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A DIALOGUE BETWEEN ETHNOMATHEMATICS AND PROBLEM-SOLVING IN ALGEBRA TEACHING

UM DIÁLOGO ENTRE A ETNOMATEMATICA E A RESOLUÇÃO DE SITUAÇÕES PROBLEMAS NO ENSINO DE ÀLGEBRA

UN DIÁLOGO ENTRE LA ETNOMATEMÁTICA Y LA RESOLUCIÓN DE PROBLEMAS EN LA ENSEÑANZA DEL ÁLGEBRA

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ABSTRACT
This article presents an experience in the Fundamentals of Algebra course of the Graduate Program in Science and Mathematics Education (PPGCEM). A dialogue is established between Problem Solving and Ethnomathematics as a methodological approach for teaching Algebra. The article begins with a brief contextualization, establishing a dialogue between Problem Solving and Ethnomathematics. This is followed by a brief historical review of Ethnomathematics and Problem Solving in Mathematics Teaching. Continuing with the work, an experience is presented in the Fundamentals of Algebra course, in which mathematical challenges were proposed with the aim of fostering cooperative learning in the classroom between Problem Solving and Ethnomathematics, in order to guide students toward meaningful learning.

Keywords: Ethnomathematics. Problem Solving. Algebra Teaching.

RESUMO
Este trabalho tem como objetivo, relatar uma vivencia ocorrida na disciplina de Fundamentos da álgebra, ofertada no Programa de Pós-graduação no Ensino de Ciências e Educação Matemática (PPGCEM). Fazendo um dialogo entre o uso da Resolução de Problemas e a Etnomatemática como uma proposta metodológica para o Ensino de Álgebra. O trabalho se apresenta incialmente com uma breve contextualização realizando um diálogo entre a Resolução de Problemas e a Etnomatemática, em seguida apresentaremos um breve recorte histórico sobre a Etnomatematica e a Resolução de Situação Problemas no Ensino de Matemática. Em continuidade ao trabalho, segue com um relato de uma vivencia ocorrida na disciplina de Fundamentos da Álgebra, em que foi proposto desafios matemáticos com o objetivo de se trabalhar em sala de aula uma aprendizagem cooperativa entre a Resolução de Problemas e a Etnomatemica, objetivando levar ao aluno a uma aprendizagem significativa.

Palavras-chave: Etnomatemática. Resolução de Problemas. Ensino da Álgebra.

RESUMEN
Este artículo presenta una experiencia en el curso Fundamentos de Álgebra del Programa de Posgrado en Enseñanza de las Ciencias y la Educación Matemática (PPGCEM). Se

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establece un diálogo entre la Resolución de Problemas y la Etnomatemática como enfoque metodológico para la enseñanza del Álgebra. El artículo comienza con una breve contextualización, estableciendo un diálogo entre la Resolución de Problemas y la Etnomatemática. A continuación, se presenta una breve reseña histórica de la Etnomatemática y la Resolución de Problemas en la Enseñanza de las Matemáticas. Continuando con el trabajo, se presenta una experiencia en el curso Fundamentos de Álgebra, en la que se propusieron desafíos matemáticos con el objetivo de fomentar el aprendizaje cooperativo en el aula entre la Resolución de Problemas y la Etnomatemática, con el fin de guiar a los estudiantes hacia un aprendizaje significativo.

Palabras clave: Etnomatemáticas. Resolución de Problemas. Enseñanza del Álgebra.

1 INTRODUCTION

When we talk about Mathematics Education, it is difficult not to remember great Brazilian researchers such as Lourdes Onuchic and Ubiratan de Ambrósio who focus on research in Mathematics Education. These researchers, as well as so many others, have been raising discussions over the years about pedagogical practices that can offer the student their insertion as a protagonist in the construction of their own knowledge.

Starting with a mathematics education, based on problem solving, as Onuchic suggests, is not easy, "it is a challenging task for mathematics teachers who seek strategies based on Problem Solving as a support to improve their teaching practice, leading to student learning in a meaningful way" (HUANCA, SILVA, 2022, p.02). Thus, we believe that, "the teaching of Mathematics should take place in an atmosphere of research oriented to Problem Solving" making a correlation with the student's ethnomathematic knowledge.

Because, according to D'Ambrósio, "the pedagogical proposal of Ethnomathematics is to make mathematics something alive, dealing with real situations in time (now) and in Space (here), and through criticism to question the here and now" (D'AMBRÓSIO, 2011, p., 46,47). Because the student will only show interest in investigation, in investigating what has a correlation with his daily life and real situations in the environment in which he lives.

In this perspective, Ethnomatics associated with Problem Solving can be seen as a possibility for a better understanding of the student, in the resolution of problem situations offered in the classroom, preparing them to better deal with problem situations of their daily lives. Because ethnomathematics is directly linked to Problem Solving because

> Mathematics is almost as old as the human species. Well before the invention of numbers, early men had to develop methods to solve everyday problems, such as locating themselves in time and space, and to try to describe and explain the physical world. They created ways to compare, classify and order, measure, quantify, infer fundamental elements that the Western cultural tradition names mathematics (D'AMBRÓSIO, 2010, p. 6).

Thus, ethnomathematics arises from the needs of human beings to solve problem situations of their daily lives, for means of survival. Because according to Dante (2009),

> Solving problems is human nature itself. We can characterize man as the 'problem-solving animal', his days are filled with aspirations not immediately attainable. Most of our conscious thinking is about problems (DANTE, 2009, p. 14).

Thus, when we are faced with the teaching of mathematics it is no different. We always find a problem to be solved, a new challenge to be solved. Problem Solving as a methodology, in recent years has been increasingly present in the classroom, especially in the curricular component of mathematics. According to Allevato (2005),

> (...) when the teacher adopts this methodology, students can learn both about problem solving, and learn mathematics to solve new problems, while learning mathematics through problem solving (Allevato, 2005, p. 61).

Thus, D'Ambrósio (2004) highlights that:

> The access to a greater number of instruments and intellectual techniques gives, when properly contextualized, much greater capacity to face new situations and problems, to adequately model a real situation in order to arrive at a possible situation or course of action with these instruments (D'AMBRÓSIO, 2004, p. 51)

In this sense, the teacher must seek to correlate the student's teaching-learning with the social environment in which he lives, adopting the educational dimensions of ethnomathematics associated with Problem Solving, since this allows the teacher to contextualize the most diverse situations of the student's daily life with academic knowledge, in this way Onuchic and Allevato (2011) suggested that, This contextualization, these problems, are proposed to the student before a formalization of the content, aiming to lead the student to an investigation for means of resolution, thus using a collaborative learning between ethnomatics and problem solving.

2 ETHNOMATHEMATICS AND PROBLEM SOLVING

2.1 HISTORICAL OVERVIEW OF ETHNOMATHEMATICS

Ethnomathematics emerged around 1960, with research professor Ubirantan D'Ambrósio, shortly after World War II, in a Mathematics work for black minorities at the *State University of New York at Buffalo*. However, it was only around 1975 to 1985 that the researcher presented the term Ethnomathematics at the Fifth International Congress of Mathematics Education (ICME-5), having the word as the etymology of the word

> [...] **ethno** is now accepted as something very broad, referring to the cultural context, and therefore includes considerations such as language, jargon, codes of behavior, myths, and symbols; **Matema** is a difficult root, which goes in the direction of

> explaining, of knowing, of understanding; and tica undoubtedly comes from techne, which is the same root of art as technique. Thus, we could say that Ethnomathematics is the art or technique of explaining, of knowing, of understanding in different cultural contexts. In this conception, we approach a theorization of knowledge or, as it is modernly called, a theory of cognition (D'AMBRÓSIO, 1998, p. 5).

Thus, ethnomathematics according to the researcher would be practical mathematics in the daily life of various social groups and cultures. In which the focus of ethnomatics would be to seek to understand the mathematical knowledge/doing of a certain group, which are the result of knowledge passed down from generation to generation. According to Oliveira (2022), "Ethnomathematics is a program that seeks to explore the mathematical knowledge of a certain social group, correlating the knowledge of the past with the present in which it seeks to bring Mathematics to the classroom within a cultural system" (OLIVEIRA, 2022, p.21).

The definitions for the term Ethnomathematica differ according to the researchers. According to Monteiro (1998), ethnomathematics could never be understood as a methodological model of teaching, since it is a work to be carried out exclusively, with the researched group. Since each cultural and social group has its own specific needs and values of that group.

Gomes (2019), in turn, states that ethnomathematics is a very broad field, in which one can work with this mathematical trend associated with the most diverse areas of teaching such as philosophy, sociology, history, geography and not just mathematics (GOMES, 2019, p.20). According to Schwares (2019), taking ethnomathematics to the classroom is to offer new generations to learn mathematics from the mathematics practiced by cultural groups, with situations linked to their daily lives in a much more cultural way.

Because according to the National Curriculum Parameters (PCN), "To live democratically in a plural society, it is necessary to respect the different groups and cultures that constitute it. Brazilian society is formed not only by different ethnicities, but also by immigrants from different countries" (BRASIL, 1997, p.32). And the ethnomathematics program comes precisely to address the importance of valuing these cultural differences in the classroom, but addressing these flavors in the teaching of mathematics as well as in other disciplines.

2.2 PROBLEM SOLVING IN MATHEMATICS TEACHING

The teaching of mathematics through Problem Solving according to Huanca and Silva (2022) "is important, as it offers us an in-depth experience, an opportunity to know and outline the difficulties, to have access to the capacities and limitations of mathematical knowledge that students have" (ONUCHIC; ALLEVO, 2005, p. 04). Highlighting the advances of students in the process of acquiring knowledge that will be rooted in them from the moment students go in search of this knowledge.

For, according to Polya (1997) "a problem is a situation, quantitative or not, which requires a solution for which the individuals involved do not know evident means or ways to obtain it" (POLYA, 1997). From this perspective, we have a problem situation when we do not have already delimited means to solve them, as is the case with fixation exercises. Thus, we highlight that

> "A problem is defined here as any task or activities in which the students do not have any method or rule already prescribed or memorized and there is no perception on the part of the students that there is a specific "correct" method of solution" (VAN DE WALLE, 2009, p.57).

Thus, Walle points out that there are three specific characteristics to use Problem Solving as a Methodology in Mathematics Teaching.

The first is that the problem presented has to be associated with the student's daily life, that is, it is interconnected to the environment in which he lives so that it has meaning for the student, and can seek means of solutions for it. From this perspective, we can suggest the use of ethnomathematics.

The second, the author suggests that the problem is correlated with the content that is intended to be addressed in the classroom, presenting them in a dynamic and attractive way for the student, awakening their investigative sense.

The third activity addressed in the classroom must require the student to develop his arguments, that is, the student must be able to justify and explain each step by step achieved when solving the problem.

Thus, Onuchic and Allevo (2005) say that "the more conditions given to students to think and test an emerging idea, the greater the chance that it will be formed correctly and integrated into a rich web of ideas and relational understanding" (ONUCHIC; ALLEVO, 2005, p. 41). When the teacher enables the student to solve a problem situation, he offers his

student the chance of learning by investigation, that is, it offers the student to make use of investigative processes in his learning, as well as the use of deductive logical reasoning.

In addition to enabling the student to make a connection between the areas of algebra, arithmetic and geometry.

3 DESCRIPTION OF THE LEARNING

Our research is based on the context of classes held in the discipline of Fundamentals of Algebra offered in the Graduate Program in Science Teaching and Mathematics Education (PPGECEM), at the State University of Paraíba (UEPB), Campus – I, Campina Grande. In which the discipline has as a photo to offer the student an "analysis of learning from a collaborative perspective" (HUANCA, SILVA, 2022, p. 11).

Thus, at the beginning of each class, the teacher always offered the students situations problems to be solved. Seeking to awaken in his students the investigative sense, making the investigation of the problem situation start to a resolution through reflective and interactive means among the students.

Based on this assumption, all classes of the discipline of Fundamentals of Algebra always started with new challenges contextualized mostly with everyday situations, and then texts on algebras and problem solving were chosen to be discussed in class after the long tasks, in order to offer the student a deepening of theoretical concepts and history of algebra and Problem Solving.

Preparing the student with a greater theoretical and practical foundation to achieve possible successes in the classroom, by applying the teaching of algebra through the Resolution of Problem Situations. Professor Huanca presents to his graduate students the teaching of algebra in a dynamic, interactive way, taking teachers of physics, mathematics and pedagogy out of their comfort zone, showing that the teaching of algebra is much more than concepts, formulas and repetitions.

In which paths are offered that can enable our students to have a teaching-learning in which the student becomes the protagonist of the formation of his knowledge, in an environment "rich in authentic and spontaneous intersubjective relationships" becoming "conducive to the investigation of strategies for sharing knowledge, beyond the conceptual development itself" (HUANCA, SILVA, 2022, p. 11). Following this perspective, we will narrate below an experience in this context, which occurred in the class of Fundamentals of Algebra taught by Professor Huanca.

At first, the teacher, when entering the classroom, distributes the class in pairs to work together in the development of the first challenge presented in the classroom through slides. The challenge was as follows:

CHALLENGE 1: Salary Problem

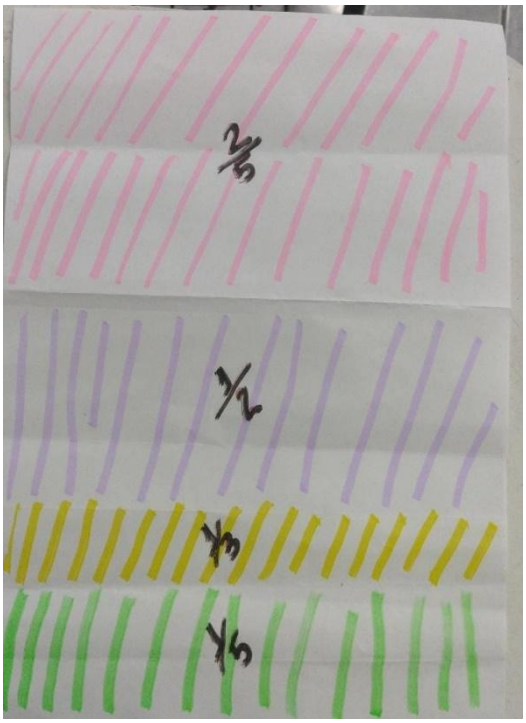
Of my salary I spent 2/5 on rent. Of what was left I spent half on food. Of the second leftover, I put 1/3 in savings. I was left with R$ 300.00. What is the value of my salary?

To solve this problem, the teacher distributes blank A4 sheets to all students, and asked us to try to solve the situation initially by means of folding, to be carried out with the use of the sheet of paper, as shown in the following figure.

Resolution 1:

Figure 1

Folds



Source: Elaborated by the author

After following the step-by-step information offered by the problem situation, by performing the folding, we easily obtain the result equal to R$ 1,500.00 as an answer to the salary presented in the problem earlier.

Thus, we made a connection between algebra and geometry to solve the problem situation, allowing us to explore the concepts of fractions and the use of arithmetic

calculations in understanding the composition of how many parts qualify in the whole in the Salary situation.

Then the teacher asked us to carry out the same problem situation, but now with an algebraic representation. It was a real challenge, because most of the class felt great difficulty in performing this representation, evidencing our lag, in the understanding of concepts and algebraic representations when we left the comfort zone, the ready-made formulas and the mechanized application of teaching.

Noticing this difficulty of the students, the teacher begins to give guidelines, so that we can achieve the objectives proposed by him. Later we will present the algebraic demonstration for the resolution of problem 1 situation.

Resolution 2:

We will represent by x, the value of the salary. Soon

We have X = Salary amount

The problem presents 2/3 of the salary was allocated to rent, so we have to

Step 1: x - = = $\frac{2x}{5}\frac{5x-2x}{5}\frac{3x}{5}$

Then, of what was left of the salary, 1/2 was spent on food, so we have

Step 2: = . = $\frac{\frac{3x}{5}}{2}\frac{3x}{5}\frac{1}{2}\frac{3x}{10}$

After payment was made with food, 1/3 of the surplus was placed in savings

Step 3: . = $\frac{3x}{10}\frac{1}{3}\frac{x}{10}$

Having found the three expressions to represent each situation of the statement, we then have that the salary will be

$\frac{3x}{5}$ - = 300$\frac{3x}{10}\frac{x}{10}$

Thus, solving the equation we have to

$\frac{6x-3x-x}{10}$ = 300

2x = 300. 10

X = = 1,500$\frac{3000}{2}$

After the presentation of the first step demonstrated by the teacher, the class together, carrying out informal exchanges with each other. Managed to achieve the full demo as previously presented. By promoting this type of activity in the classroom, the teacher enables the student to investigate means of resolution based on his already internalized knowledge and opens the possibility of investigative and collaborative learning, developing in the student skills such as logical reasoning, argumentation and critical sense.

Continuing the class, the teacher presents a second challenge, namely:

CHALLENGE 2: Sandwich Problem

One person came to a diner and asked: I want half of the sandwiches you have, plus 1/2 sandwich. A second buyer came in and asked, I want half the sandwiches you have, plus 1/2 sandwich. A third person came and asked: I want half the sandwiches you have, plus 1/2 sandwich. The owner of the snack bar saw that there was only one sandwich left. How many sandwiches did he initially have?

The challenge initially could not be completely solved by any student, using algebraic representation. Paths were reached, which was a proposal to be completed at home, and posted on Google Classroom, which was used by teachers for notices, sending activities and a Meet link when it was necessary to use online classes.

Thus, aiming at the students' difficulty in being able to solve the problem, the teacher performs a demonstration using other methods, so that it would not interfere or coincide with the method that was being developed by the students. Later I will present the method of resolution presented by the teacher and the method of resolution developed by the author of this work.

Teacher's Resolution: End to Start

Step 3: $\frac{x}{2}$ + Left (+) 1.$\frac{1}{2}$

Thus, it has to

$\frac{x}{2}$ = + 1 $\frac{1}{2}$

$\frac{x}{2} = \frac{1+2}{2}$

$\frac{x}{2}$ = therefore we have x = 2 $\frac{3}{2}$

Step 2: $\frac{x}{2} + \frac{1}{2}$ 3 left

$\frac{x}{2} = \frac{1+6}{2}$

$\frac{x}{2}$ = logo x = 7 $\frac{7}{2}$

Step 1: $\frac{x}{2} + \frac{1}{2}$ 7 left

$\frac{x}{2} = \frac{1+14}{2}$

Logo x = 15

Thus, it is concluded that initially in the cafeteria there were 15 sandwiches in all.

The problem when placed in the classroom, in a graduate course, makes us reflect on the importance of algebra in the student's teaching-learning process, and especially in the continuing education of teachers, because even though we are teachers working in the classroom, we face difficulties in interpreting the rigors required by mathematics to achieve a result consistent with the situation presented.

Thus, during the situation presented. I came across problems of interpretation to solve the problem. The first mistake was not subtracting the whole. Soon I obtained it as an initial resolution

1st step (wrong): (+) = $\frac{x}{2}\frac{1}{2}\frac{x+1}{2}$

Step 2: + = . + + = + = $\frac{\frac{x+1}{2}}{2}\frac{1}{2}\frac{x+1}{2}\frac{1}{2}\frac{1}{2} = \frac{x+1}{4}\frac{1}{2}\frac{x+1}{4}\frac{2}{4}$ $\frac{x+3}{4}$

Step 3: $\frac{\frac{x+3}{2}}{2}$ + = . + = + = + = $\frac{1}{2}\frac{x+3}{2}\frac{1}{2}\frac{1}{2}\frac{x+3}{8}\frac{1}{2}\frac{x+3}{8}\frac{4}{8}\frac{x+7}{8}$

The second mistake was subtracting all three expressions and equaling 1. In this way, always arriving at an inconclusive result.

So we are left with the expression:

Resolution Failed: $\frac{x+1}{2} - \frac{x+3}{4}$ -==1$\frac{x+7}{8}$

Trying to solve the expression both by adding and subtracting, it was never possible to reach a resolution of 15 sandwiches. Simply for an initial misinterpretation, and another misinterpretation at the end of the resolution. Below I will present the correct resolution of the problem situation, which I can achieve with the guidance of Professor Huanca.

Author's Resolution: From start to finish

First step: make the correction by subtracting now the existing "x" sandwiches that were initially in the cafeteria, arriving at the following expression

1° passo: $x - (\frac{x}{2} + \frac{1}{2}) = \frac{x-1}{2}$

In the second step, we subtract from what was left of sandwiches in the cafeteria the second order, keeping the expression

2° passo: $\frac{x-1}{2} - (\frac{\frac{x-1}{2}}{2} + \frac{1}{2}) = \frac{x-1}{2} - \frac{x-1}{2} \cdot \frac{1}{2} - \frac{1}{2} = \frac{2x-2-x+1-2}{4} = \frac{x-3}{4}$

Finally, in the third step, following the same logic as the previous one, we subtract the third order, based on the expression that now represents all the remaining sandwiches in the cafeteria, thus, we reach the following expression

3° passo: $\frac{x-3}{4} - (\frac{\frac{x-3}{4}}{2} + \frac{1}{2}) = \frac{x-3}{4} - \frac{x-3}{4} \cdot \frac{1}{2} - \frac{1}{2} = = \frac{x-3}{2} - \frac{x-3}{8} - \frac{1}{2} = \frac{2x-6-x+3-4}{8} = \frac{x-7}{8}$

Notice that the owner of the snack bar observed that there will be only one sandwich left, so the last expression represents the whole left, so we have that

$$\frac{x-7}{8} = 1$$

$x - 7 = 1.8$

$x = 8 + 7$

$x = 15$ sanduiches

The problem situation presented by Professor Huanca was a real challenge that as a teacher and student made me leave my comfort zone, stretching myself to algebraic and investigative thinking, which made it possible after numerous attempts to achieve an algebraic demonstration of the problem situation. Giving not only a theoretical but also a practical basis for my performance as a teacher of Mathematics Education to work in the classroom with Ethnomathematics and problem solving in the teaching of algebra with a detailed investigative look, in order to play a role as a teacher, aiming more carefully at the difficulties and gaps found in the classroom, when it comes to the algebraic and mathematical thinking in general of my student.

4 FINAL CONSIDERATIONS

This work seeks to highlight the importance of working on the algebraic development of the student in an investigation environment with the use of Problem Solving in dialogue with Ethnomathematics, leading the student to make use of already internalized knowledge that is developed throughout experiences in his family and complemented at school.

In addition to providing them with the opportunity to go in search of new alternatives, thus making the student become the builder of their own knowledge. When a problem situation is offered in the classroom, based on the possible resolutions presented by the students, it allows the teacher not only to visualize the advances, but also to visualize the problems encountered in this process of evolution. For example, the concept of fractions, the notions of geometric representations and arithmetic representations as previously exposed in the described experience.

Thus, we realize that "the notion of practice involved in solving problems through the construction, (re)construction and interpretation of problems" together with ethnomathematics, is more than a simple problem solving. Because it enables the student to search for new knowledge, developing in the same critical, investigative, argumentative

sense, preparing them not only for problem situations in contracts in the classroom, but mainly to know how to deal with the problem situations experienced in the midst of a society.

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