

Troubleshooting Math Box as a didactic-pedagogical-playful resource

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Abstract

The formative and dialogic meeting between the authors of this article, in the year 2019, based on the sharing of the contributions of Caixa Mathematics in teacher training and practice, enabled them to creatively reinvent it as Caixa Mathematics Problematizing. The objective of this text is to discuss the theoretical-methodological perspectives of the dynamization of the Problematizing Math Box as a didactic-pedagogical-playing resource in face-to-face and online training meetings. In the narratives produced in the second half of 2020, students of specialization courses highlight the experiences shared with this methodological resource, interactive, dynamic and mathematical learning moments. In addition, curiosity and the desire to learn with enthusiasm and motivation the mathematical concepts and contents intertwined in Caixa stand out. Experiencing the Problematizing Math Box in teacher training and practice contributes to the teaching-learning processes of mathematics, in a dialogic and interactive perspective, which enables the development of different strategies for solving problematizations created in the fabric of shared resources.

Keywords: Problem-solving Mathematics Box. Teacher Training and Practice. Teaching-learning. Dialogue and Interaction. Problematizations.

Caixa de Matemática de Problemas como um recurso didático-pedagógico-jogador

Resumo

O encontro formativo e dialógico entre os autores deste artigo, no ano 2019, baseado na partilha das contribuições da Caixa Matemática na formação e prática dos professores, permitiu-lhes reinventar de forma criativa o tema como Problematizador da Caixa Matemática. O objectivo deste texto é discutir as perspectivas teórico-metodológicas da dinamização da Caixa Matemática Problematizante como um recurso didático-pedagógico em reuniões de formação presencial e on-line. Nas narrativas produzidas no segundo semestre de 2020, os estudantes de cursos de especialização destacam as experiências partilhadas com este recurso metodológico, momentos interactivos, dinâmicos e de aprendizagem matemática. Além disso,



destaca-se a curiosidade e o desejo de aprender com entusiasmo e motivação os conceitos e conteúdos matemáticos entrelaçados na Caixa. A experiência da Caixa de Problematização Matemática na formação e prática de professores contribui para os processos de ensino-aprendizagem da matemática, numa perspectiva dialógica e interactiva, o que permite o desenvolvimento de diferentes estratégias para a resolução de problematizações criadas no tecido de recursos partilhados.

Palavras-chave: Caixa de Matemática para a resolução de problemas. Formação e Prática do Professor. Ensino-aprendizagem. Diálogo e Interação. Problematizações.

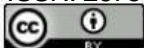
2

1 Introduction

Suddenly schools are closed and their physical spaces, characterized by the noise of students, the routine of classes, and the bell that marks rites of entry, recess, snack and exit, are not part of the daily lives of teachers, students, staff and managers of the institution. The interruption of face-to-face classes due to the Covid-19 pandemic has caused moments of uneasiness, uncertainty, and doubt. A state of quarantine is in place. Quarantine is a noun word that designates a phenomenon of isolation, is it an imprecise word of 10, 30, 40 days, 5 months?

In the imprecision of the pandemic situation, face-to-face education and online education are widely discussed and reflected in groups of teachers and managers of universities and public schools in Brazil: a rush to plan the Emergency Remote Learning (ERE) from the appropriation of technological resources consistent with the reality of the popular classes - cell phone and the use of the social network WhatsApp -, and accessible to teachers and students to enable human interaction to continue in online contexts (ENGELBRECHT; LLINARES; BORBA, 2020).

Indeed, the classes outlined for face-to-face education in the 2020 school year were suddenly transferred to distance online classes as a result of Covid-19, declared by the World Health Organization (WHO) in March 2020 as a global pandemic, which drove many countries to apply strict measures of social distancing and a policy of blocking face-to-face operation of schools and universities, which had to adopt the online teaching and learning approach (ENGELBRECHT et al., 2020). Moreover, the challenge of an inclusive





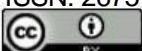
education that truly ensures access, permanence and learning for all students is highlighted.

Given this scenario, we corroborate Nóvoa's (2020, p. 1) statement: "The best were the reactions of many teachers who, in very difficult conditions, managed to invent useful and pedagogically consistent answers, through collaborative dynamics inside and outside of schools" to continue their teaching know-how in ERE. Thus, they had to learn how to organize video classes; access other functions of WhatsApp; enter digital platforms to participate in meetings, lectures, mini-courses, and events as listeners; learn digital technology tools and resources to share materials and ideas in the meetings held in online distance education; and other technological learning.

As teacher-researcher-trainers we sought to accompany and guide the pedagogical work of teachers who teach mathematics in early childhood education and the early years of elementary school, through online meetings using the most accessible social network (WhatsApp) to collaborate in the planning of mathematical tasks experienced in the ERE and to "reflect on their own ways of learning and teaching [...]" (MIZUKAMI et al., 2006, p. 167) and on the appropriation of theoretical and practical knowledge in the teaching-learning processes of mathematics.

In a dialogical relationship with basic education teachers, in this moment of social isolation, we resume our experiences with the Math Box in the formative meetings of the National Pact for Literacy at the Right Age (Pnaic) of Mathematics, held in the city of Juiz de Fora, state of Minas Gerais; in the context of teacher training in the Pedagogy course of the Education Department of Guanambi, Campus XII of the State University of Bahia (UNEB); in the mathematics extension training projects developed in partnership with this university and basic education schools; and in mathematics classes in basic education, in the period from 2014 to 2018.

In the context of Pnaic it was only the Math Box. But, the meeting and dialogue between the authors of this text in the year 2019, from the sharing of the contributions of this methodological resource in training and teaching practice, enabled them to reinvent it creatively as a Troubleshooting Math Box. Thus, it is a didactic-pedagogical-playful





resource that gives teachers and students the opportunity to teach-learn mathematics in a creative, dynamic, innovative, and problematizing way.

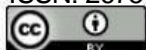
In this article, we discuss the theoretical and methodological perspectives of the dynamization of the Troubleshooting Math Box as a didactic-pedagogical-playful resource (OLIVEIRA; SILVA; TOMÉ, 2021a) in the face-to-face meetings and in the SRE experienced in the pandemic moment that interrupted the realization of Mathematics Education activities experienced face-to-face and added technological learning in online contexts. Indeed, the materials contained in this theoretical-methodological tool "are characterized by the physical involvement of students in an active learning situation" (PASSOS, 2006, p. 78).

This playful and problematizing methodological resource can be part of the planning of teachers who teach mathematics, since it provides "the teacher/student/knowledge relationship at the moment when a knowledge is being built" (PASSOS, 2006, p. 78) in online contexts that allow us to consider the articulation between the processes of meaning construction and collaborative participation with other students and the classroom teacher in online distance education.

2 Theoretical and methodological perspectives of the Problematizing Math Box in face-to-face and online training meetings

In relation to Mathematics Education, "characterized as a praxis that involves the domain of the specific content (mathematics) and the domain of ideas and pedagogical processes related [...] to the appropriation/construction of school mathematical knowledge" (FIORENTINI; LORENZATO, 2006, p. 5), considered as a cultural and historical challenge, we ask ourselves: Which teaching-learning strategies of mathematics can be experienced in face-to-face and online contexts? What methodological resources can be used in teaching practices in mathematics? How can we experience the reading of the world through situations presented by the media? How to articulate everyday mathematical practices to the teaching-learning processes?

In order to answer these reflective questions, and considering our work as teacher-trainer-researchers, in this article we share different theoretical and methodological perspectives intertwined in the Troubleshooting Math Box as a didactic-pedagogical-playful resource that allows students to appropriate mathematical concepts and content intertwined in each playful and problematizing resource contained in the Box.

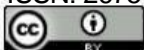




According to Oliveira, Silva, and Tomé (2021b, p. 20), experimenting with the Troublesome Math Box in teacher training and practice "is a possibility to offer students the joy of experiencing the teaching-learning process of mathematics with pleasure, motivation, and learning [...]". In this context, mathematical concepts and contents are mediated by the teacher with the collaborative and dialogical participation of students who interact and collaborate in the development of different strategies in solving problems created in the weaving of shared resources. Thus, they communicate the mathematical ideas used to solve the problem situations proposed and formulated through the resources contained in the Troubleshooting Math Box. In addition, they elaborate problematizations during the dialogical exposition of the mathematical content discussed in connection with the didactic-pedagogical-playing resource in the teaching-learning action (OLIVEIRA; SILVA; TOMÉ, 2020, 2021a).

The didactic-pedagogic-playful resources of the Troublesome Math Box, such as: popsicle sticks, straws, logic blocks, golden material, Cuisenaire scale, abacus, numbers from 0 to 9, signs of mathematical operations (addition, subtraction, multiplication, and division), Tangram, dice, measuring tape, clock, scales, ruler, geometric solids, dominoes, and others, provide an opportunity to alphabetize and literate mathematically, since "[...] imply the action of teaching-learning the writing, reading and interpretation of numbers, operations, problem solving, geometric shapes, and other mathematical content related to the social practices of children" (SILVA; ALMEIDA; OLIVEIRA, 2021, p. 462).

According to Muniz et al. (2014, p. 19), "in mathematical literacy, understanding the structure of the decimal and positional system should be a child's construction: the student will incorporate such structures as properties full of meanings [...]". In this process, the resources included in the Troubleshooting Math Box contribute to mathematical literacy "[...] from the perspective of forming a mathematically literate citizen" (GRANDO, 2016, p. 3).





In this scenario, the Troubleshooting Math Box experienced in training and teaching practice, in face-to-face and online meetings, constitutes a perspective in the conception pointed out by Alro and Skovsmose (2006, p. 29):

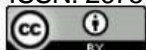
A perspective resides in the tacit dimension of communication, and it is from this dimension that statements gain their meaning. A perspective is a source of meaning. The perspective determines what the participant chooses to see, hear, and understand in a conversation [...].

Indeed, the resources shared in the Box are useful tools for the teaching-learning processes (LORENZATO, 2006), as they allow students to choose the resource to play freely, to experience games mediated by the teacher, in a dialogical and dynamic conversational relationship in the scope of this didactic-pedagogical-playing resource, which provides the active participation of students, whether in face-to-face or online classes.

Thus, regarding the use of methodological resources in mathematics classes, we corroborate the statement by Rocha, Santana, and Oliveira (2021, p. 4): "Before they are used [...], it is necessary to know their possibilities of use and characteristics, bearing in mind that they are at the service of the teaching work and not as instruments to replace the teacher's mediation."

The Troubleshooting Math Box integrates a learning environment based on dialog (FREIRE, 1987; ALRO; SKOVSMOSE, 2006), as it allows teachers and their students to think mathematically about each resource through elaborate problematizations: Which resources indicate Quantities and Measures? Is there a puzzle in the Troubleshooting Math Box? If so, put it together and record the strategies used in the game. Do the abacus and the golden material represent the Decimal Numbering System? How? Use the numerals in the Math Troubleshooter Box and form the largest even natural number, without repeating the digits. Perform mathematical operations with the numbers and signs shown in the Math Box. And others.

To make the Problematizing Math Box more dynamic in face-to-face and online meetings in teacher training and mathematics classes, we propose the experience of four





dialogical moments: Establishing contact; Choosing and sharing the meanings of the didactic-pedagogical-playful resource; Invigorating experience; Dialogical-problematizing records (OLIVEIRA; SILVA; TOMÉ, 2021a). These were created by the authors of this article to resignify the teaching practices in mathematics with more dynamic, motivating, challenging, participatory and reflective classes.

7

The first dialogical moment, "Establishing contact", involves the participants in observing the Troubleshooting Math Box and imagining what is inside this didactic-pedagogical-playful resource. In effect, they investigate mathematically through contact, interaction, curiosity and respective inquiries about what is inside the Box.

In the second dialogical moment, "Choosing and sharing the meanings of the didactic-pedagogical-playful resource", the participants of the activity choose a resource from the Box and share the meanings of this resource in their daily and school experiences. At this moment, the mediator reflects on mathematical concepts and content included in each resource.

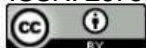
The third dialogical moment, "Invigorating experience", makes it possible to play, play, energize, narrate, create and problematize with resources from the Box, in a dialogical and problematizing relationship. What is inside this didactic-pedagogical-playing resource provides group interaction in the discussions of diversified mathematical concepts and contents.

In the fourth dialogical moment, "dialogical-problematizing records", the participating group reflects on the pedagogical practice through the writing of narratives, the formulation of problem-situations involving resources from the Box, the elaboration of reflective questions about the experience, among other records. This moment will be shared in the next section.

Based on these dialogical moments created to make the Troubleshooting Math Box more dynamic in face-to-face and online training meetings, we emphasize that it is important to create different theoretical and methodological perspectives to enthusiastically learn the mathematical concepts and content presented in the training spaces of the university and basic school, through the "pleasure of creating and the possibilities of daring" (D'AMBROSIO; LOPES, 2015, p. 12) the foundations of Mathematics Education.

Indeed, we need to create opportunities for students to reorganize their knowledge during the interaction with others (ENGELBRECHT et al., 2020), in face-to-face and online formative meetings, sharing spaces of interactivity in the mediation of mathematics classes using different technological resources. The Troubleshooting Math Box can also be presented through video, datashow animation, software, and others.

When using this didactic-pedagogical-playful resource in face-to-face and online educational meetings, "the experience of the student and the possibility of exchange should be valued whenever possible" (BORBA; PENTEADO, 2010, p. 76) in the planned activities, considering the specificities of each class that works as a mathematics teacher.





3 Dynamizing the Problematizing Math Box in the formative processes

The Troubleshooting Math Box as a didactic-pedagogical-playful resource provided the teachers who teach mathematics and their students who experienced it during face-to-face and online training meetings with various possibilities for games, games, children's stories, problem solving, among others intertwined in the box, to teach-learn mathematics as participants "[...] learners, and therefore teachers, or as teachers and therefore learners too" (FREIRE, 2002, p. 28).

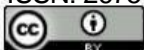
When experiencing this methodological resource in mathematics classes, the teacher can propose to the students the creation of their Problematizing Math Box using resources from their familiar environment. In this way, they can record through a narrative the process of its construction and the meanings of each dialogical moment. Later on, the production will be socialized in math classes.

The dynamics of the Troubleshooting Math Box provided significant learning of mathematical concepts and content discussed and shared with the active and collaborative participation of the teacher and students who sought to dialogue and share knowledge, experiences and learning from the formative processes in the university and basic school.

In this article we share the fourth dialogical moment "dialogical-problematizing records", which represents reflections from specialization course students about the problematizing math box in the formative processes.

In the excerpt of the narrative produced in August 2020, the teacher Maria, a student of the Specialization course in Teaching Science and Mathematics in the Early Years, reports:

When organizing my Math Box I put objects that refer to the measure of time and that are part of my pandemic context. A monthly calendar where I try to write down tasks, meetings, lives [...]. An hourglass and a dice that are part of my children's board games. I have to play with them so they don't stay just in front of the screen [...]. An old clock that brings back a time of memories of a loved one who is no longer on this plane [...].





Maria's narrative about the experience with the Troubleshooting Math Box refers to everyday life issues such as aspects of time organization for the simultaneity present with more intensity in the current context (being a student, being a teacher, being a mother, being a housewife, being a daughter, wife etc.), children's play and its mathematical elements - hourglass and dice that reflect children's culture present in the processes of learning and development in the area of mathematics. And also memory, feelings expressed by one of the objects, the clock, which records the moments experienced during the time of social isolation of the Covid-19 pandemic.

Below, we share what some students from the Specialization course in Institutional and Clinical Psychopedagogy expressed during the course "Learning Mathematics and the Formation of Logical-Mathematical Reasoning", in the second semester of 2020, mediated by professor Sandra Alves de Oliveira, about the construction and experience of the Problematizing Math Box in psychopedagogical intervention.

- The Math Trouble Box was built with a medium-sized plastic box with details in EVA. Inside it I put several mathematical games, such as: math bowling, geometric shapes bingo, clock, math puzzle, and sum game. Some I already had at home, but others I made myself.

I decided to experiment with two students that I tutor at home, both are seven years old, Pedro and Bento, in the first year of elementary school. They do not have much learning difficulty, so everything went well in the development of the activity.

Among these games, the one that was most successful was Math Bowling; they loved the experience of being able to experience these games. They found them very cool and different. The experience of the Troubleshooting Math Box, especially in the classroom, can be a great way to work with children in a more fun, light way, and to awaken their interest in liking mathematics. (Adyla, Specialization student, narrative, December 2020)

- The Troubleshooting Math Box is of utmost importance, because besides bringing some organization to the teacher's material, it awakens curiosity in the student and interest in knowing which material we will use today. Moreover, it allows the student to get to know the mathematics that is present in our daily lives, because by using this material we can handle, get to know, see, exchange ideas, ask questions, make comments about moments when we used this material, among other things.

We believe that the experience of the Box was great for online classes, because it was a moment of relaxation, knowledge, conversation and fun, but we affirm that





for face-to-face classes, it would be much more fruitful. (Specialization student Ana Carla, narrative, Dec. 2020)

- The activities carried out with the Interactive Math Box were chosen considering the children's interest, needs and stage of development. The moments of interaction and construction of learning were carried out collectively and cooperatively, because the games, the constructions and the games collaborated for exchanges, comparisons and discoveries of strategies, even remotely, sometimes in the online class, sometimes with the families. (Student of Specialization Alexandra, narrative, Dec.. 2020)

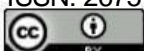
In the students' narratives we notice different theoretical-methodological perspectives in the dynamization of the Mathematical Problem Box in online classes due to the Covid-19 pandemic. They reveal in the shared experiences interactive, dynamic and mathematical learning moments. Moreover, they highlight the curiosity of the participants in the experience of this didactic-pedagogical-playful resource.

Alexandra and Adyla highlight the tendency of Math Education towards Games and portray its approach to the children's universe. Ana Carla emphasizes the possibilities of exploring the History of Mathematics Education, relating everyday materials to the construction of mathematical concepts. Alexandra also reminds us that children go through stages of development that require the manipulation of resources from their cultural practices, bringing them closer to Ethnomathematics. It also leads us to think about the Digital Information and Communication Technologies (ICT) that became more urgent during the ERE, showing that the Interactive Math Box adapts to different contexts.

4 Concluding remarks

The shared experiences show us the diverse possibilities of giving new meaning to the dialogical moments creatively invented to make the Troubleshooting Math Box more dynamic in training and teaching practice. This didactic-pedagogical-playful resource allows us to (re)think about teaching practices in mathematics.

Each resource contained in the Troubleshooting Math Box makes it possible to teach and learn mathematical concepts and content in an investigative, playful and dynamic manner. In effect, sharing, dialoging, and giving new meaning are verbs that are revealed and forged in lived experiences and in the memories of learning that will constitute new ways of looking at and experiencing methodological resources for the teaching-learning processes of mathematics.





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11

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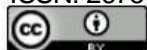
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