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Actions of a Trainee Teacher in Orchestrating Mathematical Discussions

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Abstract

Background/purpose. This article aims to identify and analyze the actions of a trainee teacher in orchestrating mathematical discussions in an Exploratory Teaching environment.

Materials/methods. This qualitative study of an interpretative nature and case study design focuses on analyzing the content of four Multimodal Narratives.

Results. The results show that the predominant actions focus on questioning to foster understanding. In the sessions where the students experienced the most difficulties, it proved necessary to interpret the interactions with the students and between the students by attributing meaning and sense to the different interactions. There was a need for the trainee teacher to understand the students' strategies better and to reflect on the questioning strategies. The characteristics of Exploratory Teaching facilitated actions related to the systematization of learning. The phase of systematizing mathematical learning led the trainee teacher to actions related to systematizing learning. Finally, the absence of some actions reinforces the importance of reflection for professional development.

Conclusion. These results indicate that during the orchestration of collective discussions, the teacher's main actions center on questioning and asking for clarification to interpret interactions with and between children. The study also shows that Exploratory Teaching helps to systematize learning, such as revisiting and summarizing the main topics of the discussion and recovering students' prior knowledge. The absence of some actions leads us to believe in the importance of analyzing and reflecting on practice for teachers' professional development.

1. Introduction

Learning to teach is a highly complex and challenging for trainee teachers (Stavridis & Papadopoulou, 2022). So, analysis and reflection on practice are essential for the professional development of teachers, especially student teachers (Borko et al., 2014; Stein & Smith, 2009). Learning to question, listen, understand children's strategies and foster interactions in the classroom is a crucial skill for teachers (Carvalho & Ponte, 2013).

Managing discussion moments in the classroom is a complex process for teachers (Gomes et al., 2023). For prospective teachers, managing these moments is particularly challenging (Martins et al., 2024) due to the difficulty they experience in predicting children's problem-solving strategies. The same authors note that future teachers struggle to anticipate questions that could help clarify children's doubts. Similarly, Faria et al. (2024) point out that questioning during discussions is a complex challenge for teachers.

In this context, when teachers investigate their practice, they engage in introspection and reflection conducive to their improvement (Vilelas, 2020), allowing them to think critically about how they teach (Stein & Smith, 2009). Reflection on practice is considered a means of developing teachers' professional knowledge (Martins et al., 2024). Professional knowledge encompasses various aspects, with the development of practical teaching knowledge being fundamental. This enables teachers to manage classroom activities effectively, creating learning opportunities for children (Martins et al., 2024; Ponte, 2012).

Collective discussion plays a significant role in mathematics learning (Guerreiro et al., 2015; Stein et al., 2008). Gomes et al. (2023) highlight that guiding a discussion is challenging, as it requires teachers to understand children's strategies and encourage them to listen to and analyze their peers' approaches.

According to Rodrigues et al. (2020), more is needed to know about how teachers manage moments of collective discussion. In this context, the following research question arose: What actions does a student teacher take while orchestrating collective discussions using an Exploratory Teaching approach? The analysis used a reference framework for classifying teacher actions during collective discussions, adapted from Ferreira et al. (2023).

This study shows the type of actions that a trainee teacher (TT) takes during the orchestration of collective discussions. During these moments, the teacher's main actions center on questioning and asking for clarification to interpret interactions with and between children. The absence of some actions leads us to believe in the importance of analysing and reflecting on practice for teachers' professional development, as can be seen in the study of Stavridis and Papadopoulou (2022). Finally, the study also shows that Exploratory Teaching (ET) helps to systematize learning, such as revisiting and summarizing the main topics of the discussion and recovering students' prior knowledge.

2. Literature Review

Mathematical discussions in the classroom can enhance and promote children's learning, allowing them to share, justify, argue, and systematize the mathematical reasoning derived from the tasks they perform in class (Rodrigues et al., 2018). Carvalho and Ponte (2013) emphasize that promoting reflection during these moments is essential for exploring and giving meaning to mathematical concepts. Carvalho and Ponte (2013) highlight the preparation of discussions as a crucial action for their successful implementation, as anticipating them enables teachers to reflect on how, when, and why they should question children (Carvalho & Ponte, 2013).

In ET, children's learning occurs not only through the tasks carried out by the children but also through the exchange of ideas and discussions between children and teachers (Oliveira et al., 2013;

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Rodrigues et al., 2020). In a class of this type, there are moments of collective work, where the children work autonomously while the teachers monitor the children's work and guide them when necessary (Oliveira et al., 2013). According to Canavarro et al. (2012), an ET lesson has four phases: Introduction of the task, Development of the task, Discussion of the task, and Systematization of mathematical learning. In the Task Introduction phase, the lesson's objectives and the tasks that will be developed are presented. In the Task Development phase, the children actively and autonomously solve the proposed tasks. In this phase, teachers monitor the children's work, guiding them whenever necessary. The children's different solutions are shared, compared, and discussed in the Task Discussion phase. In the Systematization phase, a summary of the content worked on throughout the lesson, including establishing connections with previous learning (Canavarro et al., 2012; Oliveira et al., 2013).

Collective discussions play a fundamental role in constructing mathematical knowledge, allowing children to better understand concepts through the sharing and negotiating meanings (Guerreiro et al., 2015; Stein et al., 2008). In the study by Freitas et al. (2024), we found that ET allows for better lesson structuring. Moreover, the moment of discussion was essential for building students' knowledge. However, discussions in class are often a challenge for teachers, as it requires them to be able to guide the discussion so that it is mathematically productive (Ferreira et al., 2023; Stein et al., 2008). Freitas et al. (2023) propose the creation of an educational roadmap to help teachers manage moments of sharing and discussion.

According to Guerreiro et al. (2015), teacher mediation is necessary during collective discussions, as these do not occur spontaneously. In this way, teachers play an essential role in managing the discourse through the questions they ask and the moments they create to include children in the discourse (Rodrigues et al., 2020).

Collective discussions begin with the presentation of ideas and then reflection on the children's reasoning (Rodrigues et al., 2020). Teachers should, therefore, encourage children to share their ideas (Brodie, 2010). During collective discussions, questioning plays a key role (Ponte et al., 2013). In the study by Faria et al. (2024), teachers used questioning to involve them in the discussion. The questions asked by teachers vary throughout the orchestration of this moment, involving questions of verification or confirmation, focus, reflection or inquiry, and provocation (Carvalho & Ponte, 2013; Guerreiro et al., 2015; Rodrigues et al., 2020). Initially, the questions relate to aspects of the shared resolution and later include connections between the resolutions (Rodrigues et al., 2020). Verification or confirmation questions aim to assess children's knowledge. These questions usually involve a short, immediate answer and serve mainly to guide the way children learn (Rodrigues et al., 2020). The answers given by children who want to complete an answer initiated by teachers also come from this type of question (Rodrigues et al., 2020). According to Ponte et al. (2012), verification questions, i.e., when teachers ask a question, listen to the child, and then make an assessment, do not encourage children's creative participation. Focus questions focus the child's attention on a specific aspect. Reflection or inquiry questions challenge children to explain their reasoning so that they develop a deeper understanding of ideas and engage in discussion (Carvalho & Ponte, 2013; Rodrigues et al., 2020). These types of questions encourage a variety of answers (Ponte et al., 2012). Finally, provocative questions invite children to consider and evaluate their peers' ideas (Rodrigues et al., 2020). This type of question makes it more likely that children will be involved in the discussion (Brodie, 2010).

During the collective discussion, teachers develop a set of actions, such as inviting, challenging, supporting/guiding, and informing/suggesting (Carvalho & Ponte, 2013; Ponte et al., 2023). The study by Ponte et al. (2013) found that the actions Support, Suggest, Challenge, and Invite often occur during the orchestration of discussions. Gomes et al. (2023) used Invite, Challenge, and Support actions to encourage children to explain their solutions and access their thinking. According to Gomes

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et al. (2023), the Inform/Suggest and Support actions occur mainly when introducing concepts. In the same study, the teacher used the Support action to help the children explain their ideas. The study by Ponte et al. (2013) observed that action Support appears more frequently when children experience difficulties, which makes it necessary for teachers to provide support so that children can overcome these difficulties. For the discussion to become productive, teachers not only need to challenge the children and ask them for explanations, but they also need to introduce information so that the children continue to participate (Gomes et al., 2023).

In the study by Ferreira et al. (2023), the practices of a mathematics teacher educator during the orchestration of collective discussions in a training context are investigated, resulting in a general reference framework. Five leading practices were identified and categorized: (i) Establishing a learning community, (ii) Interpreting interactions with teachers and between teachers, (iii) Establishing connections, (iv) Challenging teachers to advance their knowledge and (v) Systematizing learning. Each practice includes a set of actions by the trainer. This framework can help teachers in planning and orchestrating collective discussions, as it allows them to investigate and understand how teachers create and support learning opportunities during the orchestration of discussions (Ferreira et al., 2023). Thus, this study aimed to analyze the actions of a trainee teacher during the orchestration of collective discussions from an ET approach.

3. Methodology

This study is qualitative (Cohen et al., 2018), interpretive (Amado, 2017), and has a case study design (Amado, 2017). As this is a qualitative study, the TT and researcher were the primary data collection agents, using participant observation (Creswell, 2014). Field notes, documents produced by the children, photographs, and audio and screen recordings were collected throughout five sessions. All parents, children, and school authorities involved consented to this collection. The anonymity of the participants was guaranteed by complying with the Declaration of Helsinki and approved by the Ethics Committee of the Polytechnic Institute of Coimbra (reference: 101_CEIPC/2022 approved on June 24, 2022).

As this is an interpretive case study, we sought to interpret and understand the actions of an TT through the detailed description and interpretation of the data (Amado, 2017). The data collected made it possible to construct four Multimodal Narratives (MN) (Freitas, 2024) using the protocol presented by Lopes et al. (2018). Each MN describes, chronologically, self-contained, and multimodally, the TT's and the children's actions during the lesson, fulfilling the characteristics mentioned by Lopes et al. (2018). This instrument allowed the analysis of the TT's actions throughout the four sessions.

The study participants were a trainee teacher and 24 students from a 2nd-grade primary school class in mainland Portugal. The trainee teacher was studying for a Master's degree in Primary School Teaching and 2nd Grade School Teaching in Mathematics and Experimental Sciences. She carried out her internship in a class made up of 24 children aged between seven and eight. The class had 11 female and 13 male students. The students were between seven and eight years old. The students were grouped into 12 pairs during the sessions of the pedagogical intervention. The pairs were formed based on the results of tasks carried out by the students before the pedagogical intervention. Analysis of the tasks allowed each student to be assigned knowledge levels. Knowledge levels were assigned according to pre-defined knowledge level classification criteria. The pairs were formed considering the conditions of the Zone of Proximal Development (ZDP) (Vygotsky, 1980): pairs of levels one and two, pairs of levels two and three, and pairs of levels three and four.

The sessions involved using an applet for learning the meanings of the arithmetic operation multiplication, resulting from the need to overcome the difficulties identified by the children of the class (Freitas, 2024; Freitas et al., 2023). The first session focused on the additive sense, the second

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and third on the combinatorial sense, and the fourth on both senses. The sessions were conducted similarly based on the ET. Thus, each session was structured in four phases (Canavarro et al., 2012). In each session, the children solved problems in pairs using the "Multiplication" applet on the Hypatiamat platform (Freitas, 2024; Freitas et al., 2023). When planning the sessions, the TT tried to anticipate the children's possible solutions to orchestrate the discussions productively (Stein et al., 2008).

The content analysis was carried out with a rigorous and objective representation of the content (Amado, 2017) present in the MN, following the principles of Bardin (2011). The discussion of the task and the systematization of the mathematical learning phases of each session were analyzed. MAXQDA software (Kuckartz & Rädiker, 2019) was used to code and classify the categories (Amado, 2017) based on the classification system for teachers' practices and actions during collective discussions (Table 1), adapted from Ferreira et al. (2023).

Table 1. Classification of teacher practices and actions during collective discussions

Teacher practices	Description	Teacher actions
Setting up a learning community	Providing an environment where children feel safe and encouraged to share their ideas	Praise and encourage
		Play
		Backing
		Share personal experiences
		Invite
Interpreting interactions with children and between children	Attribute meaning to different interactions	Validate
		Revoicing
		Extend/enlarge
		Ask for clarification
		Listen
		Clarify/explain
Establish connections	Establish relationships with internal and external elements of mathematical content	Relate
		Take back
Challenge children to advance their knowledge	Asking questions to challenge children to advance their knowledge	Counterpose
		Ask questions
Systematize learning		Summarize the main topics of discussion

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Summarize the discussions and knowledge in relation to the objectives of the lesson	Recover prior knowledge

According to Table 1, the actions “Praise and encourage”, “Play”, “Backing”, “Share personal experiences”, and “Invite” allow for “setting up a learning community”, in the sense of “Providing an environment where children feel safe and encouraged to share their ideas”. The “Invite” action occurs when the TT asks children to socialize their observations. This action does not apply when the TT tries to include a participant in the discussion by inviting a specific child. The actions “Validate”, “Revoicing”, “Extend/enlarge”, “Ask for clarification”, “Listen”, and “Clarify/explain” make it possible to interpret the interactions between children and the TT and between children, to make sense of the interactions. The “Validate” action allows for validating shared knowledge and highlighting important ideas. In the “Revoicing” action, the TT interprets and reformulates the ideas shared by the children, maintaining their meaning. The “Extend/enlarge” action occurs when the TT suggests broadening children’s knowledge through alternative perspectives. In the “Ask for clarification” action, the TT encourages children to explain their ideas to reach a common understanding. In the “Listen” action, the TT observes children influencing each other without interfering in the discussion. In the “Clarify/explain” action, the TT provides important information for understanding the discussed content. The “Relate” and “Take back” actions allow “connections” between internal and external elements of the mathematical content. The “Relate” action occurs when the TT tries to relate content through connections (internal or external). The “Take back” action is observed when something already discussed is resumed. The “Counterpose” and “Ask questions” actions allow you to challenge children to advance their knowledge through questions. In “Counterpose”, the TT uses questioning to compare ideas. Through the “Ask questions” action, the TT abstracts the children’s knowledge so that they can reflect and rethink their ideas. The actions ‘Summarize the main topics of discussion’ and ‘Recover prior knowledge’ make it possible to systematize learning by summarizing the discussions and the knowledge worked on in class (Ferreira et al., 2023). The action “Summarize the main topics of discussion” takes place at the end of collective discussions (Ferreira et al., 2023). In ET, this action takes place in the Systematization of mathematical learning phase, when the content worked on and discussed throughout the lesson is systematized (Canavarro et al., 2012; Ferreira et al., 2023; Oliveira et al., 2013). Finally, the action “Recover prior knowledge” occurs when the TT allows children to build new knowledge from their prior knowledge (Ferreira et al., 2023).

First, we identified the MN excerpts containing evidence related to each TT action category. We then proceeded to count the occurrences of each action in each session and as a whole.

4. Results

This section is divided into three subsections. The first subsection presents the TT's actions during the task discussion and mathematical learning systematization phases of each session. The second subsection provides evidence of these actions. Finally, the third subsection summarizes the results, detailing the number of occurrences of each action in the four sessions and the total.

4.1. Frequency of actions by the trainee teacher

Figure 1 shows the frequency of TT actions during the orchestration of discussions in the first session. Figure 1 shows that the most frequent action is “Ask for clarification”, with 45 occurrences. This action made it possible to “interpret interactions with and between the children”. The second most frequent action is related to challenging children to advance their knowledge. This action was “Ask questions”, with 29 occurrences. Another action that made it possible to “interpret interactions with children and between children” was “Validate”, a common practice that occurred 20 times. The actions “Praise and encourage” and “Clarify/explain” occurred 18 and 17 times. These actions made

it possible to “set up a learning community” and “interpret interactions with and between children”. The remaining actions were less frequent, occurring between 2 and 9 times.

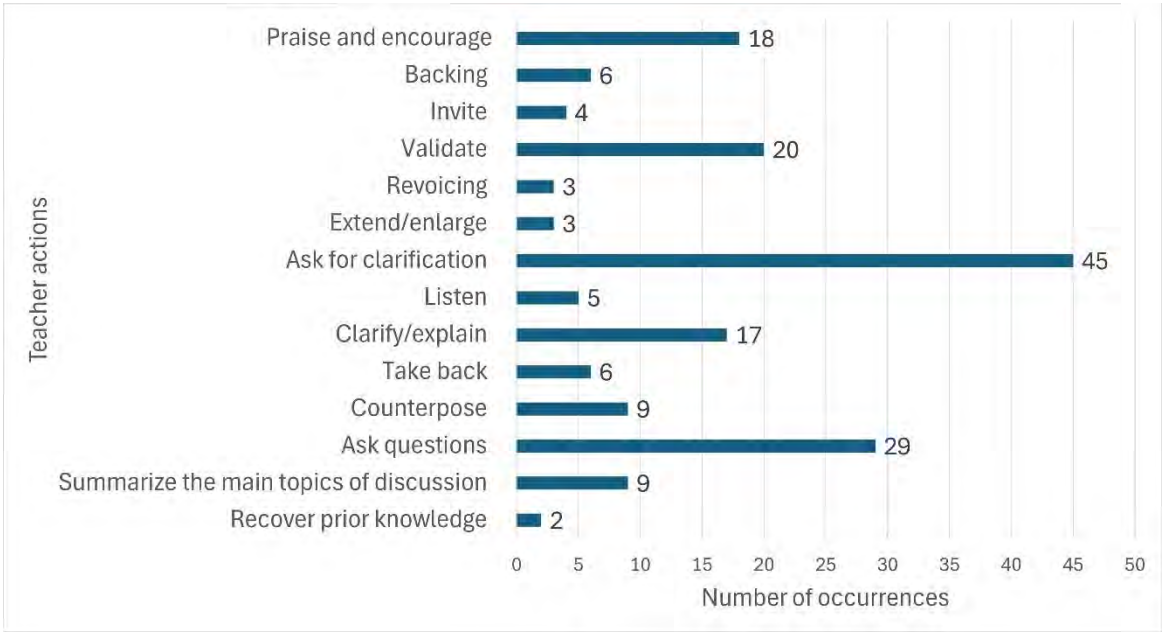

Figure 1. Trainee teacher actions in the first session

Figure 2 shows the frequency of occurrences of the TT's actions during the orchestration of the discussions relating to the second session. According to the graph in Figure 2, the most frequent actions were “Ask questions” and “Ask for clarification”, with 20 and 23 occurrences. These actions are related to challenging children to advance their knowledge and “interpreting interactions with and between children”. The remaining actions had fewer occurrences, between 1 and 9 times.

Figure 2. Trainee teacher actions in the second session

Figure 3 shows the frequency of occurrences of the TT's actions during the orchestration of the discussions relating to the third session. According to the graph in Figure 3, the most frequent action was “Ask for clarification,” which occurred 27 times. This action made it possible to “interpret interactions with and between children”. This was followed by “Praise and encourage” and “Clarify/explain” 18 and 19 times. These actions relate to “setting up a learning community” and “interpreting interactions with and between children”. The graph also shows that the action

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"Validate" had 12 occurrences and "Ask questions" had 9 occurrences. These actions are related to "interpreting interactions with children and between children" and challenging children to advance their knowledge. The other actions had fewer occurrences, between 1 and 6 times.

Figure 3. Trainee teacher actions in the third session

Figure 4 shows the frequency of occurrences of the trainee teacher's actions during the orchestration of the discussions relating to the fourth session. In the fourth session, the most frequent actions were "Praise and encourage", "Ask questions", and "Ask for clarification", with 20, 22, and 26 occurrences (Figure 4). These actions enabled "setting up a learning community", "interpret interactions with and between children", and challenging children to advance their knowledge. The graph in Figure 4 shows that the actions "Clarify/explain" and "Validate" were also common practices, occurring 13 and 16 times and relating to "interpreting interactions with children and between children". The remaining actions were less common, occurring between 1 and 8 times.

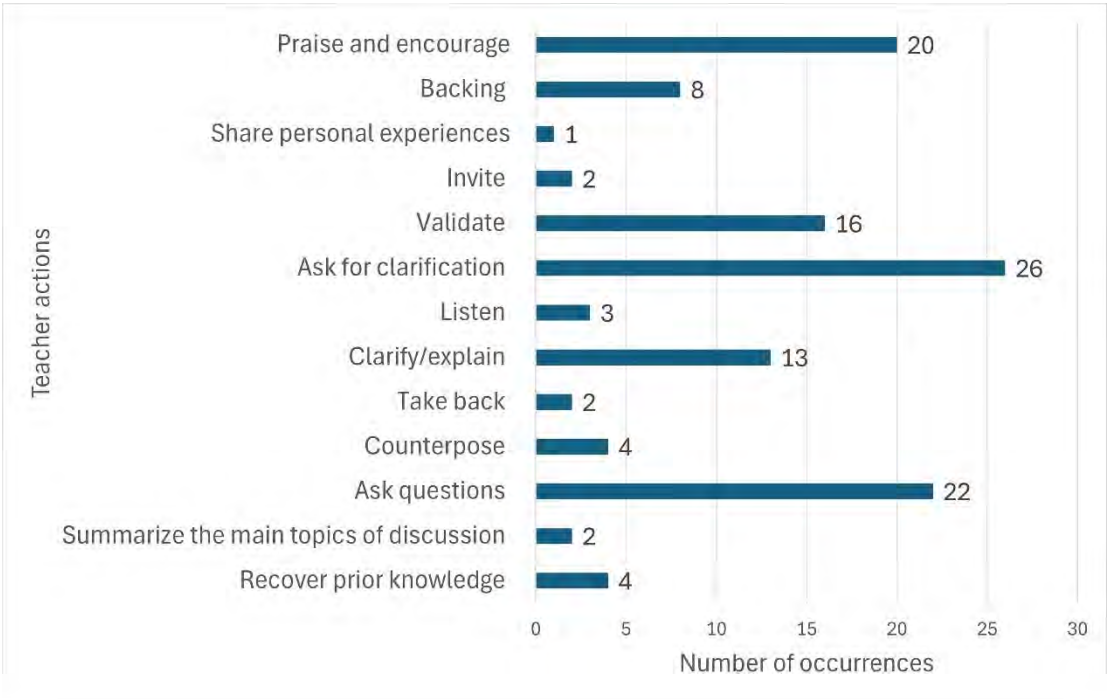

Figure 4. Trainee teacher actions in the fourth session

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4.2. Evidence of the trainee teacher's actions over the four sessions

We begin by presenting the actions of "providing an environment in which children feel safe and encouraged to share their ideas". The action "Praise and encourage" is visible throughout the sessions when the TT values the children's sharing, with phrases like "Well done!", "as student X said and very well", "And as you did and very well", "Look, this strategy is perfect. This is one of Student Q's strategies". About the "Backing" action, we can see that the TT tries to encourage the children to share and explain their solutions to the class, using phrases such as "You were talking well about... the baskets.", "Tell me how you know.", "Count me in.", "Let's see together.", and "Go in parts.". This encouragement is also visible in TT's encouragement of the children to support their classmates while they are sharing their resolutions. This encouragement is realized with phrases like "Do you want to help student H?", "Does anyone want to help student S?", "Who wants to help their classmates?" or "Help student K.".

The "Share personal experiences" action was only visible in the last session, where a student shared the following: "The teacher agreed with us that if we did well at lunch on Friday, we would get a reward.". As for the "Invite" action, this can be found when the TT uses phrases such as "Do you agree?", "Who remembers the property?", "Who did not do 4 × 2?", "Who did it differently?", "Who wants to tell Student G?". "The meaning of multiplication that we learned in this lesson.", "Who did not use the clue?", "Who knows the name of this scheme?", "Could anyone does it any other way?".

We now move on to the actions related to interpreting the interactions with the children and between the children. Throughout the four sessions, a considerable number of occurrences of the "Validate" action were identified in phrases such as "With three eggs. Very good!", "Four baskets, three eggs, yes.", "That's right", "That's right, we have four groups", "It's a table", "Right", "Multiplication. Write it down, multiplication.", "It could also be a drawing", "OK, there are 8 children". Most of the validations centered on the repetition of the children's answers, accompanied by the expression "Very good". About the Revoicing action, at times, the trainee teacher interpreted the children's explanations and shared them with the class, maintaining the meaning of the sharing:

TT: So, repeat it, girls. You counted?

Student E: Groups.

Student M: Groups of plates.

TT: The groups. Did you hear? (talking to the class) The classmates counted the groups of plates to find out how many times Emma moved the plates. And how many plates did she take each time?

The "Extend/enlarge" action took place when the TT challenged the children to find other ways of determining the number of possible combinations, saying, for example, "Now, imagine that we could not use either a double-entry table or a tree diagram, how do we calculate the possibilities?" or "We know there are two consonants and five vowels. Look here: 2 consonants and five vowels. How do we work out the total number of possibilities?". The aim was to help the children realize they could use multiplication to calculate the number of possible combinations. On the other hand, the TT gives an alternative example – "Now imagine...for example...imagine we had a table with...with a hundred eggs. Not a hundred eggs, a hundred baskets, and in each basket, there were two eggs. How would we calculate the total number of eggs?" – to help the children understand the meaning of multiplication factors in the task context. As for "Asking for clarification", the TT often used this action to ask the children to explain/clarify their ideas better. This action is present in sentences like "And how did they know there were three?", "The questions? How did they realize it was four baskets?", "The other way round?", "They multiplied. What?" or "Explain, explain. What does the drawing

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represent? What were they doing with that drawing?". Most of the evidence of the "Listen" action is present in the moments when the groups share their resolutions:

TT: So, you mean you counted the plates?

E: No... no... no... we count...

Student M: Not the plates... sometimes...

E: We counted the groups.

TT: The groups. Well done!

This action is also evident in the second session after the TT questions the children to focus them on a specific content, namely the commutative property of multiplication:

PE: It's multiplication, do you remember the word commutative?

Student K: No.

Student C: Yes.

Student Q: Commutative property.

Student K: No.

Student Q: Commutative property of multiplication.

The action "Clarify/explain" is visible when the TT provides information to the children in order to guide them towards understanding the concepts explored:

TT: Three times. So that means we have three times four, which equals twelve. This property here, which says that when we change the... the... the factors, the result or the product does not change, is the commutative property. In the additive sense of multiplication, we cannot use this commutative property because it will change the meaning of addition; for example, here (pointing to the task on the interactive whiteboard), if we had 3 \times 4, we would not have four baskets. How many baskets would we have?

Regarding actions related to establishing connections, the evidence of the "Take back" action is concentrated in the systematization phase of mathematical learning during the completion of the systematization sheet. This action made it possible to connect with the content explored in the discussion. Evidence of this action includes, "We have already seen that, haven't we? How many times has the same digit been repeated?", "Does it change the result or not? The product.", "And why is it combinatorial?" or "What does the additive sense of the arithmetic operation multiplication say?".

As for the actions aimed at challenging the children to advance in their knowledge, the evidence shows that in the action "Counterpose", the TT asked questions to compare situations to understand the additive meaning of multiplication. Among the questions asked were: "Is four times three the same?", "Is four plus four plus four the same as three plus three plus three?", "student V, why wasn't it two times four?", "And why wasn't it zero times four?", "Is it additive or combinatorial?". The action "Ask questions" is evident when the trainee teacher challenges the children to rethink their ideas and guides them towards reflection. This action is present in sentences such as "How many times does four repeat?", "Three times four? Think again. Four is repeated three times? (referring to the addition 3 + 3 + 3 + 3)", "Do you think?", "Two times three? Think again.", "Is this a table?" or "How often do you have two there?".

As for the actions related to the systematization of learning, the action "Summarize the main topics of the discussion" is now predominantly present in the systematization of mathematical

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learning, as seen in sentences like, “In this one, we are faced with the meaning...” What is the meaning? That we talked about today.” or “And so we conclude that changing the order of the factors does or does not change the meaning of the problem?”. It’s also present in the sentence “Now let's record what we’ve learned in this lesson on this sheet, kids.” since the purpose of the systematization sheet is to systematize the content explored during the lesson. The action “Recovering previous knowledge” is evident in sentences such as “But there's a property you've learnt”, “What was the property we talked about in previous lessons that's here?” or “Student H, what's this diagram called? (5-second pause) Remember? We talked about it in the last lesson”. This shows that throughout the sessions the TT questioned the children about content worked on in previous sessions, making them recover their previous knowledge.

4.2. Summary of results

Table 2 summarizes the number of occurrences of TT actions in each session and as a whole.

Table 2. Summary of the number of occurrences of trainee teacher actions

Teacher practices	Teacher actions	Session 1	Session 2	Session 3	Session 4	Total
Setting up a learning community	Praise and encourage	18 (10.2%)	9 (8%)	18 (16.2%)	20 (16.3%)	65 (12.4%)
	Play	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
	Backing	6 (3.4%)	10 (8.8%)	4 (3.6%)	8 (6.5%)	28 (5.4%)
	Share personal experiences	0 (0%)	0 (0%)	0 (0%)	1 (0.8%)	1 (0.2%)
	Invite	4 (2.3%)	3 (2.7%)	2 (1.8%)	2 (1.6%)	11 (2.1%)
Interpreting interactions with children and between children	Validate	20 (11.4%)	10 (8.8%)	12 (10.8%)	16 (13%)	58 (11.1%)
	Revoicing	3 (1.7%)	3 (2.7%)	1 (0.9%)	0 (0%)	7 (1.3%)
	Extend/enlarge	3 (1.7%)	5 (4.4%)	0 (0%)	0 (0%)	8 (23.1%)
	Ask for clarification	45 (25.6%)	23 (20.4%)	27 (24.3%)	26 (21.1%)	121 (91.4%)
	Listen	5 (2.8%)	1 (0.9%)	2 (1.8%)	3 (2.4%)	11 (2.1%)
	Clarify/explain	17 (9.7%)	18 (15.8%)	19 (17.1%)	13 (10.6%)	67 (12.8%)

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Establish connections	Relate	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
	Take back	6 (3.4%)	2 (1.8%)	6 (5.4%)	2 (1.6%)	16 (3.1%)
Challenge children to advance their knowledge	Counterpose	9 (5.1%)	0 (0%)	0 (0%)	4 (3.3%)	13 (2.5%)
	Ask questions	29 (16.5%)	20 (17.7%)	9 (8.1%)	22 (17.9%)	80 (15.3%)
Systematize learning	Summarize the main topics of discussion	9 (5.1%)	6 (5.3%)	5 (4.5%)	2 (1.6%)	22 (4.2%)
	Recover prior knowledge	2 (1.1%)	3 (2.7%)	6 (5.4%)	4 (3.3%)	15 (2.9%)

Figure 5 shows the total number of occurrences of each action. Related to "setting up a learning community", Table 2 shows that the action "Play" had zero occurrences. The remaining actions varied from session to session. Figure 5 shows that "Praise and encourage" was the fourth most frequent action, with 65 occurrences in all the sessions. This action was justified because it was a time for discussion, where it was necessary to provide an environment in which the children felt safe and encouraged to share their resolutions and ideas. The "Backing" action had 28 occurrences in total (Figure 5), with an increase between sessions 1 and 2 (from 6 to 10 occurrences) and between sessions 3 and 4 (from 4 to 8 occurrences) (Table 2). About the "Share personal experiences" action, there was only one occurrence in the last session (Table 2). The "Invite" action had 11 occurrences (Figure 5).

Figure 5. Total number of occurrences of each trainee teacher action

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As for the actions relating to “interpreting interactions with children and between children”, the action “Validate” had a total of 58 occurrences (Figure 5), with a reduction between sessions 1 and 2 (from 20 to 10 occurrences) and an increase between sessions 3 and 4 (from 12 to 16 occurrences) (Table 2). This increase is justified by the fact that there was a change in the meaning of multiplication explored, which made it necessary to support the children in “attributing meaning and sense to the different interactions”. The “Extend/enlarge” action had a low number of occurrences throughout the sessions, with eight occurrences (Figure 5), with an absence in sessions 3 and 4. The action “Ask for clarification” had the highest number of occurrences in all the sessions, totaling 121 (Figure 5). This action was justified because it was a time for sharing resolutions and discussion, which made it necessary to ask the children for clarification to encourage them to participate and “attribute meaning to the different interactions”. The “Listen” action also had fewer occurrences in all the sessions. As for the “Clarify/explain” action, there were 67 occurrences (Figure 5), with an increase between sessions 1 and 3 and a decrease between sessions 3 and 4 (Table 2). This increase is also justified by the fact that there was a change in the meaning of multiplication explored. This made it necessary to clarify and explain the resolutions explored, especially those related to the combinatorial meaning of the arithmetic operation multiplication.

About the actions designed to “establish connections”, there were no occurrences of the “Relate” action and that the “Take back” action had a total of 16 occurrences (Figure 5), with a reduction between sessions 1 and 2 and sessions 3 and 4, from 6 to 2 occurrences (Table 2).

As for “challenge children to advance their knowledge”, the action “Counterpose” had 13 occurrences (Figure 5), with a reduction between sessions 1 and 5 and no occurrences in sessions 3 and 4 (Table 2). The action “Ask questions” was the second most frequent action in sessions 1, 2, and 4 (Table 2), totaling 80 occurrences (Figure 5). Throughout the sessions, it was necessary to question the children to stimulate their participation and encourage them to think about the content explored to advance their knowledge.

Finally, regarding “systematizing learning,” the action “Summarize the main topics of discussion” had 22 occurrences (Figure 5), reducing the number of sessions (Table 2). The action “Recover prior knowledge” had a total of 15 occurrences (Figure 2), with an increase in occurrences between sessions 1 and 2 (from 2 to 3 occurrences) and a decrease between sessions 3 and 4 (from 6 to 4 occurrences) (Table 2). The presence of these actions is justified by the fact that there is a moment dedicated to systematizing mathematical learning.

5. Discussion

According to the results presented, the action with the highest number of occurrences in all the sessions was “Ask for clarification”, followed by “Ask questions”. The high number of occurrences of the “Ask for clarification” action was also seen in the study by Gomes et al. (2023). This action allowed the TT to access the children's thoughts, as shown in that study. On the other hand, the TT used the “Ask questions” action to involve the children in the discussion, as also seen in the study by Faria et al. (2024). Through the actions “Ask for clarification” and “Ask questions”, the TT sought to encourage the children to share and discuss the solutions to “Attribute meaning to the different interactions”, and help the children advance in their knowledge. This need for questioning and clarification is also seen in the study carried out by Rodrigues et al. (2022). As Carvalho and Ponte (2013) and Ponte et al. (2013) point out, the fact that this was a time to explore the children's solutions made reflection and questioning necessary.

The third action with the highest number of occurrences in all the sessions was “Clarify/explain”, revealing the TT's need to interpret the interactions with the children, providing them with important information for understanding the content. This action occurred more often in the combinatorial sense sessions, which can be explained by the fact that this is the sense in which the children

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experienced the most difficulties (Freitas, 2024). This action can also be justified by what Gomes et al. (2023) say that it is necessary to introduce information so that the children continue to participate in the discussion. The children's difficulties with combinatorics may also explain the reduction in the number of occurrences of the "Validate" action, where the TT validated the knowledge shared by the children less frequently.

The fourth action with the highest number of occurrences in all the sessions was "Praise and encourage", which corroborates the idea that it is necessary to encourage children to share their solutions and participate in the discussion (Brodie, 2010; Guerreiro et al., 2015). The "Support" action had more occurrences in the sessions involving the combinatorial sense of multiplication, which can be justified by the children's difficulties. These difficulties made it necessary for the TT to provide support, as seen in Ponte et al. (2013). In this sense, the TT used this action to help the children explain their ideas, as can also be seen in the study by Gomes et al. (2023). The low number of occurrences of the action "Counterpose", and the absence of occurrences of the action "Relate", related to "establishing connections" and challenging children to advance their knowledge, is justified by what Carvalho and Ponte (2013) say, that understanding children's strategies is a learning experience for teachers. The "Revoicing" action allowed the TT to interpret interactions with the children and highlight important aspects of their sharing, as was also seen in the study by Gomes et al. (2023). However, this action decreased throughout the sessions, and there was less need for the TT to interpret the interactions with the children and to rephrase the ideas shared. About the "Extend/enlarge" action, there was a low number of occurrences, which leads us to believe that a more in-depth anticipation by the TT could help her to "interpret interactions with children and between children" and reflect on how to question them (Carvalho & Ponte, 2013) to help them understand mathematical content. It also leads us to reflect on future teachers' difficulty anticipating questions, as Martins et al. (2024) point out.

According to Guerreiro et al. (2015), collective discussions do not occur spontaneously, which makes it necessary to induce them by inviting children to participate. In this sense, the "Invite" action was used by the TT with the aim of "setting up a learning community", and it was necessary to encourage children to take part in the discussion, as seen in Gomes et al. (2023) and Rodrigues et al. (2022). However, the TT focused mainly on invitations directed at specific children, using phrases such as "student H, what is that diagram called?" or "What is missing student T?" preventing the children from socializing their observations. The low number of occurrences of the "Listen" action, related to "interpreting interactions with children and between children", can be explained by the low number of occurrences of the "Invite" action, which focuses on questions for the class (e.g., "Do you agree?" or "Who did it differently?"). The invitations directed at specific children were evaluated (Guerreiro et al., 2015), which may have hindered the children's creative participation (Ponte et al., 2012).

The type of questions asked by the TT may also explain the low number of occurrences of the "Listen" action, because the evidence of this action is the result of focusing questions asked by the TT ("It's multiplication, do you remember the word commutative?"), The aim is to focus the children's attention on a particular aspect (Guerreiro et al., 2015). The TT could have used reflection or inquiry questions since these are characterized by inviting the children to get involved in the discussion (Carvalho & Ponte, 2013). TT's difficulty in anticipating and asking appropriate questions aligns with what Faria et al. (2023) and Martins et al. (2024) says that anticipating questions and questioning in the classroom are complex challenges for teachers. In this sense, it would be important to create an educational script, as Freitas et al. (2023) mentioned. This script would help the TT in the discussion, anticipating the children's strategies and questions that would stimulate discussion among the children.

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The actions “Take back”, “Summarize the main topics of discussion” and “Recover prior knowledge” are visible in all the sessions, especially in the mathematical learning systematization phase. These actions led the TT to “establish connections” and “systematize learning” (Ferreira et al., 2023). This leads us to believe that the characteristics of the EE guided the TT towards these actions since, in this phase, the contents worked on throughout the lesson are recalled through synthesis and the establishment of connections with previous learning (Canavarro et al., 2012; Oliveira et al., 2013). The absence of the action “Play” and the near absence of the action “Share personal experiences”, related to “setting up a learning community”, is justified by the limited knowledge of the TT's teaching practice (Ponte, 2012).

Anticipating possible resolution strategies allowed the TT to support and clarify the children, making the discussion productive (Stein et al., 2008). In addition to this foresight, it would be important for the educational roadmap created when planning the sessions to include the use of this frame of reference to reduce the unpredictability of the discussions (Ferreira et al., 2023) and contribute to discussions with greater discussion between the children.

6. Conclusion

This study sought to analyze the actions of a TT during the orchestration of collective discussions from an EE approach. The analysis made it possible to understand the type of actions the TT promoted during the four TT sessions focused on the arithmetic operation of multiplication. The predominant actions relate to “interpreting interactions with children and between children” and challenging children to advance their knowledge. These actions included “Ask for clarification” and “Ask questions” revealing the importance given by the TT to reflection and understanding of the content being worked on. The “Clarify/explain” action was more frequent in the sessions involving combinatorial sense. In these sessions, the children showed the most difficulties, and it was necessary to “interpret interactions with children and between children” by attributing meaning and sense to the different interactions. There were few or no occurrences of the actions “Counterpose” and “Relate”, which are related to “establishing connections” and challenging children to advance their knowledge, highlighting TT's need to learn to understand children's strategies. The decrease in the occurrences of “Paraphrasing” throughout the sessions indicates a progression in the children's ability to express their ideas more clearly, reducing the TT's need to “interpret interactions with children and between children”. The reduced use of the “Listen” action and the predominance of invitations directed at specific children indicate the need for greater anticipation and reflection on questioning strategies by the TT, to promote more comprehensive and creative participation by the children.

This study showed that the phase of systematizing mathematical learning, characteristic of TE, contributed to the occurrence of the actions “Take back”, “Summarize the main topics of discussion” and “Recover prior knowledge”, guiding the PE towards practices of systematizing learning. The absence of the actions “Play” and “Share personal experiences” in several sessions leads us to believe in the importance of analysis and reflection on practice for TT's professional development.

This study offers contributions to teacher training, as it demonstrates the type of actions of a teacher in training during the orchestration of collective discussions based on a TE approach, highlighting the importance of reflection on practice. It is, therefore, important to highlight the importance of the NMs in identifying the number of occurrences of TT actions. This tool made it possible to analyze and reflect on TT practice, allowing for awareness.

7. Suggestion

In future studies, we suggest better anticipation of actions encouraging discussion between children. This study focused on analyzing the actions of a TT in a particular ET context involving

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specific math content with children in the 2nd grade. In this sense, it is also suggested that the actions of different teachers in different contexts be analyzed to identify aspects that contribute to improving collective discussions.

Declarations

Author Contributions. Conceptualization: Y. F., F.M.; Data Curation: Y. F., F.M.; Formal analysis: Y. F., S.N.M.-S., F.-J.R.-R.; Funding acquisition: F.M.; Investigation: Y. F., F.M., S.N.M.-S., F.-J.R.-R.; Methodology: Y.F., F.M.; Project Administration: F.M., F.-J.R.-R.; Resources: Y. F., F.M.; Software: Y. F.; Supervision: F.M., S.N.M.-S., F.-J.R.-R.; Validation: Y. F., F.M., S.N.M.-S., F.-J.R.-R.; Visualization: Y. F., F.M.; Writing—original draft preparation: Y. F., F.M.; Writing—review and editing: Y. F., F.M, S.N.M.-S., F.-J.R.-R.. All authors have read and agreed to the published version of the manuscript.

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Ethical Approval. The anonymity of all involved participants was maintained, in strict compliance with the Declaration of Helsinki and approved by the Ethics Committee of the Polytechnic Institute of Coimbra (reference: 101 CEIPC/2022 approved on June 24, 2022).

Data Availability Statement. To review the data from this study, contact the primary author for more discussion about the request.

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References

Amado, J. (2017). *Manual de Investigação Qualitativa em Educação* (3ª ed.). Imprensa da Universidade de Coimbra. https://doi.org/10.14195/978-989-26-1390-1

Bardin, L. (2011). *Análise de Conteúdo*. Edições 70.

Borko, H., Jacobs, J., Seago, N., & Mangram, C. (2014). Facilitating Video-Based Professional Development: Planning and Orchestrating Productive Discussions. In: Li, Y., Silver, E., Li, S. (eds) *Transforming Mathematics Instruction. Advances in Mathematics Education*. Springer, Cham. https://doi.org/10.1007/978-3-319-04993-9_16

Brodie, K. (2010). *Teaching mathematical reasoning in secondary school classrooms*. Springer.

Canavarro, A., Oliveira, H., & Menezes, L. (2012). Práticas de ensino exploratório da matemática: o caso de Célia. In L. Santos, A. Canavarro, A. Boavida, H. Oliveira, L. Menezes, & S. Carreira (Eds.), *Investigação em Educação Matemática* (pp. 255–266). Sociedade Portuguesa de Investigação em Educação Matemática.

Carvalho, R., & da Ponte, J. P. (2013). Prática profissional para a promoção do cálculo mental na sala de aula: Uma experiência no 6. º ano. *Quadrante*, *22*(2), 83-108. https://doi.org/10.48489/quadrante.22893

Cohen, l., Manion, L., & Marrison, K. (2018). *Research Methods in Education* (8ª ed.). Routledge.

Creswell, J. W. (2014). *Educational Research: Planning, Conducting and Evaluating Quantitative and Qualitative Research* (4ª ed.). Pearson.

Faria, F., Da Ponte, J. P., & Rodrigues, M. (2024). Teachers' leading whole-class discussions in a mathematics lesson study: From initial understanding to orchestration in practice. *European Journal of Science and Mathematics Education*, *12*(1), 156-174.

Ferreira, M. C. N., Ribeiro, A. J., & Ponte, J. P. D. (2023). Práticas e ações do formador de professores que ensinam Matemática na orquestração de discussões coletivas. *Bolema*, *37*, 666-687. http://dx.doi.org/10.1590/1980-4415v37n76a14

Freitas, Y. (2024). *A applet multiplicação da Plataforma Hypatiamat na compreensão dos sentidos da operação aritmética multiplicação* [Relatório final de Mestrado, Escola Superior de Educação de Coimbra]. Repositório Comum.

Freitas, Y. A., Abbasi, M., Brito-Costa, S., Pinto, R., Rato, V., & Martins, F. (2024). Exploratory teaching: Integrating applet to teach arithmetic multiplication operation. *Eurasia Journal of Mathematics, Science and Technology Education*, *20*(12). https://doi.org/10.29333/ejmste/15666

Freitas, Y. A., Pinto, R., Rato, V., Gomes, A., & ML Martins, F. (2023). Sentidos da multiplicação e a applet multiplicação da plataforma Hypatiamat. *Revista APEduC*, *4*(1), 119-137. http://dx.doi.org/10.58152/APEduCJournal.401

Gomes, P., Ponte, J. P. e Quaresma, M. (2023). "O que descobriram?" Tarefas e discussões coletivas usando diferentes representações durante e após estudos de aula. *PNA*, *18*(1), 77-103. https://doi.org/10.30827/pna.v17i4.27033

Gomes, P., Quaresma, M., & da Ponte, J. P. (2022). Leading whole-class discussions: from participating in a lesson study to teaching practice. *International Journal for Lesson & Learning Studies*, *12*(2), 139-151. https://doi.org/10.1108/IJLLS-02-2022-0022

Guerreiro, A., Ferreira, R., Menezes, L., & Martinho, M. (2015). Comunicação na sala de aula: a perspetiva do ensino exploratório da matemática. *Zetetiké*, *23*(44), 279–295.

Kuckartz, U. y Rädiker, S. (2019). Introduction: Analyzing Qualitative Data with Software. In U. Kuckartz & S Rädiker (Eds.), *Analyzing Qualitative Data with MAXQDA: Text, Audio, and Video* (pp. 1–11). Springer International Publishing. https://doi.org/10.1007/978-3-030-15671-8_1

Lopes, J., Viegas, M., & Pinto, A. (2018). *Melhorar práticas de ensino de ciências e tecnologia – Registar e investigar com narrações multimodais*. Edições Sílabo.

Martins, M., Ponte, J. P. e Mata-Pereira, J. (2024). O desenvolvimento do conhecimento didático de futuros professores: o estudo de aula como processo formativo integrado na formação inicial. *PNA*, *18*(2), 105-130. https://doi.org/10.30827/pna.v18i2.27258

Oliveira, H., Menezes, L., & Canavarro, A. (2013). Conceptualizando o ensino exploratório da Matemática: Contributos da prática de uma professora do 3.º ciclo para a elaboração de um quadro de referência. *Quadrante*, *22*(2), 1–25.

Ponte, J. (2012). Estudiando el conocimiento y el desarrollo profesional del profesorado de matemáticas. In N. Planas (Ed.), *Teoría, crítica y práctica de la educación matemática* (pp. 83–98). Graó.

Ponte, J. P. D., Mata-Pereira, J., & Quaresma, M. (2013). Ações do professor na condução de discussões matemáticas. *Quadrante*, *22*(1), 55-81. https://doi.org/10.48489/quadrante.22894

Ponte, J. P., Branco, N., Quaresma, M., Velez, I., & Mata-Pereira, J. (2012). Perspetivas teóricas no estudo das práticas profissionais dos professores de matemática. In A. P. Canavarro, L. Santos, A. M. Boavida, H. Oliveira, L. Menezes & S. Carreira (Eds.), *Práticas de ensino da Matemática: Atas do Encontro de Investigação em Educação Matemática* (pp. 267-279).

Rodrigues, C., Da Ponte, J. P., & Menezes, L. (2020). Práticas discursivas de professores de Matemática na condução de discussões coletivas. *Quadrante*, *29*(2), 24-46. https://doi.org/10.48489/quadrante.22575

Rodrigues, C., Menezes, L., & Ponte, J. P. D. (2018). Práticas de Discussão em Sala de Aula de Matemática: os casos de dois professores. *Bolema: Boletim de Educação Matemática*, *32*, 398-418. http://dx.doi.org/10.1590/1980-4415v32n61a05

Rodrigues, R.N., Costa, C., Martins, F., & Ruiz Rey, F.J. (2022). Ações de uma estagiária na promoção e sustentação de práticas epistémicas. Revista *Practicum*, *7*(2), 148-168. https://doi.org/10.24310/RevPracticumrep.v7i2.13518

Stavridis P., & Papadopoulou V. (2022). The Contribution of Teaching Practice to Preservice Teachers' Training – Empirical Research of the Department of Primary Education of Western Macedonia University Students' Evaluation. *Educational Process: International Journal*, *11*(4): 92-111. https://dx.doi.org/10.22521/edupij.2022.114.5

Stein, M. K., & Smith, M. S. (2009). Tarefas matemáticas como quadro para a reflexão: da investigação à prática. *Educação e Matemática*, *105*(5), 22-28.

Stein, M., Engle, R., Smith, M., & Hughes, E. (2008). Orchestrating productive mathematical discussions: Five practices for helping teachers move beyond show and tell. *Mathematical Thinking and Learning*, *10*(4), 313–340. http://dx.doi.org/10.1080/10986060802229675

Vilelas, J. (2020). *Investigação – O processo de construção de conhecimento* (3ª ed.). Edições Sílabo.

Vygotsky, L. S. (1980). *Mind in society: The development of higher psychological processes.* Cambridge MA: Harvard University Press.

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