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La intervención docente en el aprendizaje de las matemáticas en la zona norte de Colegio de Bachilleres del Estado de Sinaloa

The teaching intervention in the learning of mathematics in the northern area of the Colegio de Bachilleres del Estado de Sinaloa

Intervenção docente na aprendizagem da matemática na zona norte do Colegio de Bachilleres del Estado de Sinaloa

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Resumen

Las matemáticas constituyen una de las asignaturas más importantes dentro del currículo del bachillerato en México. Sin embargo, al mismo tiempo, se observa que es la materia que más dificultades presenta para los estudiantes. Ante esta situación, es crucial que los profesores de dicha asignatura realicen intervenciones efectivas para abordar estas deficiencias, de modo que contribuyan a elevar el dominio de los conocimientos matemáticos en este nivel educativo. Por tal razón, el objetivo de la presente investigación fue describir las formas de intervención que llevan a cabo los profesores de matemáticas en el Colegio de Bachilleres del Estado de Sinaloa (COBAES) para enfrentar las dificultades de aprendizaje de los estudiantes, especialmente en la zona norte. Para ello, se adoptó un enfoque cualitativo y descriptivo, enmarcado en el paradigma etnográfico, que permitió efectuar registros de diarios de observación y entrevistas estructuradas con los profesores de matemáticas. Los resultados revelan que la intervención de esos docentes es limitada y carece de un plan

definido para mejorar el rendimiento de los estudiantes en esta asignatura. Además, se identifica una gran deficiencia en los conocimientos previos (bases) de los estudiantes, lo que exige que el docente realice una doble labor: enseñar conocimientos básicos de aritmética mientras avanza con el programa de estudios. Finalmente, se halló que el recurso más utilizado por los profesores es recurrir a tutores para ayudar a los alumnos que tienen rezagos en matemáticas.

Palabras clave: bachillerato, intervención docente, enseñanza-aprendizaje, matemáticas.

Abstract

Mathematics constitutes one of the most important subjects in the high school curriculum in Mexico and at the same time it is the subject that is most complicated for students. Given this, it is necessary for the mathematics teacher to carry out interventions that can help correct these deficiencies in young people, thus being able to contribute to raising the mastery of mathematical knowledge at this educational level. The objective of this research is to describe the forms of intervention of the mathematics teacher of the Colegio de Bachilleres del Estado de Sinaloa (COBAES) in the face of students' learning difficulties, particularly in the northern area. The qualitative and descriptive research method, therefore, diary records, observation and structured interviews were carried out with the mathematics teachers, having ethnography as an analytical reference. The results indicate that the intervention of mathematics teachers is scarce, without a defined plan that can help students improve their performance in the subject, coupled with the great deficiency of prior knowledge that the students present. Therefore, the teacher must do double duty, teaching basic arithmetic knowledge and continuing with the study program. According to this research, the resource most used by teachers is to rely on peer tutors and in this way help students who are lagging in mathematics.

Keywords: Teaching intervention, teaching-learning, mathematics.

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Resumo

A matemática é uma das disciplinas mais importantes do currículo do ensino médio no México. Porém, ao mesmo tempo, observa-se que é a disciplina que apresenta mais dificuldades para os alunos. Dada esta situação, é crucial que os professores desta disciplina realizem intervenções eficazes para colmatar estas deficiências, de modo a que contribuam para elevar o domínio do conhecimento matemático neste nível de ensino. Portanto, o objetivo desta pesquisa foi descrever as formas de intervenção realizadas pelos professores de matemática do Colegio de Bachilleres del Estado de Sinaloa (COBAES) para enfrentar as dificuldades de aprendizagem dos alunos, especialmente na zona norte. Para tal, adotou-se uma abordagem qualitativa e descritiva, enquadrada no paradigma etnográfico, que permitiu registos diários de observação e entrevistas estruturadas com professores de matemática. Os resultados revelam que a intervenção destes professores é limitada e carece de um plano definido para melhorar o desempenho dos alunos nesta disciplina. Além disso, identifica-se uma grande deficiência nos conhecimentos prévios (bases) dos alunos, o que exige do professor uma dupla tarefa: ensinar conhecimentos básicos de aritmética enquanto avança no programa de estudos. Por fim, constatou-se que o recurso mais utilizado pelos professores é recorrer a tutores para ajudar os alunos que estão atrasados em matemática.

Palavras-chave: ensino médio, intervenção docente, ensino-aprendizagem, matemática.

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Introduction

Currently, upper secondary education (EMS) in Mexico is experiencing its historical maximum in terms of enrollment nationwide, according to official figures provided by the Ministry of Public Education (SEP) (2020), with a record of 5.2 million of adolescents distributed in various subsystems and modalities (general high school, technical professional, technological, and online high school, among others). However, despite this high number of students, a number of problems have arisen, mainly related to learning mathematics, a subject that has historically been challenging for students.

Various measurements, such as the Program for International Student Assessment (PISA), as well as national evaluations such as the National Learning Assessment Plan (PLANEA) have pointed out the great deficiency in mathematical knowledge at this educational level (Organization for Cooperation and Development). Economic Development [OECD], 2018). For example, the results of PLANEA (INEE, 2017) indicate that 66.7% of

third-year high school students are at level I (low), which implies that they barely have basic knowledge. Likewise, 31.3% are at levels II and III (basic and medium), while only 2.5% reach level IV (high), which represents 125,000 students with outstanding proficiency.

Furthermore, the OECD reports that Mexican students obtain an average of 408 points in mathematics, well below the organization's average, which is 490 points. These figures are worrying when compared to countries with high technological development, such as China, Canada, Singapore, Japan, Finland and Germany, where 70% of their students are at level IV, which translates into critical skills, reflective and analytical in mathematics (INEE, 2016).

Within the field of mathematics teaching, what is known as traditional teaching prevails, which incorporates elements of constructivism, but is still based on the notion that teaching mainly involves exposing the contents in an orderly manner, with little attention to the development of mathematical thinking and with little student participation (Jiménez Espinoza and Gutiérrez Sierra, 2017). On the other hand, when teachers intervene more actively in the teaching of mathematics, significant improvements are observed in students, since spaces for reflection are created that promote the development of mathematical competence (Varón and Otálora, 2012).

Considering the above, the purpose of this article is to describe the forms of intervention of the mathematics teacher at the Colegio de Bachilleres del Estado de Sinaloa (COBAES), especially in the northern zone, in the face of the learning difficulties faced by their students. Furthermore, we seek to answer the following research question: how does the COBAES mathematics teacher address the learning difficulties of his students? This question focuses on aspects such as personalized intervention, students' prior knowledge, tutoring and the use of monitors.

The structure of this document is organized as follows: section two presents the theoretical framework, including the definition of some fundamental concepts for this research and references to relevant theorists. Section three describes the methodology used, that is, the research design, the participants, the instrument used and the procedure followed. Next, the fourth section presents the results obtained and their analysis, and finally the conclusions and references used in the article are presented.

Background

Next, some theoretical aspects in which this research is framed will be revealed.

The educational model in upper secondary education

Agreement number 08/17/2022 establishing the new Common Curricular Framework for Higher Secondary Education (MCCEMS), in its fifth article establishes the following:

> The fundamental purpose of the MCCEMS is to develop the knowledge, cultural and learning base of adolescents, young people and adults who study EMS, which includes both the knowledge that civilization has achieved in its history, as well as that which comes from the fields family, local, national and global; Likewise, that the students can access them, build new knowledge and put it into action throughout their lives (SEP, 2022, p. 8).

Regarding the fundamental curriculum of the Common Curriculum Framework for Higher Secondary Education (MCCEMS), the following characteristics stand out: 1) comprehensive, 2) articulating, 3) regulatory, 4) flexible, 5) inclusive and equitable, 6) transitional, 7) recognition of learning, 8) open, and 9) guidance (SEP, 2022). In this sense, it is essential that teachers can apply these characteristics to more effectively influence the teaching-learning process with their students.

The same agreement of August 18, 2022, regarding the graduation profile of the high school student, highlights the following points:

- Assess the application of automatic procedures and algorithms to anticipate, find and validate solutions to problems in different areas of knowledge (mathematics, natural sciences, experimental and technology, social sciences, humanities and everyday life).
- Adapt mathematical reasoning processes that allow relating information and obtaining conclusions from problems in various areas of knowledge (mathematics, natural sciences, experimental and technology, social sciences, humanities and everyday life).
- Model and propose solutions to problems in various areas of knowledge (mathematics, natural sciences, experimental and technology, social sciences, humanities and everyday life) using mathematical language and techniques (SEP, 2022, p. 17).

Therefore, it is imperative that the mathematics teacher carry out interventions that contribute to improving the quality of teaching within their discipline to ensure that students at the end of high school can truly meet the graduation profile and continue their studies at the level academic.

Teacher intervention in mathematics teaching

Teacher intervention in mathematics teaching plays a crucial role, since the teacher's decisions and actions have a great impact on student achievement, which encompasses a wide range of interventions carried out during classes (Robalo, 2014). This teaching intervention also contributes to students acquiring mathematical knowledge in a more direct and personalized way, which leads to considering the teacher as a reflective and strategic subject capable of implementing what is known as strategic teaching (De la Cruz, 2017; Jones *et al* ., 1995).

Robalo (2014) defines teaching intervention as "the interactions that the teacher carries out during class, directed at one, several, or all students, with the express intention of favoring the use or construction of a proto-mathematical , para-mathematical notion. or mathematics " (p. 43). For this, it is important to highlight the intention that must guide these interventions, since they are often spontaneous and not always conscious and voluntary (Castro, 2007). The teacher's interventions must contribute to the understanding of the study problem, so that they allow the development of new knowledge with meaning for the student (Santos, 2009). In addition to this, they must offer clues that allow the student to correct their thoughts and modify their learning strategies (Baquero, 1995, cited in Colque, 2005, p. 87). Therefore, it can be stated that teaching transcends the simple transmission of information. In this regard, Maruny Curto (1989) explains the following:

> Teaching is not only about providing information, but about helping to learn. To do this, the teacher must have a good knowledge of his students: what are their previous ideas or prior knowledge that he has. Before addressing and explaining a new topic, it is also important to know the work habits, the attitudes and values that they manifest towards the specific study of certain topics, etc. (p. 11).

From the above, it can be inferred that the more the teacher knows his students, the better he can adapt his teaching strategies so that they are more effective and meaningful, always starting from what the students already know. Therefore, the class should not be

unidirectional, but rather interactive, so that students can actively participate and be builders of their own knowledge. In this sense, Pérez Gómez (1992) points out:

> The intervention in the classroom must start from the meanings that really flow in the class group, from the meanings that those students bring to their academic exchanges, from their daily experience prior to and parallel to school and from the meanings that they generate as consequence of their experiences in the school institution, sharing learning experiences in progressive contact with public knowledge (p. 99).

In addition to the above, it is necessary that the interventions by the teacher be closely related to the level of competence in the learning task that the student manifests, since the more difficulties the student has in understanding mathematics, the more directive the interventions should be. of the teacher, not only in quantitative terms, but also qualitatively (Caballero *et al.* , 2016; Díaz Barriga and Hernández Rojas, 2002).

Another crucial aspect that must be considered is the context in which these interventions are developed. On this matter, Santos (2009) maintains that these should not point out errors or correct them directly, but rather they should facilitate the student's reflection on what he has done and how he has done it to allow him to realize his own errors and improve accordingly. Therefore, for the intervention to be successful it must present achievable challenges that question and modify the student's knowledge (Onrubia , 1993).

Difficulties of high school students in learning mathematics

In recent years, research on difficulties in learning mathematics has acquired great relevance. According to the *Dictionary* of the Royal Spanish Academy (RAE) (2024), the word *difficulties* refers to obstacles, oppositions or setbacks that prevent achieving, executing or understanding something adequately and quickly. In the context of mathematics, difficulties are associated with the complexity that students face when solving problems. Therefore, Castro (2009) considers that this term applies to students who, for various reasons, experience delays or difficulties in learning instrumental skills such as reading, writing and calculation. This author classifies the difficulties into two main groups:

- Primary difficulties: They affect intelligent children who do not have motor or sensory disorders, attend school regularly and learn with an appropriate methodology.
- Secondary difficulties: These refer to situations in which children do not learn due to a known factor, such as inadequate methodology, lack of teacher training, a hostile

environment, a depressive state or lack of attention, among others. In these cases, if the known cause disappears, learning occurs without major difficulties.

In relation to the above, Hernández and Moreno (2001) indicate that difficulties in learning mathematics are not related to mental health problems, but rather to adequate pedagogy and student motivation. Along the same lines, Suárez *et al.* (2014) point out that difficulties in learning mathematics are related to anxiety and negative emotions, which results in poor performance in evaluations.

For his part, Socas (1997) adds that these difficulties are not limited to the least able students, since all students face challenges at some point in the acquisition of mathematical knowledge. This author identifies five categories that characterize the nature of these difficulties: the complexity of mathematical objects, mathematical thinking processes, teaching processes, students' cognition processes and, finally, the difficulties associated with the affective attitude. and emotional towards mathematics. To the above, Ladislao (2000) adds the low interest of students in learning mathematics, as well as the difficulties in establishing relationships between the data of a problem and the unknown to be solved.

Regarding procedural difficulties, Martínez *et al.* (2015) point out that high school students face problems when moving from arithmetic to algebra, such as the use of the sign rule, factorization, grouping signs, laws of exponents, algebraic multiplication, clearances, and the use of signs. Finally, Larios *et al* . (2017) indicate that students prefer to use arithmetic strategies instead of algebraic strategies because they find the symbolic representation of algebra meaningless.

Methodology

The present research is qualitative, and is framed within the ethnography approach. For Martínez (2012), ethnography is defined in the following terms:

> Etymologically, the term *ethnography* means the description (*grafé*) of the lifestyle of a group of people accustomed to living together (*ethnos*). Therefore, the ethnos , which would be the unit of analysis for the researcher, could not only be a nation, a linguistic group, a region or a community, but also any human group that constitutes an entity whose relationships are regulated by custom or by certain reciprocal rights and obligations (p. 29).

In Martínez's definition, the relevance of the relationships between individuals, common practices and the prevalent culture in their environment is observed as part of a

research reality. Along these same lines, Gómez Rodríguez *et al.* (1996) describe it as follows: " Research method by which the way of life of a specific social unit is learned. Through ethnography, the analytical description or reconstruction of an interpretative nature of culture is pursued " (p. 44).

Now, in this work, ethnography was used to describe the activities of a social group—in this case, the classroom context—and at the same time interpret the forms of interaction in the group, especially in the relationships between the teacher and students, in relation to the intervention processes in the learning of mathematics.

Ethnography offers the researcher a particularly valuable approach to studies in education (Goetz and Lecompte , 1988; Velasco and Díaz de Rada, 2006; Woods, 1987). In fact, more and more research is found that uses qualitative research methods, and a growing number of authors choose to follow ethnographic orientations in their work.

Techniques and instruments

In this research, two instruments were used: participant observation and structured interviews with teachers. According to Canales *et al.* (2001) observation is defined as " the visual record of what happens in a real situation, classifying and recording the relevant events according to some planned scheme and according to the problem being studied " (p. 160). Carrying out observation involves focusing attention on an important aspect of reality that is related to the nature of the object of study.

In accordance with this idea, Gómez Rodríguez *et al* . (1996) define it as " a systematic process by which a specialist collects information related to a certain problem for himself. As such a process, the perceptions of the observing subject and their interpretations of what is observed intervene " (p. 150). It is important to highlight that observation is an unrepeatable event, hence it must be recorded at the moment of practice, since " the events of a social reality will never be the same " (Ortiz and García, 2007, p. 121).

The other research technique used was the structured interview, which aims to obtain more information about a particular phenomenon (Ávila *et al* ., 2020; Giroux and Tremblay, 2004) from individuals who know and experience the reality investigated. Gómez Rodríguez *et al.* (1996) define it like this:

> A technique in which one person (interviewer) requests information from another person or from a group (interviewees, informants), to obtain data on a specific problem. It presupposes, therefore, the existence of at least two people and the possibility of verbal interaction (p. 167).

From the previous conception, we can highlight the nature of the qualitative interview when attention is paid to the verbal interaction between the interviewer and the interviewee, which leads to the understanding and sharing of the interviewee's references with the researcher. In accordance with this idea, Briones (1998) indicates that " an interview is a conversation between a researcher and a person who answers questions aimed at obtaining the information required by the specific objectives of a study " (p. 42). These conceptualizations underscore the need for the researcher to come face to face with the research subjects in any research process.

Participating subjects

The population under study was represented by eight teachers in the field of mathematics, assigned to schools 01, 02 and 54 of school zone 01 of the municipality of Ahome. These teachers (six men and two women, aged between 28 and 56) have work experience ranging between 5 and 33 years of service. It is important to note that 100% of the teachers come from careers related to engineering, and three of them have a master's degree, although only one has a degree.

Likewise, seven of the eight teachers have completed the Higher Secondary Education Teacher Training Program (PROFORDEMS), which certifies them to teach classes at this educational level.

The field work was carried out in the three COBAES campuses located in the area of the city of Los Mochis.

- COBAES 01. Prof. Marcial Ordoñez Ibáñez. It is located in the Scally neighborhood , to the west of the city. It has an enrollment of 456 students and operates in the morning shift.
- COBAES 02. Prof. Braulio Pizarro Ceballos. It is the largest campus in the entire state of Sinaloa. It has an enrollment of 1,756 students and offers classes in morning, afternoon and evening shifts. It is located in the center of the city.
- COBAES 54. Prof. Jesús Llamas Ramírez. It has an enrollment of 741 students. It offers classes in morning and evening shifts and is located in the center of the city.

The universe of the student population was 283 students, distributed in 8 groups of approximately 35 students per classroom. The vast majority of these students come from low economic strata, where parents work in the fields, work in maquilas and temporary jobs such as livestock and agriculture.

8 interviews were carried out, one for each teacher, using a previously structured script (see Annex 1). The objective was to know the intervention processes of mathematics teachers with students who face difficulties in acquiring knowledge of this scientific discipline. Each interview had an average duration of approximately 40 minutes.

Regarding the observation records (see Annex 2), 18 recordings were made (3 for each teacher), with the prior consent of the teachers. This allowed a better understanding of the development of a mathematics class and the interaction between the teacher and students within the teaching-learning process. Each recording had an average duration of 50 minutes, which added up to a total of 15 hours of observation.

Results

The objective of this research was to describe the forms of intervention of the mathematics teacher in COBAES in the northern zone, with emphasis on the specific contexts of the classrooms and teacher-student interaction. Special attention was paid to the following aspects: personalized help to students, prior knowledge of students, tutoring and use of monitors.

To identify the empirical references, the following nomenclature was used: the first letter corresponds to the technique used (for example, E for interview, O for observation, P for teacher, C for questionnaire), followed by the letter indicating the gender of the teacher trainer (M for male, F for female) and, finally, the registration number.

Deficiency of prior knowledge

One of the main challenges faced by the mathematics teacher at COBAES is related to the students' lack of prior knowledge. That is, many of them lack the necessary foundations in the subject of mathematics when entering high school, which includes fundamental concepts such as arithmetic. In many cases, students cannot solve basic operations such as division or percentages, much less understand the change from arithmetic to algebraic language.

These knowledge that students are supposed to master upon entering COBAES are largely absent. In this situation, the teacher is faced with the task of advancing the curriculum while simultaneously providing support to reinforce basic primary and secondary concepts. In fact, it should be noted that this lack of prior knowledge is not exclusive to COBAES, but is observed at all educational levels of this subsystem in Mexico.

When a teacher was asked about the difficulties he identifies in his students in mathematics, he mentioned the following:

> They are lagging, generally half of the group or two-thirds are lagging in addition, subtraction, multiplication and division signs, they also struggle with fractions and they also need a little algebra, that's what you have to be repeating every so often (EPF1).

From the previous quote, we can point out not only the deficiencies in arithmetic that young people present when entering COBAES, but also the difficulties in understanding algebra. In this regard, it should be noted that to master algebra effectively it is essential to have a complete command of the basic operations (addition, subtraction, multiplication and division), since this allows the transition from arithmetic to algebraic language in a fluid manner.

Following this same line , and taking as reference the study plan of the General Directorate of Baccalaureate (DGB, 2017), specifically in the case of the subject of mathematics I, the following is established:

> Promote the development of creativity and logical and critical thinking among students, through processes of reasoning, argumentation and structuring of ideas that lead to the deployment of different knowledge, skills, attitudes and values, in the resolution of mathematical problems and in their applications. transcend the school environment, whose purpose is to allow the student to use different algebraic procedures to represent relationships between constant and variable magnitudes, and solve problems of daily life (pp. 5-6).

In the previous section it is observed that the Mathematics I curriculum has as its main objective the resolution of problems through logical thinking. However, this aspiration contrasts markedly with the reality experienced in the classroom, where the majority of young people, or at least a large percentage of them, present significant deficiencies in terms of basic knowledge of mathematics. This discrepancy is evident in the response of another mathematics teacher when asked the same question:

> There are many, but I can mention it to you in just one, that they do not have bases, I struggle a lot with that, in fact, right now as an integrative project for the entire semester I did a workshop course, all the advisors, I am not an advisor for any group right now Because? Because I am doing the material, I made a material of pure addition, subtraction, multiplication and division, they are pure basic operations, if it is addition it says how much is two plus three, like this, how much is five plus eight, if it is division, how much is fifteen by three so vain but the student does not bring it (EPM3).

Based on the previous fragment, it can be assured that basic knowledge in mathematics is fundamental for entering high school, hence students must reach the level of upper secondary education with a solid foundation that allows them to perform more abstract operations in stages. later. The National Council of Teachers of Mathematics (NCTM) (2003) supports this idea by stating:

> Students need to understand, analyze, reflect on (algebra) its concepts, the structures and principles that govern the manipulation of symbols and how these can be used to record ideas and expand their understanding of situations, converting arithmetic language to algebraic language (p. 39).

From this perspective, it is crucial to teach children from primary and secondary education to reflect on the importance of mathematics in all aspects of daily life, which can be achieved by instilling in them a true taste and love for this discipline. In this sense, Dickson *et al.* (1991) point out:

> The teaching of mathematics in the early years is essential for the optimal development of the individual's potential, recognizing that in primary school they become good or bad students, depending on the training and pedagogy used by the teacher, specifically mathematics. which is one of the most stigmatized by students (p. 22).

From this perspective, it is essential to understand the context of students, their emotional state, the most common difficulties they face when solving mathematical problems, and the way in which they can learn more successfully. In other words, it is necessary to apply a student-centered pedagogy so that the student plays an active role in the learning process.

In relation to errors, it is important to highlight that they can be seen as a useful tool, as they provide valuable information about the aspects in which students are failing, so that

they can be guided to solve problems, from simple exercises to challenges. of high complexity. In this regard, Socas (1997) states:

> The error in mathematics learning difficulties must be considered as the presence in the student of an inadequate cognitive scheme and not only the consequence of a specific lack of knowledge or distraction. In the field of mathematics education, errors permanently appear in the students' productions. However, these errors should be detected during the process of teaching mathematics in the early grades, taking into account that the entire teaching process is based on the stages of human development, allowing the learning paths that are observed, analyzed and validated. have to continue in the students (p. 125).

In addition to the above, the emotional aspect must be recognized, which is encouraged when the teacher establishes a positive environment and camaraderie with the students to facilitate a better flow in the teaching process. However, the following dynamic lacks this essential property:

> Very well, first, let's remember what the Cartesian plane is, yesterday's class we saw that it is made up of four quadrants, where first we are going to do something simple, locate the points on the plane, to later solve more complex problems. that involve trigonometric functions (OPF5).

It is evident in this observation extract that the mathematics teacher seems to lack warmth in his pedagogical approach. That is, it does not establish an effective environment in the classroom that facilitates a better development of the teaching process. Instead of rescuing and valuing students' prior knowledge and ideas, he simply rushes to explain the topic without considering their previous experiences.

On this topic, Cassarini (1998) emphasizes the importance of the mathematics teacher being sensitive to the individual needs of students and constantly motivating them to achieve their goals. Therefore, it highlights the need for the teacher to become a friend whom students trust enough to ask their questions without fear.

On the other hand, Gutiérrez (1991) emphasizes that the commitment and dedication of the teacher are fundamental in the current educational context. In other words, the importance of the teacher becoming a facilitator of learning and a friend for his students is highlighted, which means giving the best of himself to promote the comprehensive development of the students.

Lack of intervention by mathematics teachers

When investigating the intervention processes of mathematics teachers in COBAES, specifically in students with difficulties in understanding mathematical concepts, a notable absence was observed. On the one hand, during the interviews, teachers stated that they provide personalized intervention during classes. However, when investigating the nature of this intervention, the opposite was evident. For example, when asking a teacher about how he addresses learning difficulties in mathematics, he noted the following:

> There is no other way in a personalized way, it has to be personalized, generally when I explain a topic to the boys, I survey each of the work tables and find out if there are doubts, subsequently my work strategy is following: explain the topic in one hour or one day and the next day or the next hour depending on how the classes are, they develop work similar to the one I explained to them, at that moment (EPM5).

In the previous quote you can see that the teacher mentions intervening in a personalized way with students who have difficulties in mathematics. However, when examining the observation records of their teaching practice, a contradiction is evident, since the effective help processes that could raise the level of students' mathematical understanding are not observed. In fact, when asking the same question to another teacher, his response was the following:

> I do it in a personalized way, focusing on those who are more behind, but before that I start to explain the topic in a general way to the group, then I train them to work as a team to solve some exercises and then, as I told you, I focus my attention. those who are very educated, with those who are neophytes in knowledge, those who do not bring anything and well it is my responsibility to see for them, sometimes it gets complicated because here at COBAES the groups are 40 young people and the classes are 50 minutes and if it is difficult to attend to them in an adequate way (EPM6).

The lack of teaching intervention, in the context of this research work, refers to the situation in which the teacher is in front of the group and does not actively look for ways or resources that allow students to make those conceptual leaps and acquire knowledge. Furthermore, it does not take into account prior knowledge, as proposed by the constructivist approach. In relation to this last point, Maruny Curto (1989) warns the following:

> Teaching is not only about providing information, but about helping to learn. For this, the teacher must have a good knowledge of his students: what are their previous ideas or prior knowledge that he has before addressing and explaining a new topic, it is also important to know the work habits and values that they express regarding studying specifically (p. 174).

For this reason, Onrubia (1993) explains that for pedagogical help to be effective, two characteristics must be met: a) that the teacher takes into account the student's initial knowledge and b) that he presents achievable challenges that question and modify said knowledge. knowledge. These aspects are of utmost importance, since teaching must start from what students already know. However, when observing the teacher's daily teaching process, it was noted that the students' ideas or prior knowledge are not being rescued. This can be seen in an extract from an observation record of a mathematics teacher, who begins the class as follows:

> Yesterday we started trigonometric functions in the Cartesian plane, we made a table where we analyzed the reason why a trigonometric function has a positive sign and a negative sign depending on the sign and we are going to work with that, first we are going to remember what it is The Cartesian plane, in yesterday's class we saw that it is made up of four quadrants, a horizontal line called the abscissa axis and a vertical line called the ordinate axis, which intersect perpendicularly and that this point is known as the origin. (OPF1).

In the previous quote, it can be deduced that the teacher does not establish a climate of friendship and trust with the students, but instead focuses quickly on explaining the topic, offering a quick summary of what was seen in the previous session, but without questioning or asking. to students about aspects that could help rescue previous ideas. Furthermore, it is observed that the teacher is the one who carries most of the class load. In relation to the latter, Rizzo (2015) states:

> The teacher, in addition to considering the epistemological characteristics of the content and the mastery of techniques and resources, must develop a mode of personal intervention, paying special attention to the particular characteristics of the students, to the affective (human) aspect, reconstructing the object of study. from the student's experience, to achieve a prosperous learning climate, because when the student is the one who participates in the

> discovery, there are more possibilities that he will be able to reconstruct the path, explain it to others and improve himself (p. 28) .

The previous fragment highlights the importance of the teacher always creating an emotional environment with the group, overcoming the barriers of poor communication and promoting harmony and a positive environment to facilitate learning. Furthermore, it is crucial that the teacher develops teaching strategies that take into account the individual characteristics of each student, since everyone is different and learns in a unique way.

A significant fact found during the interviews with the teachers was that six of them claimed to intervene in a personalized way, but in practice no record of this was observed, while the other two mentioned that they rely more on students who act as monitors. In another observation fragment, a teacher mentions the following:

> Well, with this we have finished the fundamental theorem of calculus, I know that it is not a simple topic, but it is not impossible either, those who are willing will pass the course without any problem, but those who are lagging behind must put more effort into it, since the semester is almost over. Very good, copy the example that I explained to you on the board and immediately take out the book on page 126 and we will solve the 12 exercises that come in the booklet, if you have any questions, come here with me (OPM2).

It is worth mentioning that the teacher teaches his class in a traditional and mechanical way, that is, following an approach in which he first explains an exercise and then assigns students to solve similar exercises in the booklet, generally in teams. This practice results in limited, almost superficial intervention, and is the norm for most teachers. Likewise, it is worth highlighting the intervention of a teacher with five years of experience, who expressed the following:

> Well, does anyone else have any doubts about the trigonometric functions and how to use each of them, depending on the data that the problem gives us: does this row have any doubts? Is everything okay? Is there any doubt here? Pedro, do you understand now? Yulissa, how are we doing? Here's how this row goes, so let's move on to the next thing, we're going to solve some small exercises to see if what we just saw was clear to us (OPF7).

It is observed in our observation record how the teacher walked through all the rows of the room to ask her students if they had questions and stopping when a student asked for help. He taught them trigonometric functions and explained how to solve. His intervention

was very beneficial for the students, who were motivated by solving the exercises. It is important to note that this teacher has only five years of teaching experience.

Tutorials and use of monitors

One of the techniques most used by mathematics teachers at COBAES is tutoring and the use of monitors. It consists of assigning students who have a good command of mathematics to teach those who have difficulties appropriating knowledge. When the teachers were asked what techniques they used most with those young people who have difficulties in mathematical knowledge, one of them mentioned the following:

> Well, what I do is support myself with the students, the peer tutors, that is what they call students who have a knack for mathematics, I grab three or four boys or girls and they help me with their classmates, because they have the natural method that Among young people, they also explain in their language, on some occasions if they understand the young person more than how they explain it to the teacher sometimes (EPM6).

In the previous fragment you can see how teachers turn to students who have a good command of mathematics to support those who have difficulties with the topics. This is an effective technique, but it is limited to the classroom setting, without formal monitoring by the teacher to evaluate student progress. According to Alcántara (1990), the methods that have been most successful in improving learning focus on the student and the interaction between them. In this regard, he comments:

> The tutorial system is a student-centered method in which the role of the tutor teacher has positive attitudes towards teaching, students, the institution and change, meets the conditions provided to improve learning, since it also involves a student asset. Most of the time it is based on practice and feedback is constant. Likewise, the goals they aim for are well defined (p.52).

Among the most common tutoring is that between peers or also known *peer tutoring* :

> It is a cooperative learning method based on the creation of pairs, with an asymmetric relationship (derived from the role of the tutor or tutor that they play respectively) with a common, shared and known objective (acquisition of a curricular competence), which is achieved through through a relationship

framework planned by the teacher (Duran and Vidal, 2004, cited by Durán Gisbert and Huerta Córdova, 2008, 2).

Now, although well-planned tutoring by the teacher can lead to good results, in practice within COBAES this is not common, since most of the time it is improvised without a clear strategy or an established plan that guides the process to improve the knowledge of students with difficulties in mathematics.

Regarding the results, the deficiency of prior knowledge has been generalized in the high school in Mexico, which affects practically all its subsystems. This can be stated because young people who enter high school usually have large gaps, which means that the teacher's work focuses on continuing with the study program and, at the same time, reinforcing basic knowledge such as arithmetic. This provides them with the necessary tools to make conceptual leaps and advance in topics that require greater complexity and skill in the domain of mathematics.

Due to this reality, teachers at all educational levels are faced at the beginning of the school year with students who have major deficiencies in the area of mathematics. This situation makes it very difficult for students to acquire new knowledge, since many topics require prior knowledge (Barrón *et al* ., 2013, p. 108). Faced with this challenge, it is crucial, especially in upper secondary education, to offer induction courses focused on reinforcing the basic mathematics knowledge of incoming students, which would allow teachers to effectively advance the curriculum and reduce high rates. of failure in this subject (Blanco Hernández , 2020; Rivas, 2005).

Likewise, it is essential that high school mathematics teachers actively seek mechanisms and strategies to encourage greater interest and achievement in this discipline. This involves carrying out interventions aimed at supporting students and helping them overcome the difficulties they may face. To do this, the feedback provided by the teacher must focus on providing constant help and motivation to the students, so that any intention to embarrass them can be avoided (Anijovich, 2017).

Discussion

The nature of this research focused on describing the forms of intervention of the mathematics teacher in COBAES, northern zone. Within the first subcategory, “Deficiency in prior knowledge”, it is observed that students entering high school present significant delays in basic knowledge, especially in the transition from arithmetic to algebra. In this regard, Martínez *et al.* (2015) highlight that this transition is problematic for students, since it is difficult for them to convert arithmetic language to algebraic language. Given this situation, the implementation of a preparatory leveling course prior to high school is suggested, focused on reinforcing the concepts of arithmetic and algebra.

In the subcategory “Absence of teaching intervention”, it is relevant to note that although the teachers mentioned intervening in a personalized way, classroom observation reveals a discrepancy between what was stated and the teachers' daily practice. This means that there is a lack of intervention to help students struggling in mathematics.

Therefore, it is essential to return to the approach of Rizo (2015), who suggests that the teacher develop a personalized intervention plan that takes into account the particularities and individual needs of each student. However, this practice often takes a backseat due to time pressure and the urgency to complete the syllabus. As a result, teachers tend to adopt a traditionalist and mechanical approach in the classroom, where they simply explain examples and then ask students to solve similar exercises, often without contextualizing them in the students' reality.

Regarding the subcategory “Tutoring and use of monitors”, it is observed that teachers use students with a good command of mathematics to use them as monitors, who help those young people with difficulties in understanding mathematical content. Although the use of monitors can be beneficial for communication between students, it lacks a defined plan that allows monitoring and evaluating the progress of students with low mastery of mathematical content.

Therefore, effective feedback from the teacher is essential for the success of the tutorials. As Alcántara (1990) points out, it is important that the goals of the tutoring are clearly defined and that the feedback is constant to guarantee its success, since this—as Cedeño Romero and Moya Martínez (2019) explain—plays a crucial role in the improves student learning, and requires planning, commitment, dialogue and reflection, which benefits both students and teachers.

For all of the above, it can be ensured that activities such as identifying and addressing deficiencies in prior knowledge, implementing an appropriate teaching intervention and using an effective system of tutoring and monitors can help improve students' mathematical skills , even to apply them in everyday life situations.

Conclusion

The research on the teaching intervention of mathematics teachers at the Colegio de Bachilleres del Estado de Sinaloa, specifically in the northern zone, revealed that students who enter the upper secondary level largely lack basic knowledge. This forces mathematics teachers to address a double task: on the one hand, teaching fundamental concepts and, on the other, advancing the curriculum as planned.

Furthermore, a lack of willingness on the part of teachers to address students' learning problems in mathematics was observed, which creates a vicious circle in which teachers simply present the class without implementing a variety of pedagogies to teach the subject or intervene. to help students improve their knowledge.

Likewise, the lack of theoretical and pedagogical knowledge is also a reality, since more than 90% of teachers come from careers related to engineering, but lack training in specific pedagogy for teaching mathematics. Therefore, it would be beneficial for COBAES to focus its efforts on hiring personnel with pedagogical training in mathematics or on training mathematics teachers in pedagogical aspects. This would improve teaching and the transmission of knowledge in this subject, which would have a positive impact on student learning.

Another notable aspect is the use of monitors by teachers, that is, students who have outstanding skills in mathematics to support those who have learning difficulties. Although this technique can be effective, observing the classes shows the lack of a specific plan, an established route or a work plan that guarantees a significant impact and that truly fulfills the purpose of helping students improve their understanding in this crucial scientific discipline. That is, adequate feedback from the teacher is needed for this strategy to be effective.

In short, it can be stated that COBAES teachers do not intervene adequately so that students acquire the necessary mathematical knowledge. In fact, in the cases in which they intervene, they do so without a specific plan or work methodology, and they often rely on students who do understand mathematical concepts. This shows that the absence of intervention in COBAES is a reality, and the little intervention that is carried out lacks

direction and a planned approach, which continues to generate deficiencies in students to acquire basic knowledge of mathematics.

Future lines of research

As a future line of research, the development of guidelines is proposed that serve as a guide for teachers in teaching mathematics in the Colegio de Bachilleres with the aim of improving the quality of teaching in this area. Furthermore, it is considered important to test these guidelines in other contexts and schools, both inside and outside the Colegio de Bachilleres system, such as CONALEP, CECYTE, among other institutions of higher secondary education, which would allow contrasting the results obtained in this research and analyzing whether the problems identified are common in other educational environments and whether the proposed strategies are equally effective.

Finally, it is suggested to investigate the process of mathematics communication between student monitors to determine how they provide feedback to each other and how this interaction influences the acquisition of mathematical knowledge by their classmates. This research could provide valuable information about the role of students as mediators of learning among their peers and how this dynamic can improve the teaching and learning process in the mathematics classroom.

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Annex 1. Script the interview

General data

1. - Name:

2. - Age:

3. - Years of service:

4. - Teaching experience:

5. - Academic preparation:

6.- How do you organize teaching strategies in the mathematics subject that you teach?

7. - Could you briefly explain to me what a mathematics class that you teach to the young people you serve is like?

8. - What are the difficulties that arise daily in your teaching practice?

9. - What difficulties do you identify as a mathematics teacher in your students?

10.- How do you evaluate the mathematics subject that you teach and what criteria do you consider in this process?

11.- What are the techniques you use most with those young people who have difficulties in mathematical knowledge?

12.- What is the intervention you provide to students who have difficulties learning mathematics?

13.- What is metacognition for you?

14.- What strategies do you use in your class to develop metacognition in students?

Revista Iberoamericana para la Investigación y el Desarrollo Educativo
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Annex 2. observation record format

School: _____

Grade: _____ Group: _____

Ethnographic record # ____

Date: _____

Start time: ____ End time: ____

Observer: _____

Description of the activity or action

HOUR	DESCRIPTION OF THE ACTIVITY AND/OR ACTION	INTERPRETATION

Contribution Role	Author(s)
Conceptualization	José Cristóbal Solís Pollorena
Methodology	José Cristóbal Solís Pollorena
Software	Alan Ramirez-Noriega
Validation	José Cristóbal Solís Pollorena and Alan Ramírez-Noriega (same)
Formal Analysis	José Cristóbal Solís Pollorena and Alan Ramírez-Noriega (same)
Investigation	José Cristóbal Solís Pollorena (main) Alan Ramírez-Noriega (Supporting)
Resources	Alan Ramírez-Noriega and José Cristóbal Solís Pollorena (same)
Data curation	Alan Ramirez-Noriega
Writing - Preparation of the original draft	José Cristóbal Solís Pollorena (main) Alan Ramírez-Noriega (Supporting)
Writing - Review and editing	Alan Ramirez-Noriega
Display	Alan Ramirez-Noriega
Supervision	José Cristóbal Solís Pollorena and Alan Ramírez-Noriega (same)
Project management	José Cristóbal Solís Pollorena (main) Alan Ramírez-Noriega (Supporting)
Fund acquisition	Alan Ramírez-Noriega and José Cristóbal Solís Pollorena (same)