

Teacher intervention and its pedagogical guidance in Mathematics classes in the 2nd cycle of Mozambican General Secondary Education

A intervenção docente e sua orientação didática em aulas de Matemática no 2º ciclo do Ensino Secundário Geral moçambicano

Intervención docente y orientación didáctica en las clases de Matemáticas del 2º ciclo de la Educación Secundaria General de Mozambique

Intervention des enseignants et son orientation didactique dans les classes de Mathématiques du 2ème cycle de l'Enseignement Secondaire Général mozambicain

Gabriel Mulalia Maulana¹

Rovuma University, Moçambique
Doctor in Science Teaching and Mathematics Education
<https://orcid.org/0000-0003-3859-8266>

Sergio de Mello Arruda²

State University of Londrina (UEL), PR, Brazil.
Doctor in Education
<https://orcid.org/0000-0002-4149-2182>

Marinez Meneghello Passos³

State University of Londrina (UEL), PR, Brasil
Doctor in Education for Science
<https://orcid.org/0000-0001-8856-5521>

Abstract

This article presents the results of a research project that sought to characterize teacher actions related to intervention in Mathematics classes in the 2nd cycle of Mozambican General Secondary Education. The research question was: through which teacher actions do Mathematics teachers intervene in their classes, and how can the pedagogical guidance of these

¹ gmulalia@gmail.com and gmaulana@unirovuma.ac.mz

² sergioarruda@uel.br

³ marinez@uenp.edu.br and marinezpasseos@uel.br

Educ. Matem. Pesq., São Paulo, v. 28, p. 01-30, 2026, e63660

interventions be characterized? The research followed a qualitative approach, and the data were obtained through observation of Mathematics classes taught by four teachers in three secondary schools in the province of Cabo Delgado. Based on the methodological procedures described by Content Analysis, the collected information, after organization and interpretation, showed that the teacher interventions were carried out through the actions of Warning, Commenting, Writing, Explaining, Asking, Reinforcing, and Reminding, which stemmed from students' mistakes and insecurity. The interventions were configured through cognitive, metacognitive, or motivational strategies, which aimed, above all, at conceptual understanding, procedural fluency, and productive disposition. This pedagogical-strategic approach, however, does not represent a mathematical instruction that can be considered successful, since no teacher linked the interventions to proficiency in Mathematics.

Keywords: Mathematics education, Teacher action, Teacher intervention, Mathematics proficiency, Self-regulated learning.

Resumen

Este artículo presenta los resultados de una investigación que buscó caracterizar las acciones docentes vinculadas a la intervención en las clases de matemáticas del 2º ciclo de la Educación Secundaria General de Mozambique. La pregunta de investigación fue la siguiente: ¿a través de qué acciones docentes intervienen los docentes que imparten matemáticas en sus clases y cómo pueden caracterizarse los lineamientos didácticos de dichas intervenciones? La investigación siguió un enfoque cualitativo y los datos se obtuvieron mediante la observación de las clases de Matemática impartidas por cuatro profesores en tres Escuelas Secundarias de la provincia de Cabo Delgado. Con base en los procedimientos metodológicos descritos por el Análisis de Contenido, y a partir de la información recolectada, luego de su organización e interpretación, encontramos que las intervenciones docentes se realizaron mediante las acciones Advertir, Comentar, Escribir, Explicar, Preguntar, Reforzar y Recordar, las cuales

surgieron de los errores e inseguridades de los estudiantes. Las intervenciones se configuraron mediante estrategias cognitivas, metacognitivas o motivacionales, centradas, sobre todo, en la comprensión conceptual, la fluidez procedimental y la disposición productiva. Esta orientación didáctico-estratégica, sin embargo, no constituye una enseñanza de matemáticas que pueda considerarse exitosa, ya que ningún docente vinculó las intervenciones con el dominio de las matemáticas.

Palabras clave: Educación matemática, Acción docente, Intervención docente, Competencia Matemática, Aprendizaje autorregulado.

Résumé

Cet article présente les résultats d'une recherche visant à caractériser les actions pédagogiques liées à l'intervention dans les classes de mathématiques du 2^e cycle de l'enseignement secondaire général mozambicain. La question de recherche était la suivante : par quelles actions pédagogiques les enseignants de mathématiques interviennent dans leurs classes et comment caractériser les orientations didactiques de ces interventions ? La recherche a suivi une approche qualitative et les données ont été recueillies par l'observation de cours de mathématiques dispensés par quatre enseignants dans trois écoles secondaires de la province de Cabo Delgado. Sur la base des procédures méthodologiques décrites par l'analyse de contenu, les informations recueillies, après organisation et interprétation, nous avons constaté que les interventions pédagogiques ont été réalisées à travers les actions Avertir, Commenter, Écrire, Expliquer, Demander, Renforcer et Rappeler, qui provenaient des erreurs et de l'insécurité des élèves. Les interventions ont été conçues à partir de stratégies cognitives, métacognitives ou motivationnelles, visant avant tout la compréhension conceptuelle, la fluidité procédurale et la disposition productive. Cette orientation didactique et stratégique ne constitue cependant pas un enseignement de mathématiques qui puisse

être considéré comme réussi, car aucun enseignant n'a lié les interventions à la maîtrise des mathématiques.

Mots-clés : Éducation mathématique, Action pédagogique, Intervention pédagogique, Maîtrise des mathématiques, Apprentissage autorégulé.

Resumo

Este artigo apresenta os resultados de uma pesquisa que procurou caracterizar as ações docentes relacionadas a intervenção em aulas de Matemática no 2º ciclo do Ensino Secundário Geral Moçambicano. A questão de pesquisa foi a seguinte: por meio de quais ações docentes os professores que ensinam Matemática intervêm em suas aulas e como podem ser caracterizadas as orientações didáticas das intervenções? A pesquisa seguiu a abordagem qualitativa e os dados foram obtidos por meio da observação de aulas de Matemática ministradas por quatro professores, que ensinavam Matemática em três Escolas Secundárias da província de Cabo Delgado. Com base nos procedimentos metodológicos descritos pela Análise de Conteúdo, as informações coletadas, após organização e interpretação, constatamos que as intervenções docentes foram realizadas por meio das ações Advertir, Comentar, Escrever, Explicar, Perguntar, Reforçar e Relembrar, que provieram de erros e insegurança dos alunos. As intervenções configuraram-se mediante estratégias cognitivas, metacognitivas ou motivacionais, que visavam, sobretudo, a compreensão conceitual, a fluência processual e a disposição produtiva. Essa orientação didático-estratégica, todavia, não representa uma instrução Matemática que possa ser considerada bem-sucedida, pois, nenhum professor vinculou as intervenções à proficiência em Matemática.

Palavras-chave: Educação Matemática, Ação docente, Intervenção docente, Proficiência em Matemática, Aprendizagem autorregulada.

Teacher intervention and its pedagogical guidance in Mathematics classes in the 2nd cycle of mozambican general secondary education

Introduction

Mathematics is considered a difficult subject when compared to other subjects in the school curriculum. Furthermore, it is described as “not fun” to learn and considered as a “a nightmare” (Ali, 2011), such that being successful in Mathematics means being intelligent (Silva, 2008). In Mozambique, the situation described in the previous sentences is no different; Mathematics is considered the subject of “failure” (Chicote & Deixa, 2020; Langa, 2020), which indicates that many students face learning difficulties and, consequently, require assistance. However, the support provided by teachers and their pedagogical-strategic guidance remains largely unknown.

The preferred pedagogical assistance in Mathematics Education is intervention, carried out through actions aimed at improving a situation (Stylianides & Stylianides, 2013), by triggering self-regulation (Mendes & Buriasco, 2018; Pires & Buriasco, 2017). In this context, intervention becomes a set of actions and strategies by the teacher that intervenes, prevents and/or remedies learning problems, and also promotes self-regulated learning (Gersten et al., 2009).

Intervention can occur at three levels: I – Reference; II – Strategic; III – Intensive, a model known as the Response to Intervention Model (RTI) (Gersten et al., 2009; Hinton et al., 2013). This research focuses on Level I, Reference intervention, related to instruction during class, aiming to enhance and harmonize learning for all students. Specifically, we investigate the teacher actions employed by Mathematics teachers in their classes in the second cycle of Mozambican General Secondary Education. This also considers the pedagogical-strategic guidance for successful learning in Mathematics, which equates to the development of proficiency in Mathematics, that is, having knowledge of the content, developing skills, and building confidence in Mathematics (National Research Council, 2002).

The objective of this research was to characterize teacher intervention in Mathematics classes in the second cycle of Mozambican General Secondary Education, as we believe that such characterization can foster reflection and improvements in teacher practice, especially in the practice of assisting students in the classroom, thus improving student learning in Mathematics *in situ*. Furthermore, researching the classroom intervention process can refine practice and deepen the theoretical understanding of the phenomena inherent to this learning environment (Stylianides & Stylianides, 2013).

Theoretical frameworks

Teacher intervention is a regulatory pedagogical action aimed at ensuring student learning in a reflective and self-regulated manner (Mendes & Buriasco, 2018; Wang & Sperling, 2020). It assumes configurations that fulfill both general and specific learning processes related to Mathematics. To clarify these indications, this section of the article addresses theoretical positions on learning and the role of intervention in the teaching and learning of Mathematics.

Learning is a complex and multifaceted concept and process that lacks a single, universally agreed-upon definition (Illeris, 2009; Schunk, 2012). With regard to it, therefore, several theories or approaches coexist, some of which are considered dichotomous or disjoint, and others are agglutinative. Dichotomous theories are housed in behaviorist or cognitivist worldviews, while agglutinative theories recognize correlations between processes of the two paradigms.

Although each learning landscape can be exhaustively explained, the classroom is most often identified by its agglutinative or mixed landscape, in which teacher stimulation or reinforcement triggers cognitive processes that generate observable student responses or behaviors. For example, “teachers’ explanations and demonstrations of concepts serve as environmental inputs for students. Student practice of skills, combined with corrective feedback as needed, promotes learning” (Schunk, 2012, p. 22).

In general, through this 'view', learning is "a process of external interaction between the student and their social, cultural or material environment, and an internal psychological process of elaboration and acquisition" (Illeris, 2009, p. 8). Furthermore, instruction is the "set of external events designed to facilitate internal learning processes" (Schunk, 2012, p. 222).

These definitions encompass the influence of external processes on internal ones. Illeris (2009) considers external processes to be the general basis of learning and relates the external environment to the learner through a process of interaction. In classroom contexts, this position highlights the role of the teacher, the main external actor and formally responsible for stimulating and/or reinforcing the student's internal learning processes. In internal processes, the learner fulfills the psychological processes of elaboration and acquisition of content, in which two equal psychological functions are interrelated in an integrated way: (i) managing the content of learning, and (ii) encouraging, providing, and directing the necessary mental energy that mobilizes the process (Illeris, 2009).

The function of managing learning content occurs in the content dimension, which refers to the knowledge and skills learned, including "opinions, insights, meanings, attitudes, values, ways of acting, methods, strategies, etc." (Illeris, 2009, p. 10). According to the author, this dimension is internally related to the incentive dimension, which is responsible for providing and directing the mental energy necessary for managing the content in the learning process and includes feelings, emotions, motivations, and volitions. The author explains that these two functions, (i) and (ii), mutually influence each other: learning content is motivated by desire, interest, need, or compulsion, but new information can also change the incentive condition. This interrelation considers the thoughts, beliefs, attitudes, and values of the students (Schunk, 2012), because

What students do with information—how they attend to, rehearse, transform, code, store, and retrieve it—is critically important. The

ways that learners process information determine what, when, and how they learn, as well as what use they will make of the learning. (Schunk, 2012, p. 22).

Among the internal processes of learning acquisition, there are cognitive, metacognitive, and motivational processes. Cognitive processes are related to memory and transfer (Schunk, 2012). The author indicates that memory is related to the encoding, organized storage, and meaningfulness of information obtained from external stimuli. This information "is retrieved from memory in response to relevant cues that activate the appropriate memory structures" (Schunk, 2012, p. 23). In terms of implications for teaching, the author states that the teacher needs to present information in a way that allows students to organize it, relate it to what they already know, and remember it meaningfully.

Transfer follows memory and refers to the understanding and application of stored knowledge in different contexts, and can be triggered by similar or dissimilar elements (Schunk, 2012). In teaching, the teacher creates situations in which students apply rules and procedures to determine the desired knowledge.

Metacognitive processes are related to self-awareness, planning, verification/monitoring, and self-evaluation of performance (Corrêa et al., 2020; Schunk, 2012) and result from the conscious and deliberate control of cognitive activity (Portilho, 2011). It is a process of recoding and reorganizing information from the cognitive structure, also called self-regulation: "the process whereby learners systematically direct their thoughts, feelings, and actions toward the attainment of their goals" (Schunk, 2012, p. 24).

A student practices metacognition when they think about their thinking (Corrêa et al., 2020), when they become aware of their knowledge and understand that they must double-check what they have done (Portilho, 2011). This implies understanding what skills, strategies, and resources a task requires and knowing how and when to use these skills and strategies

to ensure that the task is completed successfully (Corrêa et al., 2020; Schunk, 2012).

When evidence that a student has not learned something does not personally bother them, the teacher should stimulate the student's metacognitive processes to lead them to rethink their work (Portilho, 2011; Schunk, 2012). According to Portilho (2011, pp. 105-106), "education should encourage individuals to stop, reflect on their own way of being, thinking, acting, and interacting, as well as consciously invite them to change when necessary to improve their learning".

Motivational processes, finally, refer to inputs that increase the likelihood of students learning (Schunk, 2012). This involves mobilizing incentives that trigger the administration of content. Therefore, in the classroom, teachers need to consider providing inputs that stimulate the incentive dimension to ensure that students remain motivated or interested in engaging in learning activities and learning (Illeris, 2009; Schunk, 2012).

Regarding the role of intervention in the teaching and learning of Mathematics, it is known that it involves general processes, with specific nuances inherent to Mathematics Education, which are linked to teacher actions, the selection of strategies, and pedagogical goals. In the case of teacher action, it is defined as the action that the teacher performs in the classroom, aiming at teaching and learning (Andrade et al., 2018) or "the teacher's performance in the classroom that modifies or maintains the student's knowledge *status*" (Maulana, 2022, p. 32).

Teacher actions in Mathematics classes have varied depending on the pedagogical-methodological approach adopted in the classroom. Andrade and Arruda (2017) identified that in "traditional" classes, four teacher actions generally occur: Bureaucratic-Administrative, Waiting, Writing, and Explaining. Other research in this area of knowledge has expanded this set of teacher actions, analyzing classes based on other pedagogical-methodological approaches, namely: the use of manipulable teaching materials (Dias et al., 2017), digital technologies (Vicentin et al., 2020), and approaches planned with games (Dias et al., 2022), which can be

consulted in the following table, where we synthesize these teacher actions, describing them in a reinterpreted way.

In Table 1, we list the teacher actions of Mathematics teachers derived from the research results of the authors mentioned in the previous paragraph, and which are linked to various pedagogical-methodological approaches, excluding those strictly related to each approach. For example, we do not describe the “calibrating” action because it is a teacher action specific to classes based on the use of technologies, in this case using a digital whiteboard and learning objects (Vicentin et al., 2020).

In column 1 we insert the actions represented by verbs conjugated in the present participle, and in the second column a description of each action.

Table 1

List of teacher actions of teachers who teach Mathematics

Teacher actions	Descriptions
Thanking	The action of expressing gratitude for the student's action.
Threatening	To promise something unpleasant to the student as a result of inappropriate student action.
Arguing	To present the student with logical ideas that prove a statement.
Calling attention	It is to warn the student who acted in a way that deviated from what was expected in the classroom.
Commenting	To critically assess student behavior.
Checking	To verify compliance in the student's activities.
Moving	It's to move in or out and into the classroom.
Writing	To write content, a demonstration, an example, or exercise on the board.
Waiting	Suspend any objective action while awaiting student action.
Explaining	To clarify content, an ambiguous exercise to make someone understand.
Justifying	To prove or present reasons for a statement or action, demonstrate something.
Negotiating	To make agreements with students regarding the activity or its outcome.
Organizing	To arrange the students in a specific order.
Congratulating	To congratulate a student who achieved something commendable.
Requesting	To request the student to grant something, perform an action or activity.
Asking	To interrogate the student, requesting information about something/someone.
Providing	To take action, to provide something for the accomplishment of something.

Reminding	To revisit something that has already been worked on previously.
Disapproving	To reject or censure the student's action or result.
Answering	To say something in response to a student's question.
Supervising	To control the student's activity.

Note. Adapted from Maulana (2022).

These actions serve the dual purpose of teaching and learning; that is, while the teacher carries out instruction through these actions, they also seek to promote student learning.

As previously indicated, Mathematics learning is considered successful when the student develops proficiency in Mathematics, that is, has knowledge of the content, develops skills, and has confidence in relation to Mathematics. To this end, according to the National Research Council (2002), teachers need to encourage students to generate and share solutions, questioning them and promoting discussions that stimulate thinking and choices of strategies, spending more time developing mathematical ideas than solely practicing skills.

Mathematical proficiency comprises five interconnected strands throughout its development: Conceptual understanding, Procedural fluency, Strategic competence, Adaptive reasoning, and Productive disposition. (National Research Council, 2002; Suh, 2007).

Table 2 summarizes the description of each of these strands, with column 1 listing the strand's name and column 2 providing a brief description of each.

Table 2

The different strands of proficiency in Mathematics and their descriptions

Strands	Descriptions
Conceptual understanding	Understanding mathematical concepts, namely operations and relationships, the meaning of symbols, diagrams, and mathematical procedures, which allow connecting new ideas to old ones and learning.
Procedural fluency	Ability to perform mathematical procedures, such as adding, subtracting, multiplying, and dividing, among others, in a flexible, precise, efficient, and appropriate manner.
Strategic competence	The ability to formulate and represent mathematical problems and devise strategies to solve them appropriately.

Adaptive reasoning	Reflection and logical construction of explanations and justifications for problem-solving or for reworking something known into a new situation.
Productive disposition	A willingness, enthusiasm, or tendency to view Mathematics as sensible, useful, valuable, and necessary, and consequently, to enjoy or take pleasure in engaging in mathematical activities and developing one's own effectiveness.

Note. Adapted from National Research Council (2002) and Suh (2007).

When comparing these strands with the internal psychological processes of learning, it was possible to recognize strong links with the management of mathematical content and with encouraging engagement. It is understood that the strands of Conceptual Understanding and Adaptive Reasoning are related to the encoding, organized and meaningful storage of information; the strands of Procedural Fluency and Strategic Competence are related to the skills and application of stored knowledge with ease; and the strand of Productive Disposition is linked to the dimension of encouragement, which is responsible for propelling the mental energy necessary for managing the content.

On the other hand, learning is not a linear and meta-axiomatic process, as unexpected situations occur throughout the lesson, especially because the object of instruction is another human being, capable of resisting the teacher's actions (Tardif & Lessard, 2014). This is independent of the quality of the planning and execution of the instruction, because, "even when instruction is planned with great care, delivered effectively, and in a way that engages students, the learning outcomes often bear little or no relation to what was intended" (William, 2011, p. 03). This proposition of the lesson requires that instruction demands reflection in action (Schön, 1987) and the regulation of the teacher's actions *in situ*.

In Mathematics Education, the preferred regulation of teacher action is intervention, which is based on student difficulties (Chin & Fu, 2021; Gersten et al., 2009; Holmes & Dowker, 2013), is a product of teacher reflection, and aims at student reflection, critique, and self-regulation (Mendes & Buriasco, 2018; Pires & Buriasco, 2017).

Teacher intervention is an act that avoids “spoon-feeding the student,” providing corrections in order to help the student reflect and learn in depth (Ali, 2011). It is believed that “by reflecting on their work and dealing with interventions, the student was able to evolve in their levels of understanding of mathematical concepts and tools” (Mendes & Buriasco, 2018, p. 49, our translation). This characteristic of teacher intervention consolidates the link between teacher intervention and teaching oriented towards the development of proficiency in Mathematics.

This connection extends to the pedagogical treatment of student mistakes, since in Mathematics proficiency “mistakes are valued as opportunities for everyone to learn, and correctness is determined by the logic and structure of the problem, rather than by the teacher.” (National Research Council, 2002, p. 26). Therefore, by triggering reflection, self-criticism, and self-regulation in students when faced with mistakes, teacher intervention offers an opportunity for the student to learn actively within the logic of the difficulty. Learning is active when students “are intensely engaged in both mental and physical exercises during the learning process” (Chin & Fu, 2021, p. 539).

Some examples of teacher intervention in Mathematics classes are: providing hints/clues and asking questions. Regarding the provision of hints/clues, Ali (2011) exemplifies with a scenario in which students failed to systematize a situation that would generate a formula. Subsequently, “the teacher did not write the exact formula, but gave a hint (indicating variables by shapes such as square, triangle)” (Ali, 2011, p. 61).

Questioning, in turn, is defined as “the use of questions and other prompts offered to students in order to help them disentangle themselves or direct their attention in a way that is potentially useful for making mathematical progress” (Mason, 2020, pp. 705-706). It was used by Trevisan and Buriasco (2014, p. 04, our translation) as “a means for students to self-regulate their learning process, giving clues to correct possible mistakes and proceed with the solution”. In addition to these authors, Kamii (1984 *apud* Hoffmann, 2018, p. 105) argues that “when a

child says that ' $4+2=5$ ', the best way to react, instead of correcting them, is to ask them: – how did you get five? Children often correct themselves autonomously as they try to explain their reasoning to another person”.

Teaching interventions can incorporate distinct or combined pedagogical strategies. In their literature review, Wang and Sperling (2020) identified three intervention strategies that can be applied in isolation or in combination: cognitive, metacognitive, or motivational. Cognitive strategies are related to the mastery of a subject and focus on improving specific skills related to that subject (Wang & Sperling, 2020). These strategies, related to the cognitive processes of memory and transfer (Schunk, 2012), aim to recall or transfer what the student has stored and can apply in new situations.

Metacognitive strategies are related to improving constructs in a self-regulated way and refer to helping students self-monitor, plan, and self-regulate their learning processes (Wang & Sperling, 2020). Finally, “motivational strategies refer to strategies that aim to motivate students and affect mathematics learning” (Wang & Sperling, 2020, p. 7). According to the authors, these interventions are intended to improve students’ self-efficacy or affective self-regulation.

Methodological procedures

As indicated in the abstract, this article presents some results from a qualitative research study, as we understand that characterizing teacher intervention from the perspective of teacher action and its pedagogical configuration/orientation requires recognizing and making explicit these configurations in teacher actions. This aim and its analytical process fit within qualitative analysis, which “is the classification and interpretation of linguistic (or visual) material to make statements about implicit and explicit dimensions and structures of meaning construction in the material and what is represented in it” (Flick, 2014, p. 05).

The qualitative data analysis for this investigation consisted of identifying teacher actions with an intervention configuration and then

classifying them as cognitive, metacognitive, or motivational strategies, and relating them to strands of proficiency in Mathematics (Conceptual Understanding, Procedural Fluency, Strategic Competence, Adaptive Reasoning, or Productive Disposition).

We present the results of this process, drawing inspiration from descriptive and explanatory approaches, as defined by Arruda et al. (2021). Description is the primary objective of qualitative data analysis (Flick, 2014), and through it, the construction of interpretations and understanding of facts is based on the study of concrete action systems (Arruda et al, 2021). The explanatory approach, as the authors explain, consists of interpreting what others are thinking and feeling in terms of objectives, desires, beliefs, motives, etc.

In practical terms, we describe the teacher interventions based on the characteristics of the acts observed *in situ* in the classroom and which, in the analytical continuity, were linked to the pedagogical strategies and strands of proficiency in Mathematics through comparison and interpretation based on the inference of objectives, desires, beliefs and/or motives of the teacher interventions, in an interpretative exercise that considered the flow and relationships between teacher actions and student actions. The descriptions and explanations were complemented by recording units representative of the teacher intervention and the student action, when necessary.

Data collection involved four teachers who taught Mathematics at the Pemba, Montepuez, and Dom Bosco de Montepuez Community Secondary Schools, who agreed to participate in the study by signing consent after a research request was submitted to the School Directors through accreditation by Rovuma University – Cabo Delgado. It should also be clarified that data collection occurred through observation of 30 of these teachers' Mathematics classes, which were filmed using a mobile phone.

The analysis process began with the selection of (video-recorded) classes, considering those in which the teachers performed self-observation (watched videos of their own classes) and provided clarifications on the

causes and pedagogical purposes of certain actions. Subsequently, from a collection of 30 classes, we selected 10 classes to compose our investigative corpus. After selection, the 10 classes were transcribed and analyzed according to the procedures of Content Analysis (Bardin, 2016; Schreier, 2014), defined as a systematic and flexible method that allows for the description and meaning of the data (Schreier, 2014). Various information relating to these selected classes is presented in Table 3.

In the first column we insert the code referring to the observed teacher, in column 2 the thematic unit developed by them and which is related to the school curriculum, in the third column some details regarding the content covered, and in the last column the class of the Mozambican Secondary System in which this teacher worked at that time.

Table 3

Information regarding the analyzed classes

Teachers	Thematic units	Content	Classes
P ₁	Introduction to Mathematical Logic	Properties of conjunction and disjunction operations and the property of propositional negation.	11th
		Material equivalence.	11th
	Module	Modulus function of type $y = x $.	12th
P ₂	Introduction to Mathematical Logic	Notion of logic.	11th
		Conjunction operation and disjunction operation.	11th
	Module	Module properties.	12th
P ₃	Module	Module properties.	12th
	Introduction to Mathematical Logic	Conjunction operation and disjunction operation.	11th
P ₄	Module	Geometric interpretation of the absolute value of the difference between two real numbers.	12th
	Algebra	Exponential and logarithmic equations.	11th

From an execution standpoint, Content Analysis fulfills the steps of coding, categorization, and interpretation (Bardin, 2016; Schreier, 2014). In the coding phase, we recursively read the transcripts and identified the

teacher actions, coding them using the verbs that represent them, based on the teacher actions described in Table 1 and on new codes for emerging teacher actions. Thus, for the action Asking we use the code *Ask*, for Reinforcing we represent it with the code *Rei*, and so on. All the actions of each teacher were numbered to allow them to be represented in the form *Codn-P_i*. Thus, act 2 of the action Asking from Teacher 3 was represented by the code *Ask2-P₃*.

During categorization, we grouped teacher actions with intervention configurations represented by the same verb and described them considering all variables. Subsequently, in the interpretation stage, we related them to pedagogical strategies and strands of Mathematical Proficiency, without neglecting the general learning processes. This connection results from comparing the clarification of the causes and pedagogical purposes of the action, revisited in the process of self-observation, and from an exercise of interpretation and inference of the intentionality of the teacher interventions, based on Mathematical ideas or skills and the learning processes triggered or targeted.

Results and discussions

In this section, we describe and discuss the interpretative results related to the analyses of teacher interventions, carried out by four teachers who were teaching Mathematics at the time of observation and recording of their classes.

The description consists of specifying the characteristics of the teacher interventions, according to their actions, and the discussion is based on understanding the pedagogical-strategic orientation of these teaching interventions, taking into account the pedagogical strategies (Wang & Sperling, 2020) and the strands of Mathematics Proficiency (National Research Council, 2002; Suh, 2007).

The analysis showed that teacher actions have diverse causes, purposes, and internal strategic configurations, such that not everything a teacher does through teaching is an intervention. For example, a teacher is

not always intervening when explaining something, although they may use that action for that purpose. Thus, the causes and pedagogical purposes of a teaching action determine whether or not the act is an intervention.

Assuming teacher intervention as a learning opportunity arising from student difficulties and aimed at student self-regulation (Chin & Fu, 2021; Mendes & Buriasco, 2018), we identified seven teacher actions with intervention configurations, namely: Warning, Commenting, Writing, Explaining, Asking, Reinforcing, and Reminding, announced in Table 1 (except for the Reinforcing action, which is emergent) and revisited in Table 4, with a description of the teacher intervention configurations evidenced in our investigative process.

Table 4

Actions related to observed teaching interventions and settings

Teacher actions and their codes	Descriptions of the settings for teaching interventions
Warning (War)	The act of calling a student's attention to encourage them to pay attention, monitor themselves, correct themselves, or engage in learning activities.
Commenting (Com)	To offer critiques of student behavior in relation to engagement in Mathematics learning activities in order to trigger reflection and self-criticism.
Writing (Wri)	The act of writing expressions analogous to those in use to trigger the transfer of content to the resolution of activities.
Explaining (Exp)	Explaining, as an intervention, consisted of clarifying tasks or activities, providing tips, or making explicit the objectives or purposes of the task.
Asking (Ask)	To question and challenge incorrect or insufficient student answers or results in order to trigger revisions and improvements.
Reinforcing (Rei)	The act of revitalizing student performance to produce desired responses through the addition of pleasant stimuli (value or score).
Reminding (Rem)	To revisit previously presented rules or concepts so that the student can apply them to independently verify and/or correct answers or task results.

In the previous table, we organized the general characteristics of the teacher interventions in each action. These characteristics are revisited in

Table 5, describing the causes that led to the possible emergencies, the purposes that support them, and some representative excerpts or acts through which some teacher actions assumed the configuration of an intervention.

Table 5

Actions, causes, purposes, and some examples related to interventions

Actions	Causes	Purposes	Representative excerpts
Warning	Mistake in completing a truth table about the conjunction of propositions.	To encourage learning through repetitive practice.	War1 ⁴ -P ₂ – “So, you must prepare many times to master this.”.
	Mistake regarding a module property that required proof.	To appeal for calm and monitoring in solving the exercise.	War2-P ₃ – “You can’t rush to the result, just look at these numbers (pointing to the expression $3 - 5 =$)”.
Commenting	Insecurity expressed through murmurs in the response.	To appeal for the production of clear and correct answers.	Com9-P ₄ – “Uhm! You see, that way of answering, you’re mumbling. You’re answering insecurely. Even if I repeat it several times, you always [...] it’s necessary to go back to 8th grade”.
	Insufficient volunteers to solve exercises on the board.	To discourage fear and encourage students to participate in learning tasks.	Com20-P ₄ – “There on the board you guys are afraid”. Com7-P ₃ – “I’ll choose back there. Because you guys here don’t volunteer”
Writing	Mistake regarding the commutative property of	To encourage the transfer of procedures	Wri1-P ₁ – “ $3 + 8 =$ ”.

⁴ The number that accompanies the verb code representing the action is related to the excerpt number in which that action is found in the transcript – in this case, War1 is excerpt number 1.

	conjunction of propositions.	from the commutative property of arithmetic to disjunction.	
	Mistake in the expression $4 \cdot (-1) = 3$.	To trigger reflection on the influence of the factor (-1) in the product $4 \cdot (-1) =$.	Wri28-P ₄ – “ $4 \cdot 1 =$ ”.
Explaining	Silence regarding the operation of the double negation of a proposition.	To clarify the task and encourage students to produce answers.	Exp16-P ₁ – “We want to refute that proposition twice”.
	Strategic mistake in solving a task.	To clarify the need for a strategy in solving the task.	Exp24-P ₃ – “Under these conditions here [...] So we have to create a condition here in the module [...]”.
Asking	Mistake in the response “operation property”, which followed a request whose response is the distributive property.	To trigger reflection and self-regulation.	Ask63-P ₁ – “What is this property?”
	Mistake regarding the sign of the second term in the expression $3 - 5 =$.	To initiate reflection and self-regulation regarding the sign of addends in arithmetic operations.	Ask42-P ₃ – “Hey! Is that positive?”.
	Mistake regarding the sign of the second term in the expression $-5 + 4 =$ when it moves from the 1st to the 2nd member.		Ask72-P ₄ – “Just like 3?”
Reinforcing	Successive mistakes regarding the application of	To revitalize student performance in	Rei1-P ₁ – “Three more points for whoever answers correctly”.

	the implication rule.	applying concepts.	
Reminding	Silence: absence of volunteers to perform the task.	To forward the resolution of the task.	Rem4-P ₂ – “Okay. We have this table for us to fill in about conjunctions. According to what we wrote, a conjunction will be true when both propositions are true [...]”.
	Mistake in completing a truth table for exclusive disjunction.		Rem7-P ₂ – “Okay. According to the rule, it will only be true when the logical values are different”.

In Table 5, we can observe that teacher intervention stemmed from mistakes or insecurities (silence or insufficiency) in student responses to requests for answers or task completion. It also makes explicit the complexity of teacher intervention in Mathematics classes, which is not linked to a single teacher action for the same cause and purpose. For example, the action of Asking, described as the act of questioning the student, requesting information about something/someone (Maulana, 2022), as an intervention, was restricted to questioning (Mason, 2020). We can say that teacher intervention in the observed classes was flexible, reflective, and adapted to the situation.

An analysis of the quantities of teacher interventions revealed variations, both from the point of view of teacher actions that aggregate interventions among teachers and from the quantity of interventions in the teacher action. In Table 6, shown below, we quantify the interventions carried out by each teacher in each teacher action. In the fractions of the form $\frac{a}{b}$, a and b represent, respectively, the number of interventions out of the total number of acts in the respective teacher action, and the dashed lines (--) represent the absence of intervention for that teacher action.

Table 6

Interventions performed by the teacher in each teaching activity.

Teacher actions	Interventions by the teacher			
	P ₁	P ₂	P ₃	P ₄
Warning	$\frac{2}{2}$	$\frac{4}{7}$	$\frac{2}{5}$	$\frac{1}{3}$
Commenting	--	$\frac{4}{9}$	$\frac{2}{4}$	$\frac{4}{21}$
Writing	$\frac{2}{71}$	--	--	$\frac{9}{34}$
Explaining	$\frac{10}{38}$	$\frac{7}{95}$	$\frac{8}{67}$	$\frac{5}{71}$
Asking	$\frac{30}{125}$	$\frac{10}{81}$	$\frac{12}{50}$	$\frac{12}{111}$
Reinforcing	$\frac{1}{1}$	--	--	--
Reminding	$\frac{6}{8}$	$\frac{5}{13}$	$\frac{12}{25}$	--

This table shows that the intervention varies from one teacher to another, both in terms of the teacher action carried out and the number of actions performed. It also shows that, despite the variation, the intervention through the actions of Warning, Explaining, and Asking was carried out by all participants in the research.

Regarding the pedagogical guidance of the teacher interventions, returning to what has been presented so far in this section where we present the interpretative results and some discussions, in the face of the teachers' reaction to mistakes or insecurities in students' responses to requests for answers or completion of tasks, such interventions are linked to pedagogical strategies and strands of proficiency in Mathematics in an amalgamated way in the teacher actions, such that it was not possible to homogeneously link a teacher intervention action to a single pedagogical strategy or strand of proficiency in Mathematics.

The interventions relate to teacher strategies in isolation or in combination, as already explained and indicated by Wang and Sperling (2020), and to strands of proficiency in Mathematics in a combined or intertwined manner, as described in the National Research Council (2002) and by Suh (2007). Regarding pedagogical strategies, only the

interventions of the actions Commenting, Reinforcing, and Asking assumed the configurations of a single pedagogical strategy: the motivational and metacognitive, respectively. The interventional comments criticized student behavior in relation to engagement with Mathematics learning activities, mainly due to affective causes, such as fear or insecurity, and due to possible effects of an emotional and volitional nature (Illeris, 2009).

Considering the causes of interventionist comments and their orientation towards propelling will and security, they were configured as strategies for promoting productive disposition for the development of conceptual understanding and procedural fluency. For example, when criticizing murmurs about responses related to expression " $2 - 3 =$ " after much repetition (Com9-P₄), the teacher pointed out shortcomings in conceptual comprehension and procedural fluency, and encouraged productive student disposition so that students could develop the required conceptual comprehension.

Interventions through the action of Asking questions took the form of inquiries (Mason, 2020), asking about the outcome of a task or requesting an explanation of the result. These questions challenged conceptual comprehension and triggered adaptive reasoning: reflection and logical construction of explanations and justifications for problem-solving (National Research Council, 2002; Suh, 2007). Therefore, the questions were configured, above all, as stimuli to metacognitive processes to lead the student to rethink their work (Portilho, 2011; Schunk, 2012) or reinforcements to guide students in self-regulation while constructing a convincing argument (Hoffmann, 2018).

The remaining teacher interventions were linked to pedagogical strategies and strands of proficiency in Mathematics, in a combined or intertwined way. For example, by drawing attention to study and monitoring aimed at correcting mistakes related to operations in the warning interventions, the teachers evoked cognitive and metacognitive strategies (Wang & Sperling, 2020), seeking conceptual understanding, adaptive reasoning, and productive disposition (National Research Council, 2002;

Suh, 2007). This analytical exercise on all interventions generated Table 7, in which we summarize how the interventions of each teacher action guided the students pedagogically.

Table 7

Pedagogical guidance of the interventions in teacher actions

Teacher actions	Pedagogical guidance of the interventions	
	Pedagogical strategies	Strands of proficiency
Warning	Cognitive and metacognitive.	Conceptual understanding, Adaptive reasoning, and Productive disposition.
Commenting	Motivational.	Conceptual understanding, Adaptive reasoning, and Productive disposition.
Writing	Cognitive, metacognitive, and motivational.	Conceptual understanding, Adaptive reasoning, and Productive disposition.
Explaining	Cognitive and motivational.	Conceptual understanding, Procedural fluency, Strategic competence, and Productive disposition.
Asking	Metacognitive.	Conceptual understanding, Adaptive reasoning, and Productive disposition.
Reinforcing	Motivational and metacognitive.	Conceptual understanding, Procedural fluency, and Productive disposition.
Reminding	Cognitive and motivational.	Conceptual understanding and Productive disposition.

Table 7 shows the predominance of pedagogical purposes of Conceptual understanding and Productive Disposition. Considering that metacognitive strategies are related to the improvement of constructs in a reflective and self-regulated way (Wang & Sperling, 2020), the motivational strategy is implicit in metacognitive interventions. Thus, we can affirm that teachers prioritized teaching interventions with potential in strategies that trigger learning activities, from cognitive ones that evoked memory and the transfer of knowledge to a specific context to metacognitive and motivational ones that propel self-knowledge, planning,

verification/monitoring and evaluation of one's own performance and increase the probability of students learning (Illeris, 2009; Schunk, 2012; Corrêa et al., 2020).

Final considerations

In this article, we discuss the pedagogical guidance of the teacher interventions of four Mozambican Mathematics teachers, with the aim of characterizing these interventions in their classes in the second cycle of General Secondary Education. Our concern was to answer the question: through which teacher actions do Mathematics teachers intervene in their classes, and how can the pedagogical guidance of these interventions be characterized?

Based on Content Analysis (Bardin, 2016; Schreier, 2014), we found that teacher interventions are acts of Warning, Commenting, Writing, Explaining, Asking, Reinforcing, and Reminding, and were triggered by students' mistakes or insecurities in their responses to the teacher's requests or in carrying out activities aimed at learning Mathematics. The configurations and pedagogical orientations of these interventions were variable and sometimes intertwined, both from a strategic point of view and in relation to pedagogical purposes.

From a strategic point of view, the teacher interventions sought to stimulate cognitive, metacognitive, or motivational activities in isolation or in combination (Wang & Sperling, 2020). Specifically, interventions stemming from mistakes were aimed at generating cognitive or metacognitive activities, while those stemming from student insecurity were fundamentally aimed at motivating students to engage in learning activities.

In terms of purposes, the teacher interventions timidly revealed an orientation towards the development of proficiency in Mathematics, mainly focusing on Conceptual Understanding, Procedural Fluency, and Productive

Disposition. We indicate “timidly” because no teacher explicitly implemented interventions that combined all strands of proficiency in Mathematics in a single lesson. Despite this emphasis, the pedagogical guidance towards proficiency in Mathematics was characterized as intertwined (National Research Council, 2002; Suh, 2007), as it was possible to recognize, explicitly or implicitly, more than one strand of proficiency in Mathematics in a single intervention.

This pedagogical-strategic approach, however, does not represent instruction for successful Mathematics learning, because, in addition to there being few interventions in each class, no teacher carried out interventions that explicitly addressed all strands of proficiency in Mathematics. Considering the quantity, origin, and pedagogical-strategic orientation of the teacher’s intervention, we can affirm it as an advantageous condition for promoting successful Mathematics learning; therefore, it should occur in equal quantity to the students’ difficulties in mathematics classes.

These results raise two questions: Are these interventions and their pedagogical-strategic guidance representative of the majority of teachers dedicated to teaching Mathematics? What is the relationship between the pedagogical-strategic guidance of the interventions and the training of Mathematics teachers?

References

- Ali, T. (2011). Exploring students’ learning difficulties in secondary mathematics classroom in Gilgit-Baltistan and teachers’ effort to help students overcome these difficulties. *Bulletin of Education and Research*, 33(1), 47-69. https://ecommons.aku.edu/pakistan_ied_pdck/81
- Andrade, E. C., & Arruda, S. M. (2017). Categorias das ações didáticas do professor de Matemática em sala de aula. *Acta Scientiae*, 19(2), 254-276. <file:///C:/Users/Usuario/Downloads/2819-9875-1-PB.pdf>

- Andrade, E. C., Arruda, S. M., & Passos, M. M. (2018). Descrição da ação docente de professores de Matemática por meio da observação direta da sala de aula. *Educação Matemática Pesquisa*, 20(2), 349-368. <http://dx.doi.org/10.23925/1983-3156.2018v20i2p349-368>.
- Arruda, S. M., Passos, M. M., & Broietti, F. C. D. (2021). O Programa de Pesquisa sobre a Ação Docente, Ação Discente e suas Conexões (PROAÇÃO): fundamentos e abordagens metodológicas. *REPPE – Revista de Produtos Educacionais e Pesquisas em Ensino*, 5(1), 215-246. <https://seer.uenp.edu.br/index.php/reppe/article/view/2328>.
- Bardin, L. (2016). *Análise de conteúdo*. Lisboa: Edições 70.
- Chicote, R. S., & Deixa, G. V. (2020). Insucesso escolar: formação de professores de matemática em questão School failure: Mathematics teachers training in question. *Educação Matemática Pesquisa: Revista do Programa de Estudos Pós-Graduados em Educação Matemática*, 22(1). <http://dx.doi.org/10.23925/1983-3156.2020v22i1p276-294>
- Chin, K. E., & Fu, S. H. (2021). Exploring the Implementation of An Intervention for A Pupil with Mathematical Learning Difficulties: A Case Study. *Journal on Mathematics Education*, 12(3), 531-546. <http://doi.org/10.22342/jme.12.3.14473.531-546>
- Corrêa, N. N. G., Passos, M. M., Corrêa, H. E. da R., & Arruda, S. M. (2020). Estudo exploratório sobre o uso da palavra “metacognição” em artigos publicados em periódicos brasileiros do ensino de ciências e matemática de 2007 a 2017. *Caderno Brasileiro de Ensino de Física*, 37(1), 6-26. <http://dx.doi.org/10.5007/2175-7941.2020v37n1p6>
- Dias, M. P., Arruda, S. M., Oliveira, A. C. D., & Passos, M. M. (2017). Relações com o ensinar e as categorias de ação do professor de Matemática. *Caminhos da Educação Matemática em Revista*, 7(2), 66-75. https://periodicos.ifs.edu.br/periodicos/caminhos_da_educacao_matematica/article/view/144/133
- Dias, M. P., Arruda, S. M., & Passos, M. M. (2022). Conexões entre as ações docentes e discentes em uma aula de Matemática planejada com jogos. *Research, Society and Development*, 11(4), e6711427061-e6711427061. <file:///C:/Users/Usuario/Downloads/27061-Article-316789-1-10-20220311.pdf>
- Flick, U. (2014). Mapping the Field. In FLICK, U. *The SAGE Handbook of Qualitative Data Analysis* (pp. 3-18). London: SAGE. E-book.
- Gersten, R., Beckmann, S., Clarke, B., Foegen, A., Marsh, L., Star, J. R., & Witzel, B. (2009). Assisting students struggling with mathematics:

Response to intervention (RtI) for elementary and middle schools. *IES National Center for Education Evaluation Practice Guide*.

Hinton, V., Flores, M. M., & Shippen, M. (2013). Response to Intervention and Math Instruction. *On-line Submission*, 1(3), 190-201. <https://files.eric.ed.gov/fulltext/ED548038.pdf>

Hoffmann, J. (2018). *Avaliação mediadora: uma prática na construção da pré-escola à universidade* (34ª ed.). Porto Alegre: Mediação.

Holmes, W., & Dowker, A. (2013). Catch up numeracy: a targeted intervention for children who are low-attaining in mathematics. *Research in Mathematics Education*, 15(3), 249-265. <https://doi.org/10.1080/14794802.2013.803779>

Illeris, K. (2009). *Contemporary theories of learning: learning theorists – in their own words*. London and New York: Routledge.

Langa, N. D. G. J. (2020). Avaliação do rendimento pedagógico dos alunos da 12ª classe na disciplina de matemática antes e depois da introdução do modelo dos exames de escolha múltipla. *Revista Ensino de Ciências e Humanidades-Cidadania, Diversidade e Bem Estar – RECH*, 4(1), 110-120. <https://periodicos.ufam.edu.br/index.php/rech/article/view/7564>

Mason, J. (2020). Questioning in Mathematics Education. In Lerman, S. *Encyclopedia of Mathematics Education* (2ª ed., pp. 705-711). Switzerland: Springer. E-book.

Maulana, G. M. (2022). *Ações Docentes com características avaliativas em aulas de Matemática no Ensino Secundário Geral moçambicano*. [Tese de doutorado em Ensino de Ciências e Educação Matemática, Universidade Estadual de Londrina].

Mendes, M. T., & de Buriasco, R. L. C. (2018). A utilização da prova em fases como recurso de ensino em aulas de cálculo. *Revista Paranaense de Educação Matemática*, 7(14), 39-53. <https://periodicos.unespar.edu.br/index.php/rpem/article/view/6117>

National Research Council. (2002). *Helping children learn mathematics*. National Academies Press.

Pires, M. N. M., & Buriasco, R. L. C. (2017). Professores dos anos iniciais, a prova em fases e a possibilidade de aprender. *Zetetiké*, 25(3), 474-495. <https://doi.org/10.20396/zet.v25i3.8648524>

Portilho, E. (2011). *Como se aprende? Estratégias, estilos e metacognição* (2ª ed.). Rio de Janeiro: Wak.

- Schön, D. A. (1987). *Educating the reflective practitioner: Toward a new design for teaching and learning in the professions*. Jossey-Bass.
- Schreier, B. (2014). Qualitative Content Analysis. In Flick, U. *The SAGE Handbook of Qualitative Data Analysis* (pp. 170-183). London: SAGE. E-book.
- Schunk, D. H. (2012). *Learning theories an educational perspective*. Pearson Education, Inc.
- Silva, V. A. D. (2008). Relação com o saber na aprendizagem matemática: uma contribuição para a reflexão didática sobre as práticas educativas. *Revista Brasileira de Educação*, 13(37), 150-161. <https://www.scielo.br/j/rbedu/a/G39FkYpfhpQtffMSvCK4rMg/abstract/?lang=pt>
- Stylianides, A. J., & Stylianides, G. J. (2013). Seeking research-grounded solutions to problems of practice: Classroom-based interventions in mathematics education. *ZDM*, 45, 333-341. <https://doi.org/10.1007/s11858-013-0501-y>
- Suh, J. M. (2007). Tying it all together: Classroom practices that promote mathematical proficiency for all students. *Teaching Children Mathematics*, 14(3), 163-169. <https://doi.org/10.5951/TCM.14.3.0163>
- Tardif, M.; & Lessard, C. (2014). *O trabalho docente: elementos para uma teoria da docência como profissão de interações humanas* (9ª ed.) Petrópolis: Vozes.
- Trevisan, A. L., & Buriasco, R. L. C. (2014). Análise da produção escrita em uma prova de Matemática em Fases. *Revista Brasileira de Ensino de Ciência e Tecnologia*, 7(3), 1-11. <https://periodicos.utfpr.edu.br/rbect/article/view/1878>
- Vicentin, F., Passos, M. M., & Arruda, S. M. (2020). Caracterização das ações de alunos e professor em aulas de matemática fundamentadas no uso de tecnologias. *Revista Paranaense de Educação Matemática*, 9(20), 62-88. <https://periodicos.unespar.edu.br/index.php/rpem/article/view/6257>
- Wang, Y., & Sperling, R. A. (2020). Characteristics of effective self-regulated learning interventions in mathematics classrooms: A systematic review. In *Frontiers in Education* (Vol. 5, p. 58). Frontiers Media SA. <https://doi.org/10.3389/feduc.2020.00058>
- William, D. (2011). What is assessment for learning? *Studies in educational evaluation*, 37(1), 3-14.

<https://www.sciencedirect.com/science/article/pii/S0191491X11000149>