing meaning for our students' learning (Figueiredo, 2020; 2021a), making it increasingly necessary for us to consider the need to make pedagogical use of digital technologies, promoting integration between methodologies and technologies.

Studies such as those by Figueiredo (2020, 2021a) and Rodrigues (2007) point to the need to understand teacher education for the use of digital technologies in cultures that develop around technological advances. In this sense, conducting this research can be configured as an important scientific instrument to understand how teachers who teach mathematics think, use, or may use Project-Based Learning Methodologies (PBLM) integrated with technologies in their teaching practice, when receiving training involving possibilities of coupling between methodologies, especially PBLM and technologies.

In PBLM, the doubts that arise come from the students themselves and are answered by them; consequently, space opens up for reformulations. We understand that through the methodology, doubts motivate learning and do not cease from the moment they are answered, since:

> if the human being ceases to be an inquisitive child, curious, inventive, confident in their capacity to think, enthusiastic about explorations and discoveries, persistent in their search for solutions, it is because we, who educate them, have decided to "domesticate" that child, instead of helping them to learn, to continue learning and discovering. (Fagundes; Sato; Laurino, 2006, p. 16).

In this sense, it is understood that the theme is emergent because we comprehend that it is increasingly prominent the need for the student to become a protagonist in the educational process, by directly engaging in all processes involving their learning. Furthermore, when we conducted a prior survey of research on the topic in the Digital Library of Theses and Dissertations (BDTD), using the keywords "digital technologies, teacher education, and project-based learning methodology," only eight works addressing the specific theme of this research were identified, which also evidences the

need for further studies on the topic.

Given the above, the article aims to understand how a closed network of conversations constituted by teachers who teach mathematics in Basic Education, and who participated in a continuing education course, structure themselves around education for understanding and planning classes involving project-based learning methodology and digital technologies.

2 TEACHER EDUCATION, PROJECT-BASED LEARNING METHODOLOGY AND DIGITAL TECHNOLOGIES: A THEORIZED CONVERSATION

Digital technologies are increasingly present in our context and, in schools or other learning spaces, these tools, even if timidly, are also becoming present. In this context, thinking about teacher education while denying these changes goes against the emerging demands of our society. During teacher education processes, whether at initial or continuing levels, it is possible to observe the importance given by future teachers in staying updated regarding their practices and knowledge, and the changes concerning available resources demanded both by schools and by students themselves.

We understand that quality education in the teacher education process provides future educators with the opportunity to achieve different experiences in the classroom. Acquiring knowledge involving diverse ways of teaching can help teachers understand advances in competencies and skills, enabling educators to act effectively in the classroom (Mendes; Alves; Santos; 2020).

In the teacher education environment, academics need to stay updated regarding content knowledge and also identify the distinct possibilities for teaching it, both in terms of methodologies and resources, so that future educators are capable of contributing to the formation of twenty-first century students, rather than rigid courses that fall short of their perspectives and needs for their lives (Lévy, 1999). However, for future teachers to know how to teach curricular content to their classes and thus achieve the lesson's objective, it is necessary and fundamental that during undergraduate studies, academics experience updated and differentiated strategies and methodologies, becoming familiar with the variety of technological resources that can be incorporated into their pedagogical practices.

When planning a lesson, teachers have numerous possibilities and ways of presenting the topic addressed, from simpler materials to advanced technological tools; this will depend on the possibilities and resources that the school provides. For a lesson to be interesting, creative, and engaging to those

who participate, it is relevant to use different ways of presenting the content.

Project-Based Learning Methodology (PBLM) is grounded in constructivist theory, in which the student is encouraged to research in detail, elaborate concrete questions and answers, use reputable references—that is, seek information and construct knowledge.

According to Schlemmer (2018, p.6):

> The Project-Based Learning Methodology has its origin in research results in "genetic psychology, on the development of intelligence and on the learning process," carried out by the Cognitive Studies Laboratory – LEC/UFRGS. This methodology was extensively investigated by LEC/UFRGS in the context of the Amora2 Project, developed at the Colégio de Aplicação of UFRGS, and also in other schools of the Municipal Education Network of Porto Alegre-RS, which gave rise to the work "Learners of the Future: The Innovations Have Begun!", by Fagundes, Maçada and Sato (1999) (Schlemmer, 2018, p. 6).

Planning and attention directed to strategic points are essential for the quality development of a Learning Project (LP). For its construction, it is necessary to elaborate questions, conduct comparisons, make associations, promote situations of cooperation among those involved, among other strategies—that is, LP is a process of collaboration where different and unique people with different prior knowledge assist each other to construct knowledge based on their own interests. In this way, we emphasize that "the elaboration of the project constitutes the fundamental stage of all research that can then be conducted through a set of questions, whether about itself or about the world around it" (Fagundes; Sato; Laurino, 2001, p. 15).

To use PBLM in the classroom, it is relevant that teachers know the methodology so that they know how to explore it with their students, understanding the specificities of the methodology, such as, for example, identifying the differences between teaching through projects and learning through projects.

> A teacher, as much a learner as their students, does not function only cognitively; therefore, in a constructivist learning environment, it is necessary to activate more than the intellect. The constructivist approach, from a genetic perspective, proposes learning both about the physical universe and about the social universe. (Fagundes; Sato; Laurino, 2001, p. 20).

In PBLM, the teacher's role presents the functions of learning activation, practice articulation, project orientation, and specialist (Fagundes; Sato; Laurino, 2001), presenting pathways and instigating reflection on the theme, so that students construct coherent questions, seek answers, and thus elaborate and construct their projects based on their knowledge, researching from reliable sources, elaborating questions to be asked to teachers. From these questions, teachers can direct which

pathways will be interesting, but without presenting ready-made answers, since the objective is for the student to elaborate and construct this knowledge, and thus solve previously existing doubts and present coherent answers.

In the movement of working with PBLM, there also arises the possibility of making use of distinct digital tools, since they can expand access to information and propagate knowledge; in this way, the student needs to be guided by teachers, because of the broad field of knowledge that digital technology provides.

In this context, it is important to highlight that:

> The use of Informatics in the evaluation of the individual or group through shared projects allows the visualization and analysis of the process and not only of the result; that is, during the development of projects, exchanges are recorded through messages, images, texts. It is possible, both for the teacher and for the student themselves, to see each stage of production, step by step, thus recording the construction process (Fagundes; Sato; Laurino, 2001, p. 24).

Using PBLM in the classroom can enable better development, cooperation, and participation among students, since the methodology makes possible the creation of a learning space capable of valuing knowledge culturally constructed by students and acts scientifically in the pursuit of knowledge construction.

Applying a methodology different from the traditional one is not something simple, since most teachers and students are accustomed to the traditional method, in view of the very education to which they were subjected and the certainties of being a teacher in this way. When differentiated forms of teaching are used, the new can present certain difficulties at the beginning and even resistance to using different formats. In traditional teaching, "[…] the centrality of the teacher's figure stands out, the emphasis given to content, the gradual determination of these and their intellectual character, the clear establishment of the method and teaching procedures". (Ramos; Ferraroni, 2009, p. 76).

When using constructivist theory in learning, we understand the student as a protagonist and offer personalized learning. PBLM aligns with constructivist theory and can be used in content in which the subject is of common knowledge; for example, in mathematics, when studying simple interest, it is possible to elaborate an LP in which students will construct problem situations involving some theme of interest, such as football. For these questions to be solved, it is necessary to apply knowledge about simple interest, and when using the PA methodology together with digital technologies, we can mobilize students through the interest demonstrated in football and thus promote

learning in an updated, creative, dynamic, and interactive way.

According to studies by Figueiredo (2020, 2021a), it is notable the lack of digital technologies in the daily lives of teachers working in the classroom, using methodological proposals associated with project-based learning methodologies, since teacher education and digital technologies must be interconnected and be frequently updated, since society is in constant transformation, often resulting from technological advances, altering the way of being and existing.

In this context, Moran (2013, p. 31) encourages reflection and analysis on the subject by presenting that "with current technologies, the school can transform itself into a set of spaces rich in significant learning, both face-to-face and digital, that motivate students to learn actively, to research all the time, to be proactive, to know how to take initiatives and interact".

3 THE DEVELOPMENT OF THE WORK: DESCRIBING THE METHODOLOGY

The research is centered on PBLM used together with digital technologies and the education of teachers who teach or will teach mathematics in Basic Education. The relevance of studying and deepening this theme is due to the low motivation, understanding, and preparation of teachers for the use of active methodologies, especially PBLM, since the teacher who will use this methodology in the classroom often did not benefit from a course during their education in which methods and practices for applying such methodology were explored.

To conduct this research, initially, a bibliographic study was conducted with the theoretical assumptions that govern the research theme, seeking to support the arguments and proposals that will be developed.

Given the above, we planned, constructed, and applied a fully online improvement course for teachers with a certificate of participation on active methodologies of project-based learning.

The course titled "Improvement Course for Teachers Who Teach Mathematics: Projects to Learn or Projects to Teach? Intertwining Active Methodologies and Digital Technologies," with an execution period beginning on August 1st, 2023 and ending on September 4th, 2023, was developed by a research group from a university in southern Brazil. The course was developed to promote education for current and future teachers who teach or will teach mathematics in Basic Education on PBLM with digital technologies.

The specific objectives of the aforementioned course were: to promote teacher training at the

improvement level; to expand access for teachers to continuing education; to provide opportunities for qualified training on active methodologies; to present and discuss possibilities for teaching work through active methodologies with emphasis on project-based learning methodology.

Forty vacancies were made available, distributed as follows: thirty vacancies for public school teachers who teach mathematics, who are trained in pedagogy and/or mathematics, with twelve vacancies for the city of Rio Grande/RS, seven vacancies for São José do Norte/RS, eight vacancies for Santa Vitória do Palmar/RS, and three vacancies for Chuí/RS, thus totaling thirty vacancies for teachers who teach mathematics in Basic Education, and ten vacancies were offered to undergraduate students in pedagogy and/or mathematics residing in the cities previously mentioned.

Registrations were via electronic form, with the course available on the university's virtual learning environment (VLE), thus allowing it to be conducted at a more flexible and comfortable time for the registered participant.

The course was divided into two categories: for current teachers and future teachers who teach or will teach mathematics in Basic Education. The vacancies offered to teachers were not filled, and thus, five vacancies were transferred to undergraduate students. In this way, the course filled the offered vacancies; however, not all registered participants completed the course, thus thirty course participants attended, among them fifteen current teachers and fifteen undergraduate students from mathematics and pedagogy courses, all of whom participated and responded to the digital form containing three argumentative questions, which can be observed in Chart 1.

Chart 1 – Research Questions

1. Based on what was studied regarding the course, how do you understand the work involving learning projects in the Basic Education classroom? Describe facilitating and/or limiting elements for its development.
2. Which digital technologies are available for your use in the school where you work, and, based on the content presented in the course, how can these digital technologies be used in learning projects to enhance the understanding of content in mathematics classes?
3. Based on what was presented in the course and through your experiences in the school environment in which you work, is it possible to work with the learning project methodology and digital technologies? If so, describe how it could be developed. If not, describe the reasons.

Source: The authors (2024)

It is worth noting that the questionnaire was used as a data collection instrument for this research and that all participants accepted the informed consent form (ICF) and that the research is approved by the Research Ethics Committee of the affiliated institution.

In this work, we chose to analyze the responses directed to current teachers who teach mathematics in basic education, understanding that they are distinct audiences, some with experience in the classroom while the other group is in the initial phase of training.

With the responses obtained through the form made available during the Improvement Course, we resorted to a qualitative approach, since we opted for such an approach due to the need to understand how people experience, interpret, and act with PBLM and digital technologies (Lankshear; Knobel, 2008), through the technique of Collective Subject Discourse - CSD. However, before presenting the CSDs constructed, we will present how the construction of CSD occurs, since it is necessary to perform some well-defined steps to then reach the objective of the technique. "In summary, the CSD is as if the discourse of everyone was the discourse of one" (Lefèvre, Lefèvre, 2000, p. 20). The technique characterizes change in qualitative research, since by using scientific methods on a given theme, it is possible to recognize thoughts, representations, beliefs, and values of a group (Figueiredo; Chiari; Goulart, 2013).

The CSD consists of using responses from a group of people who, in some way, come together and constitute themselves as a collective, such as sixth-grade students from a particular school, mathematics teachers in Brazil, adolescents between 15 and 16 years old, among others. According to Lefèvre, Lefèvre (2000, p. 19 and 20):

> The CSD is thus a methodological strategy aimed at clarifying a given social representation and the set of representations that form a given imaginary. Through this discursive mode it is possible to better visualize the social representation, insofar as it appears, not in an (artificial) form of charts, tables or categories, but in a (more lively and direct) form of a discourse that is, as noted, the way in which real, concrete individuals think. (Lefèvre, Lefèvre, 2000, p. 19 and 20).

When using the CSD technique, it is necessary to understand the methodological figures present in this technique. First, we have key expressions, followed by Central Ideas, Anchors, and the CSD itself. Key Expressions (KE) present the discursive content, corresponding in most cases to research questions, and can be pieces, excerpts, or literal transcriptions that need to be highlighted with different colors by the author. The key expression is raw material for the construction of the CSD. Central Ideas (CI) are linguistic expressions that reveal and report the perception of each discourse that will later generate the CSD, being a description of meaning rather than an interpretation of the statements. Anchoring (AC) is a linguistic manifestation explicitly stated by the author. The CSD is the union of KE organized and standardized by the researchers according to coherence between KE

and CI (Lefèvre, Lefèvre, 2005a).

The "Collective Subject Discourse (CSD) is a synthesis-discourse written in the first person singular and composed of KE that have the same CI or AC" (Lefèvre, Lefèvre, 2005a, p. 18). To construct the CSD, there are two forms of organization:

> […] in the first form (Form A), each statement is analyzed and different (but complementary) Central Ideas and their respective Key Expressions are extracted from each one. Next, the Central Ideas and/or their Key Expressions are aggregated or "summed" to obtain the CSD. In the second form (Form B), each statement is analyzed, extracting the Central Ideas. Next, equal or equivalent Central Ideas and their respective Key Expressions are identified. Finally, by aggregating or discursively chaining these Key Expressions of equal or equivalent Central Ideas, the CSDs are composed. (Lefèvre; Lefèvre; Teixeira, 2000, p. 20 and 21).

It is important to note that for the CSD to be coherent with the responses of all those surveyed, it is important that the researcher be willing to identify details and similarities, since it is fundamental that the author dedicates themselves and commits to developing a quality CSD grounded in original responses present in the collected material. "The final result of research such as CSD (a panel of collective statements) is a construct, an artifact, a systematic description of reality and a reconstruction of collective thinking as a scientific product" (Lefevre; Lefevre, 2014, p. 504).

Therefore, the CSD technique when employed in qualitative research allows the writer to explore, in a more detailed manner permeated by their subjectivity, the research data, being capable of representing the collectivity. From the data arising from the questionnaire, fifteen responses were analyzed and recorded in a chart divided into three columns: key expressions (KE), central ideas (CI), and anchoring (AC).

To begin the construction of the discourses, it is necessary to gather all responses obtained in the form and mark the (KE). The next step is to read carefully and identify with different colors each aspect of the response. For this, it is necessary to name the central ideas (CI). To differentiate them, a color was identified and established to highlight the part of the response corresponding to the central idea. It is noted that "in the CSD technique, the researcher has the major function of being a 'midwife' of social representations or their manifestations in the form of collective statements" (Lefevre; Lefevre, 2014, p. 504). In Figure 1, we present the excerpt from Table 1 that we elaborated, called Discourse Analysis Instrument I – DAI I.

Figura 1 – Recorte do IAD I

After performing these three steps, we constructed a new chart containing two columns identified as (KE) and (CSD), thus bringing together KE and CI with similar meaning to construct the CSD. After the construction of Table 1, Table 2 was constructed, called Discourse Analysis Instrument II – DAI II, composed of the grouping of excerpts highlighted with the same color and the collective discourses constructed. In Figure 2, we present an excerpt from DAI II.

Figure 2: Excerpt from Discourse Analysis Instrument I – DAI I

Using the CSD technique, it was possible to construct a collective discourse called CSD I – The Relevance of Learning Using PBLM, to be presented and analyzed in the next section.

4 THE CONSTRUCTED COLLECTIVE SUBJECT DISCOURSE AND ITS ANALYSIS

In this section, we present the collective subject discourse (Chart 2), called "The Relevance of Learning Using PBLM", and the analysis produced based on it.

CSD I – The Relevance of Learning Using PBLM (2023)

In basic education, working with learning projects can open pathways to more meaningful and contextualized learning, engaging students in practical and collaborative activities. Providing greater autonomy to the student increases self-esteem, sense of belonging, and protagonism (of the student), contextualizes the student's knowledge, as well as favors autonomy and collaboration among them. When there is interest, students tend to be participatory in this collective pursuit. Making students autonomous from the choice of topics, research methods, and presentation of results can strengthen self-confidence and responsibility. The choice for the project-based learning methodology requires much study and dedication from the teacher, since it will be up to them to organize work groups, as well as monitor research and insert mathematical concepts in the context of the researched themes. The teacher acts as a stimulator of the project through questioning posed to students, with the objective that the student be an agent of their own knowledge—that is, it is possible to create more engaging classroom experiences, lasting ones that generate, in fact, positive impacts on students' lives.

Source: The authors (2024)

The discourse presents the relevance of learning through PBLM, a methodology different from the traditional mode, in which the student becomes the protagonist of the project construction and, consequently, of their own learning. Learning mathematics through PBLM is creating a formative space based on student protagonism. It is making their ideas and curiosities an essential part of classes, relying on the specialized guidance of teachers.

For Diesel, Baldez and Martins (2017, p. 271), it is highlighted that:

> Thus, in contrast to the traditional method, in which students take on a passive posture of receiving theories, the active method proposes the inverse movement; that is, students come to be understood as historical subjects and, therefore, to assume an active role in learning, since their experiences, knowledge, and opinions are valued as the starting point for the construction of knowledge. (Diesel; Baldez; Martins, 2017, p. 271).

The teacher who proposes teaching through this active methodology provides the construction of a learning space with greater student participation. For example, using dialogues among students in which they can express their ideas, criticisms, doubts, and, in this way, they also learn to respect

the opinion of others, since each person is unique and brings with them a "baggage" of knowledge, which can be knowledge from experience or grounded in theory. In the CSD, teachers present that:

> Providing greater autonomy to the student increases self-esteem, sense of belonging, and protagonism (of the student), contextualizes the student's knowledge, and favors autonomy and collaboration among them. When there is interest, students tend to be participatory in this collective pursuit (CSD I, 2024).

This protagonism reveals to the student their ability, their potential, and their autonomy for the development of critical thinking about a given subject. Furthermore, one of the important elements in this methodology is cooperation among the students themselves, since each way of thinking is unique—it may even be similar, but each opinion is valid and important, since it is through conversation, expressing their doubts and knowledge that the new is constructed. According to teachers, "Making students autonomous from the choice of topics, research methods, and presentation of results can strengthen self-confidence and responsibility" (CSD I, 2024).

Corroborating this, Rodrigues (2007, p. 76) highlights that:

> […] students are stimulated to formulate and equate problems in a way that produces disturbances that lead them to express their doubts. When formulating significant questions, interests, values, and personal conditions emerge or are enacted from their life histories, differentiated learning focuses that need to be discussed and guided by the teacher (Rodrigues, 2007, p. 76).

A very important factor to be worked on in the school environment is how the teacher conducts dialogue so that students feel secure in expressing their own opinions, avoiding situations of discomfort, fear, and/or insecurity when they realize that many people are paying attention to them. According to teachers, "[…] it is possible to create more engaging, lasting classroom experiences that, in fact, generate positive impacts on students' lives" (CSD I, 2024). Thus, PBLM enables, through conversation, a process of cooperation among students, respecting others, among other important and necessary factors for their development.

5 FINAL CONSIDERATIONS

With this research, we sought to understand how the collective of people who, in a certain way, constitute a culture, think about the use of active methodologies, particularly PBLM, and how to offer training for elements that are characterized as defining the collective self.

The study highlighted the necessity and importance of teacher training within an emerging context of new cultural and technological perspectives. We aimed to broaden reflection on the topic, seeking to support the imminent demands of a networked society that transforms daily within a digital context, while understanding the human condition of those who learn.

Through the analysis of the constructed discourse, it was possible to identify that teacher training needs to present/explore more active methodologies, as we found in the teachers' statements that little is discussed and/or explored about such methodological issues during initial training.

In mathematics, particularly, it is interesting for teachers to know how to use PBLM and present this form of learning to students, as mathematics is often recognized by many students as a difficult subject to understand and learn. However, teachers must understand that students are subjects capable of becoming protagonists of their own learning processes, recognizing and valuing their autonomy and critical thinking.

Using the CSD technique as a tool for analyzing the responses contained in the digital form present in the course provided an awakening of an attentive look at the collective self, where individuals present their knowledge on the subject, in which everyone has a real experience. Thus, despite different words, expressions, and unique responses, it is possible to construct a discourse with which the entire collective identifies.

In this research, promoted by the contributions of teachers, it is noticeable how the particularities of each reveal themselves spontaneously, just as the similarities in their approaches to the profession were woven into the construction of discourses.

Due to the nature of this study at the master's level, there are temporal limitations. However, it is emphasized that this study served as a foundation for the production of a research project aimed at continuation at the doctoral level.

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