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Mathematics exhibition as a formative space: PET Matemática as a policy for strengthening degrees

Mostra de matemática como espaço formativo: PET Matemática como política de fortalecimento das licenciaturas

Feria de matemáticas como espacio formativo: PET Matemática como política de fortalecimiento de las licenciaturas

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Abstract: In this paper, we analyze aspects related to the initial education of prospective teachers in a mathematics teaching degree course who participated in the construction, organization, and execution of a mathematics exhibition based on the Programa de Educação Tutorial (PET) [Tutorial Education Program]. We present and analyze how a team of professors and prospective mathematics teachers from a public university in Minas Gerais developed an itinerant mathematics exhibition focused on teaching mathematics while highlighting diversity. This is a qualitative research, and data was collected through questionnaires answered by the prospective teachers participating in the project. In the analysis, we bring the mathematics exhibition as a training space and discuss the process of preparing and executing activities in schools. The paper brings different perspectives on how an action between the university and school, which we consider a space for strengthening teaching degrees, can influence teacher education.
Keywords*:* Mathematics exhibition; Mathematics teacher education; Public policy; Diversity.

Resumo: Neste texto analisamos aspectos relacionados à formação inicial de estudantes do curso de licenciatura em matemática que participaram da construção, organização e execução de uma mostra de matemática a partir do Programa de Educação Tutorial (PET). Para isso,

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apresentamos e analisamos como uma equipe de docentes do ensino superior e futuros professores de matemática de uma universidade pública de Minas Gerais desenvolveu uma mostra itinerante de matemática, voltada ao ensino de matemática, com olhar atento à diversidade. Trata-se de uma pesquisa qualitativa e os dados foram coletados por meio de questionários respondidos pelos futuros professores participantes do projeto. Na análise, trazemos a mostra de matemática como espaço formativo e discutimos sobre o processo de elaboração e execução das atividades nas escolas. O texto traz diferentes perspectivas de como uma ação entre universidade e escola, que consideramos um espaço de fortalecimento das Licenciaturas, pode influenciar na formação docente.
Palavras-chave*:* Mostra de matemática; Formação de professores de matemática; Política pública; Diversidade.

Resumen: En este articulo analizamos aspectos relacionados con la formación inicial de los estudiantes de matemáticas que participaron en la construcción, organización y ejecución de una feria de matemáticas desde el Programa de Educación Tutorial (PET). Así pues, presentamos y analizamos cómo un equipo de profesores de educación superior y futuros profesores de matemáticas de una universidad pública de Minas Gerais desarrolló una feria itinerante de matemáticas, centrada en la enseñanza de las matemáticas, con atención en la diversidad. Se trata de una investigación cualitativa y los datos fueron recogidos a través de cuestionarios respondidos por los futuros docentes que participan en el proyecto. En el análisis traemos la feria de matemáticas como espacio de formación y discutimos el proceso de preparación y ejecución de actividades en las escuelas. El artículo presenta diferentes perspectivas sobre cómo una acción entre universidad y escuela, que consideramos un espacio de fortalecimiento de las licenciaturas, puede incidir en la formación docente.
Palabras clave: Feria de matemáticas; Formación de profesores de matemáticas; Política pública; Diversidad.

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Introduction

In this text, we present how a team formed by higher education professors and prospective mathematics teachers participating in the Programa de Educação Tutorial (PET) [Tutorial Education Program] of a public university in the state of Minas Gerais proposed a mathematics itinerant exhibition visiting several primary schools in the local city with several activities to teach mathematics to all, keeping a close eye on diversity[5]. We discussed the influence on prospective teachers' initial education, highlighting the importance of projects that strengthen teaching degrees and promote learning in practice, specific knowledge, collective work, research, and teacher education, aiming to impact classrooms positively.

[5] Throughout the text we use the term diversity based on the principles of critical mathematics education.

ISSN 2238-8346
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The PET is linked to the Ministério da Educação (MEC) [Brazilian Ministry of Education]. It is developed by groups of teaching degree students —whom we call PETians—at the country's higher education institutions under the supervision of a responsible professor and includes actions related to extension, research, and teaching. The program's objective is to guarantee that PETians have experiences they do not live in conventional curriculum structures, aiming at their global education and favoring the education process (Brasil, 2006).

The planning and execution of integrated and coherent activities in formative spaces —such as basic schools, in a way that expands the opportunities for knowledge construction towards teaching degree students' autonomy— are part of the precepts that should make up teacher education policies (Gatti, 2020). Although the new Diretrizes Curriculares para a Formação de Professores [Curriculum Guidelines for Teacher Education] (Brasil, 2024) bring controversies that will be discussed later, they emphasize the relevance of understanding the contents of the knowledge area and the appropriate strategies for teaching for cultural, ethnic, gender, social diversity with and without disabilities (Brasil, 2024).

In this context, we consider that the PET program is one of the actions developed by the Brazilian government towards formative policies that strengthen teaching degrees and contribute to improving the quality of public education in the country.

For the exhibition, actions were developed with teaching strategies aimed at contributing to the mathematics learning process for the diversity of elementary school students. We seek here to present the activities developed and discuss relevant aspects of the initial education of the PETians involved in the mathematics exhibition project "The Mathemaniacs" [Os Matemaníacos]. In what follows, we indicate the main theoretical-methodological references that guided our study, present the activities developed by the PET members, our analysis of the data, and the final considerations.

Initial Mathematics Teacher Education Policies

In recent years, we have witnessed curriculum reforms at a national level that have had an important impact on initial teacher education courses. The implementation of the Base Nacional Comum Curricular (BNCC) [National Common Curriculum Base] (Brasil, 2018) and the Novo Ensino Médio (Brasil, 2017) [New Secondary Education] also led to changes in the Diretrizes Curriculares Nacionais para a Formação de Professores [National Curriculum Guidelines for Teacher Education]. Based on Resolution CNE/CP n. 02/2019 (Brasil, 2019), which updates the Diretrizes Curriculares Nacionais para a

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Formação Inicial de Professores para a Educação Básica [National Curriculum Guidelines for Initial Teacher Education for Basic School] and establishes the Base Nacional Comum para a Formação Inicial de Professores da Educação Básica (BNC-Formação) [Common National Base for Initial Teacher Education for Basic School], repealing Resolution CNE/CP n. 02/2015, a greater emphasis on pragmatist education invalidates the collective construction promoted by Resolution CNE/CP n. 02/2015 (Gatti, 2020). Currently, Resolution CNE/CP (Conselho Nacional de Educação/Conselho Pleno) n. 4/2024 [National Education Council/Plenary Council] is in force, again impacting the national teacher education policy and reinforcing a pragmatist view of teaching practice.

As a government policy and not a State policy, the new Diretrizes Curriculares Nacionais para a Formação Inicial e Continuada de Professores [National Curriculum Guidelines for Initial and Continuing Teacher Education], Resolution CNE/CP n. 4/2024, demonstrate similarities between the 2015 and 2019 Resolutions and, according to the Note from the Associação Nacional pela Formação dos Profissionais da Educação (ANFOPE) [National Association for the Education of Education Professionals] and GT08 of the Associação Nacional de Pós-graduação e Pesquisa em Educação (ANPEd) [National Association of Postgraduate Studies and Research in Education], "tends to seem like bricolage, an improvisation, which is lost in a tangle of conceptual elements, referenced by prominent researchers in the country" (ANFOPE, 2024). The changes made to the Diretrizes Curriculares para a Formação de Professores [Curriculum Guidelines for Teacher Education] without debate and time to mature and analyze what had been done in previous resolutions highlight the secondary place that teacher education has occupied in national public policies.

Kuenzer (2024, p. 11) analyzes that Resolution CNE/CP n. 4/2024 resumes the pragmatist conception in teacher education since it deals superficially with "theoretical education, resulting in the absence of critical thinking, collective organization, and the creation of counter-hegemonic projects aimed at tackling inequality and social injustice." The author highlights that, as in previous resolutions, the new guidelines go against the education of reflective teachers (Schon, 2000), as they are centered on tacit knowledge, disregarding relevant issues regarding the complexity of teaching (Belletati; Pimenta; Lima, 2021).

The adaptations of teacher education policies to the neoliberal agenda show a lightening and favoring of private institutions in such policies (Jesus; Santos; Araujo, 2023; Rosa; Manzi, 2023) to propose a simplification of teaching, focusing on a technicist and instrumental vision and reduction of theoretical education (Bellatati; Pimenta; Lima, 2021). Those setbacks evoke discourses that recognize the teacher as a mere executor and, amid

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questions about teacher education, educational platformization policies stand out, as highlighted by Barbosa and Alves (2023), when investigating curriculum proposals from the governments of the states of São Paulo and Paraná, for example. The authors show that the adoption of digital platforms and the use of artificial intelligence based on the discourse in favor of efficiency "can result in new processes of regulation, surveillance, and control that result in the emptying of pedagogical work" (Barbosa; Alves, 2023, p. 21).

Bragança, Faria, and Pezzato (2023) invite us to reflect on the paths of insurgency, which oppose a curriculum policy for knowledge standardization. The authors highlight the need for actions that counter this political scenario, including broad education aimed at teaching and researching. Proposals such as that of the mathematics teaching degree course at the University of the Federal District (UnDF), which values interdisciplinarity and knowledge specific to teaching, for example, or actions such as those mobilized via the Programa Institucional de Bolsa de Iniciação à Docência (PIBID) [Institutional Teaching Initiation Grant Program], from which Souza and Macêdo (2023) infer the positive impact on teacher education and the insertion of prospective teachers in the school context, demonstrate possible paths in contrast to current policies.

Although teacher education has been neglected in terms of national public policies, initiatives in initial and continuing teacher education courses, school contexts, and daily routines based on insurgent teacher practices and in collective spaces for research and reflection on teaching highlight the relevance of insubordination, despite policies that weaken and devalue teachers. Like the initiatives listed here, we consider PET a space for strengthening initial teacher education and valuing knowledge specific to teaching (Peixoto; Cintra; Paulin, 2022; Souza; Gomes Júnior, 2015).

Prospective teachers' construction of a mathematics exhibition requires knowledge specific to teaching (Giraldo, 2018): knowledge of the mathematics curriculum, adaptation of activities according to the students participating in the exhibition, and a careful look at the proposal of inclusive activities. Indeed, Cintra and Penteado (2018) consider initial education an opportunity to bring about an understanding of teaching and learning situations for diversity, favoring the development of a critical attitude towards inclusive education —which, for Skovsmose (2019, p. 25), is "an education that tries to go beyond differences and not as an education that tries to include the disabled in normality," introducing the concept of an education that promotes the encounter between differences.

However, we also consider relevant the aspects related to the knowledge of prospective mathematics teachers widely discussed by Ribeiro (2012), who states that, in addition to knowing how to teach, they also need to know and be able to implement such teaching; that

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is, be able to explain the meaning of concepts and procedures to students and, also, choose appropriate situations and examples to teach.

Christopher *et al.* (2023), when analyzing the political-pedagogical projects of several mathematics teaching degree courses in Brazil, consider that there is a fragmentation in the initial education of mathematics teachers, considering that the curricula have been organized into blocks of knowledge that are barely articulated. Giraldo (2018, p. 39), in turn, states that the recognition of knowledge specific to the practice of teaching mathematics does not refer solely to the knowledge that the teacher must obtain but to the "possibility of arguing about the content, situated in an educational context, from the perspective of teaching, considering the objectives inscribed in that context."

The strengthening of formative spaces in teaching degree courses that promote interdisciplinary practices, spaces for sharing knowledge, research, and reflection on teaching practice, and bringing undergraduates closer to the school context are actions that oppose standardized policies for teacher education. Regarding mathematics teachers' education, Giraldo (2018) proposes an education process in which different types of mathematics are discussed and problematized. The author argues that spaces for recognizing different ways of mathematizing can contribute to teaching mathematics based on research and reflection on different ways of learning. In this case, spaces for discussion and sharing of ways of understanding mathematics and its teaching, such as those proposed from the construction of the mathematics exhibition, can provide space for what Giraldo calls problematized mathematics (Giraldo, 2018).

The Mathemaniacs

The project of the mathematics exhibition "Os Matemanícos" [The Mathemaniacs] aimed at disseminating different approaches to the understanding and application of mathematical concepts for the entire diversity of students in basic school and promoting integration between the university through the team formed by PET professors and students of the mathematics teaching degree course and basic school teachers and students —without leaving aside the dissemination of the mathematics teaching degree course for the community in general.

Twelve students (PET scholarship holders), the PET tutor professor, and three collaborating professors, all from the university, participated in the project "The Mathemaniacs." To create the activities, the group met and discussed theoretical and methodological issues related to the mathematics education area, the construction of teaching materials, and the school context and its subjects. This process of constructing

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the activities took place collectively, and different ways of understanding, teaching, and even different types of mathematics entangled during the meetings. Thus, the activities were collectively discussed, problematized, analyzed, and validated by the entire group, with a close eye on teaching mathematics for diversity, prioritizing learning for all students. Twelve activities, which we present below, were prepared between May and November 2023. "The Mathemaniacs" exhibited at nine different times/places, including six public schools, one private school, and two university events (career fair and "getting to know the Institute"). All these moments were recorded and shared on the group's and the university's social media. The activities were:

- Geometric Hologram: works with different geometric solids. Several geometric solids are presented in three dimensions through a homemade hologram projected by a tablet. The activity briefly explains what geometric solids are and how the hologram works.
- In Search of the King: in this activity, we work on logical reasoning through the game of chess and its mathematical concepts. We begin by explaining the rules and the proposed problem involving two knight pieces and a king positioned on specific squares on the board. Students compete to find the shortest path to capture the king without the knights capturing each other.
- Caesar's Cipher: in this activity, we present the historical context of Caesar's Cipher, one of the oldest encryption methods, and explain the process of encrypting and decrypting messages by replacing letters of the alphabet using a circular table and a predefined cryptographic key. We discussed mathematical concepts related to ciphering and challenged students to decipher some encrypted messages.

Figure 1

Source: Authors' archive (2023).

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- Tower of Hanoi: this game works on geometric progression and consists of moving discs from one rod to another, following specific rules, such as moving one disc at a time and never placing a larger disc on top of a smaller one. In this activity, interesting facts about the game are presented, and students are encouraged to solve the puzzle while the teacher explains the mathematical processes present in the game.
- Remove the Ring: in this activity, we seek to stimulate students' logical reasoning to remove a ring attached to an elastic band supported by two rods. Here, we comment that the deformation and twisting of objects are studied by topology, a branch of mathematics.

Figure 2

Source: Authors' archive (2023).

- Metric Mathemagic: an activity that works with natural numbers and operations through a special sewing tape, in which the sum of the numbers on the front and back always results in 101. At least three students participate in the activity, with two holding the ribbon and one placing the markers. Students make up to five marks on the tape and add up the numbers marked, keeping this value secret. Then, the PETian reveals the value found and explains that to determine this value, one should multiply the number of markers by 101. This technique is known as "Gauss sum," observed by the German mathematician Carl F. Gauss when he was still a child, present in arithmetic progressions.
- Geometric Puzzle: this activity presents one of the demonstrations of the Pythagorean theorem through exploration. Here, we use the idea of Tangram to challenge students to demonstrate the Pythagorean theorem formula, moving the pieces formed by the areas of the squares of the legs to the area of the square of the hypotenuse.

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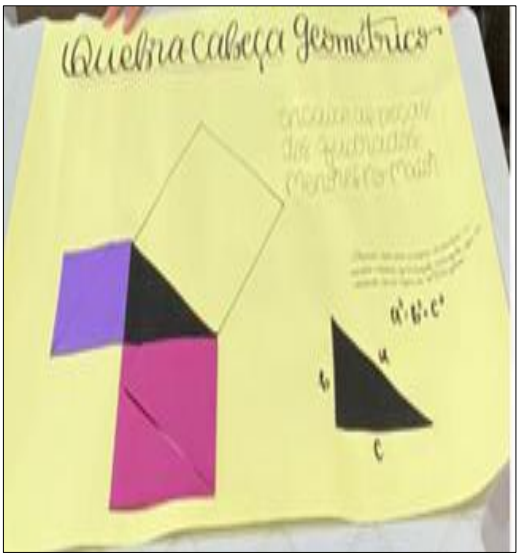
Figure 3



Source: Authors' archive (2023).

• Are Appearances Deceiving?: in this activity, we work on spatial geometry, exploring and investigating the capacity and volume of cylinders. Two cylinders are presented, constructed from an A4 sheet, in vertical and horizontal positions. The main issue is to determine which cylinder has the largest volume and to observe the implications of the radius and height in the formula for calculating the volume of the cylinder.

Figure 4

Source: Authors' archive (2023).

• The Shell Game: an activity that works on probability, created from the problem known as Monty Hall's paradox, consisting of finding a ball hidden under one of three pots. After the student chooses one of the possible pots where the ball is, an empty pot is revealed,

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and the student is asked if he would keep his choice or if he would like to change pots. At this point, through probability theory, it is explained to players that changing the pot increases their chances of finding the ball.

- Mathemagic: an activity that uses geometric progressions to determine a number between 1 and 127 with the help of seven cards with these numbers organized strategically. A student chooses a number between 1 and 127 and points to the cards that contain this number. After this step, the chosen number is revealed, and the "trick" is elucidated, showing that every number from 1 to 127 can be determined by adding the terms of the geometric progression {1,2,4,8,16,32,64}, which are present at the beginning of each of the cards.
- The Egyptian Square: in this activity, we work on plane geometry, using a rope divided into 12 equal parts to explore right-angled triangles, improving students' geometric perception and developing logical and mathematical reasoning.
- The Curves: here, we seek to relate mathematics and physics through an experiment where three paths are given: the brachistochrone curve, a straight line, and a parabola, and students are asked to guess which of these paths a ball dropped from the top reaches the base of these curves faster. Thus, we present the brachistochrone problem, which consists of obtaining a curve that minimizes the time a particle, under the action of gravity, takes to travel from a higher point to a lower one. We then explain that this curve can be obtained from a cycloid, the trajectory of a point fixed on a circumference rolling along a straight line without slipping.

Figure 5

Source: Authors' archive (2023).

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During the presentations of the activities at the exhibitions, the students were involved in a teaching and learning environment promoted by discussions on the topics addressed.

Thus, through qualitative research, besides observing the construction, organization, and execution of the mathematics exhibition activities, we applied questionnaires after the project had completed one year of its execution to investigate relevant aspects of the initial education of the undergraduates when participating in the project. The questionnaires asked open questions addressing undergraduate students' understanding of the activities developed, the execution moments, and the impacts of this process on the undergraduate students' education. According to Goldenberg (2004), there is no single model for conducting research since the data is not standardized; one is not tied to a model, the methodology is flexible and can be conducted through different paths. Therefore, we bring an analysis of the impressions produced by the PETians participating in the project[6] about the production and application of the activities that made up the mathematics exhibition.

The organization and categorization of data was based on an a posteriori data analysis and according to the research objective, in which we seek to deepen the understanding of the phenomena investigated based on rigorous and careful data analysis (Moraes, 2003). Thus, we bring the mathematics exhibition as a formative space. For this, we present reflections on the organization of the planning process, the preparation of activities, and the execution of the exhibition in schools. To this end, such data were organized into three analysis categories, which we call: "The PET members in the planning and preparation of activities," "Mathematics exhibition as a space and approximation between university and school," and "Contributions to the initial education of PET students participating in the research."

The PET members in the planning and elaboration of activities

To prepare the activities, the PET members were invited to prepare short math activities so that the students from the schools could participate in all of them during the exhibition. It was up to each student to choose the theme they wanted to address. Regarding this process, PET student André states that he sought to choose an activity "[…] that related to my tastes and personality in a way that also dialogued with mathematics. So, I was faced with a choice between working on something that involved programming, or chess, or fractals, which are things I like and that have a connection with mathematics. I decided on chess."

[6] We use fictitious names to preserve the identities of the prospective teachers: Alice, André, Camila, Irene, Tadeu, and Valdir. This information does not harm data analysis and qualification.

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For the choice of themes, at several moments in the PET members' speeches, we found a background involving their customs, origin, and "cultural baggage" (Skovsmose, 2004). As Camila explains, "The activity I created is a logical reasoning game that I played as a child and always liked, I wanted to bring it because it is a very usual topic, especially in tests and competitions." In this sense, André also states: "It was fun and easy to develop my activity because I like chess, and I found an exercise that involved chess and logical-mathematical reasoning."

We also detected the foreground, which concerns those individuals' opportunities, hopes, aspirations, and expectations (Skovsmose, 2007). About the activities they were developing, Valdir explains:

> [...] I thought about how it would be possible to attract the attention of the students in the schools we would visit, since mathematics can be seen as something difficult and uninteresting for some of them. With this in mind, I tried to work with an activity involving magic and mathematics, since magicians tend to be curious and I hope they like it.

Critical and constructive attitudes were also present, especially in view of the power of creation and adaptation of activities, as we can see in Irene's speech:

> I found an activity that simulated a demonstration of the theorem we know as Pythagoras', which used acrylic boxes to show that the square on the hypotenuse of a right triangle has an area equivalent to the sum of the squares on the legs of the triangle. However, the use of acrylic was unfeasible, so I tried to adapt the material with cardboard.

Paying close attention to the diversity of students in the different schools the exhibition would visit was also essential in this process. In this regard, Eduardo argues that: [...] One of the points I considered most when preparing my activity was that the exhibition would be presented to students of different ages and school grades. With that, I decided that the main theme of my activity would be logical reasoning."

Furthermore, they bring a close look at the participation of students with disabilities in activities:

> The process of preparing the activities, considering the different scenarios and types of students, was of great importance, as we put into practice what we saw throughout the undergraduate course, about texts that talk about diversity and inclusion, and we can see that even having read about the subject, I still had difficulties (Alice).
>
> I proposed a very visual activity with concrete material, working with volume, thinking about the possibility of expanding the learning possibilities of any student (Tadeu).

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By working with visual resources, as Sales (2013) indicates, we offer deaf students the possibility of overcoming hearing limitations and developing their knowledge about the world, connecting it to imagination, language, and reality. We also highlight the importance of a Brazilian Sign Language (Libras) interpreter to help deaf students understand the objectives of the activities.

The process of developing the activities also caused discomfort among the PET students, as they had difficulty organizing ideas for developing the activities, as Rubens reveals: "Developing an activity for the exhibition proved to be a difficult task, as bringing something accessible to students that, at the same time, had a good reference to mathematics is not a simple thing." This obstacle is not surprising. The literature tells us that most students have difficulty starting work differently than they are used to, as they tend to repeat what the teacher does and are not used to conjecturing their own ideas (Skovsmose; Penteado, 2007).

We highlight the need to prepare and study the mathematical content to be discussed in each activity, which involves the development of logical mathematical reasoning. As Rubens explains, "The mathematical content involving my activity on curves is complicated and I had difficulty understanding it, but with the help of the teachers, it became easy." Ana also reveals that "My activity involving geometry made me seek knowledge about the solids presented in the hologram and served to consolidate the content for me." The statements align with Ribeiro's (2012) notes on the specific knowledge of mathematical content on the part of PET students.

We realized that the difficulties were being reduced through the collective work of the entire group; as Irene mentions: "Thinking of something attractive and that brought cool mathematical knowledge was difficult for me, and everyone in the group helped me." From the meetings and negotiations of knowledge, it was possible to establish a space for individual and collective learning, according to Souza Jr. (2000), as each person involved contributed to the formation and development of the learning of the group members, reflecting collectively and systematically. Arthur highlights this moment of socialization and exchange of knowledge: "In addition to developing my activity, I participated in discussing all the other proposals and defining which ones would be selected for the exhibition. This moment was very interesting; everyone helped each other."

We understand that the entire process of preparing activities for the exhibition mobilized actions by the PET members, such as selecting and prioritizing information on mathematical content, deepening mathematical knowledge, making decisions, confronting ideas, and managing time and collective work.

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Mathematics exhibition as a space for bringing universities and schools closer together

The participation of undergraduate students in school contexts and the problematization of these contexts in a dialogue between theory and practice should be prioritized in teacher education policies. Currently, we have formative policies centered on neoliberal agendas and little commitment to the complexity of teacher education. Even though these scenarios do not prioritize dialogic and liberating education (Freire, 1987), complementary teacher education spaces have proven fruitful for autonomous practices that provide prospective teachers with spaces for reflection, research, and problematization of teaching knowledge.

As mentioned before, PET mathematics has been committed to promoting interdisciplinary formative spaces that provide a closer relationship between undergraduate students and basic school. In this investigation, it was possible to notice that some PET students had never participated in activities linked to schools, which was worrying, considering that some of these students are approaching the halfway point of the mathematics teaching degree course:

> I had never had contact with students at school, especially bringing mathematics in a different way, in practice. I really enjoyed participating and I will take this experience with me throughout my professional life (Camila).

Cristovão et al. (2023) argue that the 3 + 1 model still prevails in different mathematics teaching degree courses. The authors reinforce the need for specific issues relating to the classroom context to be addressed from the beginning of initial education courses to bring graduates closer to the school reality. Including prospective teachers in basic schools can enable relevant reflections on the appropriation of knowledge specific to teaching. The concern of a PET student refers precisely to the insecurities about this process of rapprochement between university and school when asked about how she felt after the first activity of the exhibition: "Anxious to know how the students would interact, their disposition if they would understand our activities" (Alice).

We corroborate Giraldo's (2018) emphasis on the need to educate mathematics teachers based on the articulation of different mathematical knowledge. The author proposes the term "problematized mathematics" for mathematical practices that require reflection, hypothesis raising, and questioning on the part of teaching degree students. The problematization of actions based on mathematical practices requires broad education that is concerned with the entire teaching process, not solely with specific mathematical content.

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PETian José's speech shows that the preparation, selection, reflection, and organization of learning situations is a complex process:

> In my opinion, experimentation, putting into practice what was developed and planned, was the most difficult stage of the process, it took a long time to get used to the students, but when I got into the rhythm and adapted, everything went well and my participation in the project became very rewarding (José).

Gatti (2020) reinforces that educational practices imply involvement, motivation, joy, and anguish for everyone involved. According to the author, "Understanding and discussing them as human relational practices with specific intentionality demands broad philosophical, didactic, pedagogical, curricular, psychosocial, and educational perspectives" (Gatti, 2020, p. 17).

A dialogical education, with the promotion of theory-action-practice-reflection relationships proposed by Gatti (2020), requires new teaching knowledge, not just specific mathematical knowledge. Most of The PETian students are good and probably have specific mathematical knowledge, but they demonstrate difficulties in promoting mathematical activities for basic school.

The PET members also mentioned resistance on the part of basic education students in relation to the mathematical activities proposed in the exhibition. André highlights that students show curiosity; however, "When it comes to activities that they have no rapport or interest in, they end up not even giving the activity a chance." The prospective teacher's notes refer to the students' rapport and interest in mathematical activities, although they do not consider these students' history with school mathematics. The conception of a ready-made and neutral science, often conveyed in schools, ends up distancing our basic education students from new ways of relating to mathematics (Pompeu, 2022):

> The first reaction of the students to any school that hosts the exhibition, from what I've noticed, is to think that they either can't solve it or that they're bad at math. And when they manage to solve the issue and understand the activity, they are always very satisfied. I think these exhibitions play an important role in this aspect: demystifying the monstrous mathematics that students see and making them see it as something interesting and even fun, over which they can indeed have control (Valdir).

For us to advance on the relevance of problematizing and demystifying the idea that mathematics is complex, Giraldo (2018) defends the urgency of rethinking the conceptions of mathematics conveyed in mathematics teaching degree courses, since the following prevails:

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> [...] A culture that [states that] the presentation of mathematics in a problematized way would imply a "weakening" of the content [...]. This culture is based on the premise that mathematical knowledge is produced in a linear and unproblematic way –which is not true even for the historical processes of production of mathematical knowledge (Giraldo, 2018, p. 42).

Promoting other conceptions of mathematics in mathematics teaching degree courses can promote new directions for mathematics education in basic school. Experiences such as the mathematics exhibition allow prospective teachers to (re)consider their own conceptions of mathematics and teaching, and, based on collaborative scenarios, they can gradually become teachers in a dialogical and reflective way.

Contributions to the initial education of the PET members participating in the research

We believe that the actions developed throughout the work involving the mathematics exhibition generated new knowledge that influenced the PET students' initial education –and we will discuss this new knowledge below.

When asked about their participation in the project and its influences on their initial education, the PET students highlighted the importance of these experiences as a way of experiencing situations that may be present in their future teaching practice. As Irene argues: "Direct interaction with students in schools provided a fundamental experience, showing me the needs and challenges that we can encounter as teachers. Sometimes, I needed to adapt my teaching strategies to make them more effective for the student to understand."

Thus, we noticed that, during the presentations of the activities, at various times, the PET members found themselves faced with the need to adapt the way they were explaining, i.e., to promote new ways of teaching the content, directly influencing the PET members' teacher education, as Camila emphasizes.

> Through interaction with students of different school levels, personalities, and tastes, I could improve my didactic communication as a teacher, as well as better understand each student's needs, adapting to everyday situations, changing the way I explained when I realized that they were not understanding my explanation. Through these moments, I can increasingly improve my strategies and adaptations in the activity so that mathematical development is more accessible to everyone. I conclude that, from participating in the project, I could learn a lot about the elements and perspectives that permeate the environment of a prospective teacher.

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This perception of the need to teach in different ways experienced by PET members is in line with Ribeiro's (2012) arguments when dealing with formative courses, as it highlights the importance of preparing prospective teachers to know and be able to use the mathematics necessary for teaching.

Regarding the PET members' aspirations on the project emphasizing the opportunity to work with basic education students in their initial education, their speeches' foreground revealed expectations and hopes (Skovsmose, 2004). José says the project "[...] awakened in me the desire to work with mathematics in different ways as a teacher. It allowed me to deal with students in a relaxed way, with a lot of purpose and responsibility, and I hope to be able to work like this as a teacher. Eduardo emphasizes that the project "[...] was of enormous importance for my teaching education, in addition to promoting and developing my taste for the school environment, thus making me a better student and a more capable and focused future professional; that's what I want to be."

We identified the interest in interdisciplinary work, which arose from the different activities since, in general, we can also relate mathematics to other sciences, as we can see in the statements: "The exhibition encourages us to carry out interdisciplinary projects outside the traditional education models to capture the attention and explore the curiosity of students in certain mathematical content and activities" (Tadeu). Luís argues, "My activity also has a history, the need to create cryptography to transmit information in the past." Furthermore, Raul adds: "In addition to explaining the mathematics behind understanding the activity of curves, there is also physics to explain the movement of each curve," which aligns with what Giraldo (2018) comments about strengthening formative spaces throughout teaching degree courses that promote interdisciplinary practices, with sharing of knowledge and reflection on teaching practice.

Regarding the importance of the mathematics teaching degree course, they reported how they put into practice what they learned during their initial education, Alice says: "I was able to see how valuable the use of concrete materials and different teaching methodologies are, where the concepts and students' learning make more sense to them, as we learned in undergraduate studies."

For many, participating in "The Mathemaniacs" was the first opportunity to be in contact with basic school students, and we noticed that it had a positive impact on the PETians, reducing their anxiety for when they were in the practicum.

> "The Mathemaniacs" is extremely important for my professional education because before the practicums, my only contact with the teacher and the students was in the mathematics exhibitions, where I could try to transmit my knowledge to the students, [...] and this helped in my academic education as a prospective teacher, and when I started the practicum, I became less apprehensive about being at school (Lourenço).

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> I believe that participating in the project was an excellent opportunity to have contact with basic education during my education and that it started before the practicums, which helped a lot (Aline).

The importance of the moment of preparing the activities as part of the initial teacher education was evident in the speeches, as Irene mentioned: "This work allowed me to improve my pedagogical skills by challenging me to create and present activities that make mathematics more accessible and interesting for students." We corroborated Giraldo (2018) on problematized mathematics in a way that requires teaching degree students' reflection. Moreover, regarding the attentive look toward inclusive education, Aline highlights: "An important point was the elaboration of the activity and thinking about teaching for diversity, which is not easy, and we were able to put into practice several texts that we read throughout the degree, thinking about an education for all."

We realized that this inclusive perspective when preparing and adapting activities was important during the demonstrations in schools, and the PET students noted the importance of understanding inclusive education as an encounter between differences, as proposed by Skovsmose (2019), as seen in Irene's words:

> For my initial education, it was very important to have this contact with different types of students with and without disabilities because in the undergraduate course, we study some teaching methods that can be used to include students with disabilities, but when we are actually in the position of a teacher in an inclusive school, we realize the difficulty we have in being able to teach everyone. So, this contact with students with disabilities is critical so that we can understand how we can explain in a way that these students can understand. My experience initially was not very good, I had to change my way of teaching many times. I ended up getting confused when trying to make it more didactic, it was complicated, it's a good experience, and I also had the opportunity to learn how to deal with my anxiety so I could teach math to everyone.

We highlight that the project involves PET students in their initial education with educational, methodological, and technological issues and is meeting our expectations that all this work will have a positive impact on the school classroom, as we can see in Valdir's statement: "In fact, now working as an education professional, I had the opportunity to use the magic I presented in the exhibition for my own students during a Talent Show held at the school where I work."

We understand that the work made it possible, as Cintra and Penteado (2018) recommend, to insert prospective teachers in different contexts, thus reflectively mobilizing their knowledge, bringing new knowledge about teaching. In effect, it favored the initial education of PETians regarding the development of a critical attitude toward education for all, the development of strategies, and the search for and socialization of knowledge.

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Final considerations

This text gives an idea of the paths taken by a team in search of achieving specific objectives in a government project, which we consider a political space for strengthening undergraduate courses and, in particular, mathematics teachers' initial education.

The team's work, from planning to executing the mathematics exhibition in schools, with a close eye on diversity, provided new learning experiences for the PETians' teaching. Furthermore, although there are different initiatives to weaken teacher education policies, the promotion of formative spaces centered on reflection, research, and specific knowledge for teaching, as advocated by Bragança, Faria, and Pezzato (2023), proves to be a fruitful path for problematizing new conceptions of teaching and mathematics.

We believe that participation in an interdisciplinary program such as PET and, in particular, in the construction and execution of the mathematics exhibition, promoted the approximation of the prospective teachers with the school context and its complexity: the adaptation of activities to the diversity of students in basic education, difficulties related to teaching, and frustrations regarding students' interest, among other factors. This experience throughout the exhibition promotes the articulation of actions with the school, "leading prospective teachers to diversified experiences, developed in co-participation to create meaningful learning environments for the school's students" (Gatti, 2020, p. 21).

We highlight the importance of government projects of this nature because, besides promoting experiences not present in conventional curricular structures, they provide knowledge of specific content, collective work, research, teaching, and extension, which, as Giraldo suggests (2018), enables the creation of spaces for discussion and sharing of ways of understanding mathematics and its teaching. Furthermore, they involve teaching degree students in educational and methodological issues, so we expect them to positively impact school classrooms by influencing teacher education.

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