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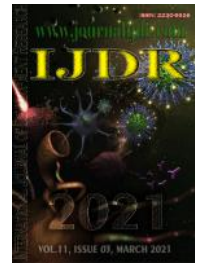
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RESEARCH ARTICLE

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SUBSIDIATING THE TRAINING OF THE MATHEMATICS TEACHER

Elaine de Farias Giffoni de Carvalho¹, Lara Ronise de Negreiros Pinto Scipião², Carlos Alves de Almeida Neto¹, Wendel Melo Andrade¹, Kelly Cristina Vaz de Carvalho Marques¹, Cleidivan Alves dos Santos³, Gilberto Santos Cerqueira^{1,4} and Maria José Costa dos Santos¹

¹Programa de Pós-graduação em Educação da Universidade Federal do Ceará, ²Secretaria Municipal de Educação de Fortaleza, SME/Fortaleza, Brasil, ³Departamento de Ciências Sociais e da Educação da Universidade Federal do Delta do Parnaíba, ⁴Pontifícia Universidade Católica de Minas Gerais, Campus Betim, Brasil

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*Corresponding author:

Elaine de Farias Giffoni de Carvalho

ABSTRACT

The presented research originates from inquiries about the questions about how to subsidize the initial formation of the mathematics teacher in the early years of Elementary School and is justified by the search for the understanding of the Fedathi Sequence (SF) methodology. Its objective is to understand the process of mathematical education of pedagogues in the subject of Teaching Mathematics. The investigation was carried out by means of the qualitative research approach and during the classes of the Mathematics Teaching course of the Pedagogy course at the Faculty of Education of the Federal University of Ceará, from March to June 2019. A descriptive study with an approach qualitative. The fieldwork was developed through observations of the teacher-trainer practices of the discipline and the students' perspectives in relation to the discipline, within the assumptions of the Fedathi Sequence teaching methodology. The results of this study showed the contributions of the Fedathi Sequence methodology to the Teaching of Mathematics, since the practices performed promoted the students' reasoning and autonomy, pointing to an active and dynamic process, both in teaching and in learning.

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INTRODUCTION

The teaching and learning processes of mathematics in schools are seen as a major challenge to be overcome, as many students see mathematics as a discipline that is difficult to understand, which directly reflects on their learning, leading teachers to adopt didactic strategies each time diversified in order to overcome students' learning difficulties. The pedagogical teacher is immersed in this scenario, as he teaches the subject of mathematics, among others and, as an aggravating factor, in many cases, he has a deficiency in his mathematical base both during the schooling process in basic education and in his initial training. academic. Research carried out with students of the pedagogy course at the Faculty of Education (FACED) of the Federal University of Ceará (UFC), in 2014, during subjects involving mathematical content, such as Teaching Mathematics and Topics in Mathematical Education, the results pointed out that the pedagogue understands that he does not have the elementary mathematical concepts for teaching mathematics, presenting an epistemological deficit, as he only takes one compulsory subject, the other being optional, therefore they are not

sufficient for a complete training in the teaching of mathematics . (SANTOS, 2015). At this moment, the education of the pedagogue and his practices in relation to the teaching of mathematics are highlighted, which assumes that the root of this problem has a didactic or epistemological nature, as stated by Santos (2015, p.1): "Didactic, because the teacher still presents an instructional methodology, and less constructivist, epistemological because it is necessary to develop mathematical knowledge that is still elementary since his basic schooling". For a long time, the process of training this professional was carried out in a wrong way and without clarity regarding the contents, mainly with regard to mathematical concepts. Borges Neto and Santos (2006) point out that good training is needed for teachers in general and note that this training needs to be better elaborated in Pedagogy courses, as these professionals will teach Mathematics in the early years of Elementary School, and in such a period of schooling it is not convenient to adopt some concepts constructed in a wrong way, as an example we can highlight the content of fundamental operations, specifically subtraction, when instead of working with exchanges, disaggregation, they use "borrow". Based on these arguments, we justify the accomplishment of this work by considering that there is a need for further study in Mathematics during the initial education of the pedagogue, both in the

understanding of concepts related to Mathematics and in the adoption of methodologies that are favorable to the teaching of this curricular component. Given the above, this article aims to understand the process of mathematical training of pedagogues in the subject of Mathematics Teaching at the Faculty of Education (FACED) of the Federal University of Ceará (UFC) seeking to identify how mathematical concepts were worked through of the various practices adopted in this discipline, following the assumptions of the Fedathi Sequence (SF) methodology. The Fedathi Sequence (SF) is a methodological process whose main focus is the teacher, where one seeks to interact with the student, stimulating him to think, to reflect on a certain problem situation (SOARES et al., 2019; SOARES et al., 2020). This methodology in its development is divided into four phases: "positioning", "maturation", "solution", "proof", where students will apply the knowledge built to solve the problem situation. The teaching methodology of the Fedathi Sequence (SF), has as its main focus the teacher, his intentionality, his behavior, participation and interaction with students in the classroom (BORGES NETO, 2017).

We organized this article in five sections, the first being this introduction, in the second section we will delve deeper into the purposes of the Fedathi Sequence methodology and its relationship with the initial training of the pedagogue in Mathematics Teaching, in the third section we will address the methodology adopted in this research, in the fourth we will present and discuss the results found, and in the fifth section, we make our final remarks. The initial training of the pedagogue and its relationship with the Fedathi Sequence (SF) methodology in Mathematics Teaching. For the teaching of mathematics in the early years of elementary school, it is no longer conceivable to think about the education of the educator only from the perspective that he acts in the labor market and "transmits" knowledge, being totally oblivious to the recurring problems in our society, such as social and economic inequality and the impartiality of the System. Santos and Matos (2017) corroborate this thinking by stating that:

[...] the teacher education we want is aimed at an ethical, critical and reflective professional who sees teaching as a pedagogical act that can be transformed, because as a professional he is aware of his knowledge and practices and knows the moment to break with some paradigms for decision making, with regard to the necessary and responsible creative insubordination. The proposal for creative insubordination presupposes a professional with decision-making capacity, capable of assuming his practice and taking actions, a subject who has autonomy, but who is above all aware of his role as an educator, and who is clear about the complexity of educational processes [...] (SANTOS; MATOS, 2017, p.16).

It is essential that in the initial training of this professional there is work for him to develop his reflective potential, as the reflective teacher rethinks his plans and reframes his practices, when he realizes that he has not achieved his goals. About this Alarcão (2005) tells us that:

The notion of reflective teacher is based on the awareness of the capacity for thought and reflection that characterizes the human being as creative and not as a mere reproducer of ideas and practices that are external to them. Central to this conceptualization is the notion of the professional as a person who, in professional situations, often uncertain and unforeseen, acts in an intelligent and flexible way, situated and reactive (ALARCÃO, 2005, p. 410).

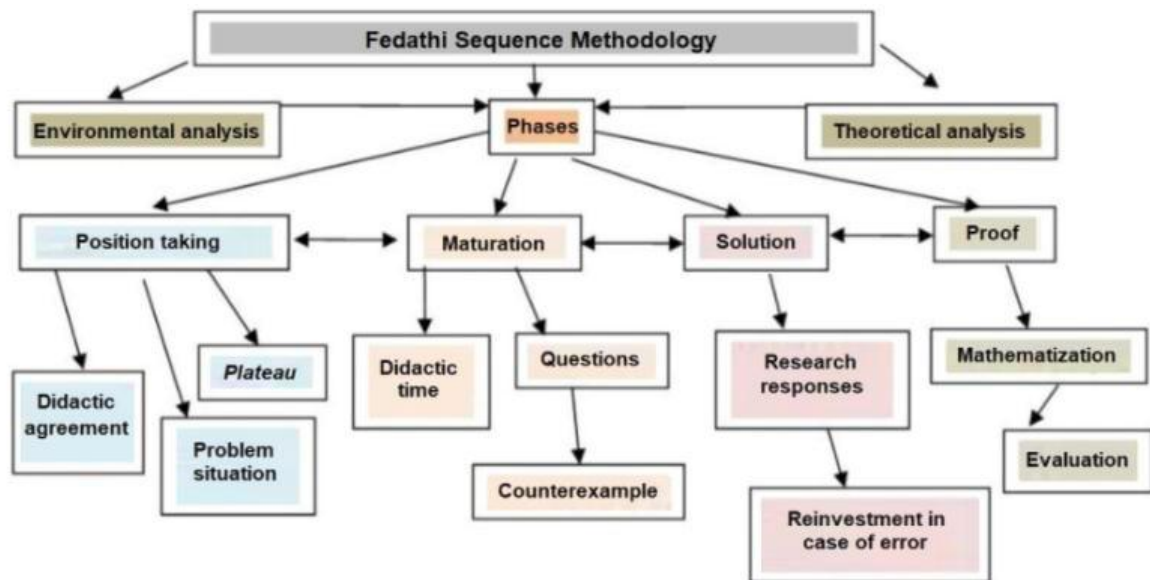
It was in this perspective that Professor Hermínio Borges Neto developed a teaching methodology that became not only effective in the Teaching of Mathematics, but for all areas of knowledge, the Fedathi Sequence (SF). Its assumptions underscore the importance of changing the Instructional Teaching model, focused on memorization and which has the teacher as the center of the teaching and learning process, for the Constructivist Teaching model, in which the student

participates and is the protagonist of his learning and the teacher becomes a mediator and also an apprentice in this teaching process. The theoretical principle of SF is to help the teacher overcome the epistemological and didactic obstacles that occur during the approach to mathematical concepts in the classroom (SANTOS, 2017). In this methodology, the lesson planning is called the Didactic Session (SD) (figure 1). According to Santos (2017, p. 86): É nesse momento que são considerados dois elementos fundantes da metodologia: (a) análise ambiental; e, (b) análise teórica; as quais atendem, respectivamente: i) a análise do *plateau* (nível de conhecimento e experiência do aluno); e, ii) escolhas do material pedagógico adequado ao lócus e ao público. Para a realização da sessão didática, o professor estabelece o acordo didático a fim de preservar o bom andamento e a participação dos alunos nas atividades. O acordo didático – para a SF é o conjunto de preceitos que entrelaça a complexidade didática na sala de aula entre o tripé: professor – conteúdo– aluno e deve estar claro no planejamento, e coerente com as demandas da sala de aula e em conformidade com a realidade e as expectativas dos alunos (SANTOS, 2017, p. 86). In the preparation of the SD, the work of the teacher and students is divided into four phases: Position, Maturation, Solution and Test. In taking the position, the teacher establishes the didactic agreement, as mentioned above, the problem situation, which places the student in a state of imbalance and the plateau, in which students are leveled according to their previous knowledge. The Maturation phase is composed of the Didactic Time, which is the time established for the resolution of the problem situation and the questions with counterexamples so that the student, even when in difficulty, thinks about a way to reach the solution. The Solution phase consists of the answers that will be given by the students during the investigation and if an error is found, a new reinvestment with another problem situation so that the student will not fail to succeed in his learning. In the last phase, which is the Exam, the "mathematization" is made, that is, the mathematical algorithm is formally presented and an assessment is made to verify the student's level of learning.

Scheme made by Santos (2017) emphasizes all phases of SF. According to the author, this methodological proposal prepares teachers for the improvement of their pedagogical practice, provides the change of posture of this professional in the classroom, in addition to acting in the initial and continuing education, contributing to overcome obstacles that prevent the understanding of mathematical concepts. during the student's learning process. We understand that the Fedathi Sequence requires from the teacher an attitude different from what we are used to seeing in classrooms, that is, the teacher is expected to have the habit of studying in groups, researching, observing, listening, motivating and intermediating work of the student, intervene pedagogically and, consequently, finish the work (SANTOS, 2007, p.21). This makes the student be contemplated, in their day-to-day, with a contextualized and dynamic Mathematics.

METHODOLOGY

This investigation was carried out through the qualitative research approach and took place from March to June 2019, at the Faculty of Education (FACED) of the Federal University of Ceará (UFC), during the Mathematics Teaching classes of the Pedagogy course and it was developed by the empirical study of academic reality, through observations of the discipline's teacher practices within the assumptions of the Fedathi Sequence (SF) and the students' perspectives in relation to the discipline. The subjects of this research are composed of 23 students enrolled in that discipline and the teacher-trainer. We proceed with unstructured or unsystematic observation. For, as Somekh and Jones (2015) emphasize, in this type of observation, the researcher considers the general aspects of the observed phenomenon, adopting a more holistic approach. For the authors, in this observation proposal, "the researcher is guided by his previous knowledge and experience and 'sees' through the peculiar lens of his socioculturally elaborated values" (SOMEKH; JONES, 2015, p. 185). This type of observation fits into this research since, when observing the discipline routine, focusing on the SF



Source: Santos (2017, p. 88).

Figure 1. Preparation steps for the didactic session (SD)



Source: Direct search

Figure 1. Logic Blocks, Place Value Chart (QVL) made in TNT and the Cuisenaire scale

methodology experienced by the students and the teacher-trainer, we must understand that all the events present at the time of observation influence the actions performed by the observed subjects, therefore, the view of the observer must consider the holistic aspects of the investigated phenomenon. As instruments for data collection, the field diary, a semi-structured questionnaire to students of the discipline and the photographic record of activities were used. We used the Content Analysis (AC) method for the treatment of data collected in the field. Categories and units of meaning were generated, which were interpreted in the light of the theories that underlie the theme of the study. For Bardin (2016), content analysis methods correspond to overcoming uncertainty and enriching reading, being possible to apply to all forms of communication. The adoption of CA followed the following phases: Pre-analysis with the exploration of the material and treatment of the results (inference and interpretation); The exploration of the material that consists of the encoding of the collected material; and the treatment of the results obtained, which was the moment when the gross results became significant and valid. Content analysis works with the passage of raw data to organized data, not allowing deviation of the collected material, but providing the perception of the invisible as raw data (Bardin, 2016). This methodology helped in the organization and interpretation of the findings, which will be discussed in the next chapter.

RESULT AND DISSUSSION

The proposal of the teacher-trainer of the discipline was based mainly on the Fedathi Sequence methodology, conducting didactic sessions throughout the semester, which according to the discipline's program had as teaching methodologies: dialogued expository class; group dynamics; readings and studies of texts and syntheses in groups;

targeted research; pedagogical workshops based on methodological and mediation proposals using materials, such as QVL preparation, Tangram, polyhedra, and learning objects, as well as workshop and report preparation guidance, lists of problem situations to solve in the classroom and at home, watch in the classroom discuss and analyze educational videos on the themes of the units, analysis of learning objects for the construction of the concept of number, exhibition and debate on methodological proposals and theories of Mathematics Education. We will proceed initially with the presentation of the data collected throughout the subject of Teaching Mathematics, through detailed reports of the activities carried out that subsidized the initial training of the pedagogue for the Teaching of Mathematics during the semester 2019.1. We highlight that these activities were planned according to the thematic units arranged in the Common National Curricular Base (BNCC) (BRASIL, 2018), which are: Numbers, Algebra, Geometry, Quantities and Measures and Probability and Statistics. Thus, the practices carried out by the teacher-trainer began with the thematic unit of Numbers. In it were presented the necessary mental schemes, according to Piaget, so that children can build the concept of number. They are: correspondence, comparison, classification, ordering, hierarchical inclusion, ranking and sequence. The concepts of numerical sense and numerical sense were also worked on, the differences between the concepts of number, number and numeral, Numbering system, presenting other systems used historically until arriving at the Decimal Numbering System and Fundamental Operations. To understand each content presented, the teacher used concrete materials such as Logic Blocks, the Place Value Chart (QVL) made in TNT and the Cuisenaire scale represented by Figure 1. In the thematic unit Algebra, studies were initiated by introducing students to the relationship between arithmetic thinking and algebraic thinking. The concept of pattern and its importance for the development of algebraic thinking was introduced. As an activity the students worked with the teaching

materials: Tower of Hanoi, for the understanding of intuitive thinking (initial) for deductive thinking (logical-mathematical) and again Logical Blocks, this time for the formation of patterns as shown in Figure 2.



Source: Direct search

Figure 2. Hanoi Tower and Logic Blocks

In this unit too, the teacher tried to work Algebra from a geometric perspective, already maintaining the relationship between the Thematic Units. For this, a sheet with a checkered mesh was made available so that the students could create geometric patterns as shown in Figure 3.



Source: Direct search

Figure 3. Checkered mesh

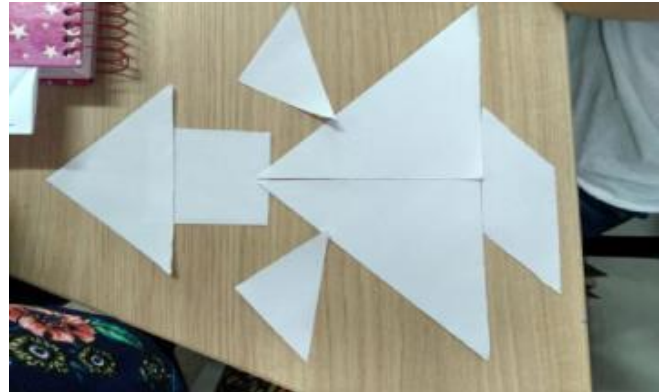
The thematic unit Geometry was worked with slide shows through the data show to visualize unconventional geometric shapes, such as fractals (non-Euclidean geometry figures), the exploration of the geometric properties of the Moebius strip, the passage of a video with the puzzle of Kapar Houser, in order to work on the visual perception of the students and also the axioms: point, line and plane. In a second moment, the teacher brought the concrete material again to work on the classification content of geometric solids as shown in figure 4. The students were asked to compare them, explaining their similar and different characteristics. Other subjects such as: concave and convex solids, polygons and planning were also addressed on this day.



Source: Direct search

Figure 4. Geometric solids

In the subsequent class, the teacher presented geometry according to Van Hiele's theory, in which 5 levels of learning stand out, namely: Visualization; Analyze; Ordering; Deduction and Rigor, since the latter two are not developed in the early years of elementary school and started the study of Fractions, noting that despite this content belonging to the Numbers Unit, it would work in an interdisciplinary way with Algebra and Geometry. In this study, the concepts of discrete and continuous quantities were presented and discussed, and the discrete ones, in some cases, do not allow fractioning, the conditions for the existence of a fraction and an activity with a sheet of legal paper for the construction of a Tangram (Figure 5), so that the students could observe the principle of conservation, cognitive ability necessary for students to understand the content of fractions.



Source: Direct search

Figure 5. Tangram made of paper

Soon after, another activity was proposed. The students divided a sheet of legal paper vertically into six equal parts (Figure 6). One part was made whole and the others were divided: one in two equal parts, another in three parts, another in four parts, another in six parts and the last in seven equal parts. After these divisions were concluded, relations were established between them to observe the concept of equivalent fractions.



Source: Direct search

Figure 6. Fractional rules made of paper

In the thematic unit Quantities and Measures, the concepts of Continuous and Discrete Quantities were brought up again, because although the contents are treated separately by the Thematic Units, they are intrinsically linked. The concepts of unconventional or non-standardized measures and conventional or standardized measures were discussed and it was found through examples and activities that it is important for man to use standardized measures today. An activity was proposed to the students in order to make measurements with non-conventional measurement instruments using rope, popsicle sticks and straws. In another activity, the students used conventional measurement instruments: measuring tape and ruler. And as a last activity (Figure 7), the students had to make the outline of one of them on a sheet of wooden paper and then measure that outline with a

rope. They were able to compare the accuracy of the measurements using standard and non-standard instruments.



Source: Direct search

Figure 7. Performing measurements with the aid of a rope

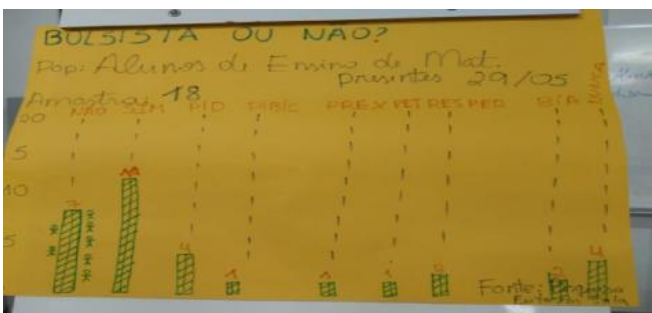
One class was dedicated only to tiling activity (Figure 8), which consisted of building a 1m square wooden paper square that was then tiled according to the choice of patterns to be used by each team. With this activity, all concepts seen up to that moment were recovered: Numbers, Algebra, Geometry and Quantities and Measurements.



Source: Direct search

Figure 8. Tiling made of paper

In the last thematic unit, Probability and Statistics, statistical literacy was discussed, that is, the subject's ability to recognize and interpret its context and critically analyze it. In this content, the teacher presented the random phenomena, the uncertain and the impossible, probable and improbable and instigated the students to present examples. In the studies on the graphics, the teacher explained in detail all the components that constitute them. Afterwards, an activity was proposed in which the students would have to divide themselves into teams to do a brief survey to collect data and subsequently create a graph to present the data collected in the survey.



Source: Direct search

Figure 9. Building graphics

Figure 9 shows us one of the graphs constructed by the students. A study using the Fedathi sequence methodology for teaching health sciences, researchers achieved significant results by promoting significant learning in the teaching of anatomy of the sensory system

(SOARES *et al.*, 2019). All activities performed during the course followed the assumptions of the Fedathi Sequence. According to Santos (2017, p. 86), the Fedathi Sequence proposes two types of analysis: environmental and theoretical. The environmental analysis basically serves the analysis of the plateau, which works for the leveling and experience of the students in relation to the Mathematics of the initial years of Elementary School. Before each thematic unit addressed, a plateau was held and it was found that most students had a deficit in the construction of mathematical concepts and were unable to bring these concepts to confront them with real life situations. Taking a position was already made explicit in the methodology applied by the teacher, when they were asked in the first unit if they knew the difference between Number, Numerals and Numerals and they did not know how to answer, for example.

Gradually, after a period of Maturation and through the mediation of the teacher in multilateral interactions, students arrived at the desired Solutions for the proposed problem situations. In all classes, the teacher's Fedathian stance was clearly perceived, which despite being the holder of the knowledge to be learned by the students, was inserted in the group with the functions of reflecting, listening, asking and raising hypotheses about this knowledge, as well as raise these questions among students (SOUZA, 2013, p. 21). During the Didactic Sessions, the teacher-trainer always sought to raise questions, as was the case during the work with the thematic unit Numbers, in which the students were asked: "What is it to operate?". In this case, the students' response was silence and then they said that during their basic education and high school they had never been led to think about it, which confirms the ideas of Santos (2015) when he says that the pedagogue brings in his root problems of an epistemological nature, because he still needs to learn elementary mathematical concepts. Their previous experiences with mathematics became visibly apparent when faced with evaluative activities, whether they were of any nature, even though it was often not a written test, causing some discomfort. In order to solve the problem, the teacher proposed a different way for the evaluation of the students. During the Numbers Unit, they were asked to meet in three groups and work on the Monetary System, elaborating problems with real situations and exposing the solution in the form of dramatization in class. Visibly the expression of the students changed and they began to plan and create with autonomy and property in a dynamic and meaningful movement for active learning. The assessment activities followed a formative and varied proposal throughout the semester, where it culminated in the workshops based on the Thematic Units studied and planned according to the Didactic Session model used in the SF. The theoretical analysis that meets the choice of teaching material appropriate to the locus and the public showed that the teacher-trainer used the available teaching resources well, in addition to making a good selection of texts fully relevant to the content of each thematic unit and the target audience, contextualizing Mathematics in a dynamic and pleasant way and mainly instigating students to develop critical and reflective thinking, raising, with the presentation of concrete and challenging questions, their capacity for abstraction. We will continue with the data analysis, now covering the data collected in the questionnaire applied to students at the end of the course. For the analysis of the information collected in this procedure, we will organize three categories, namely: students' expectations in relation to the discipline, the students' opinion about the pedagogues being able to teach mathematics and knowledge acquired in class. According to Bardin (2016), the categorical analysis works by dividing the text into units, in categories according to analogous groupings. We will treat the research subjects by students A, B and C, in order to preserve their identities.

The analysis of the first category showed that one of the greatest expectations regarding the discipline was to learn how to teach mathematics to children properly and learn about the contents, according to the students:

Improve my knowledge on thematic units related to mathematics and obtain new teaching methods to put into practice with students (student A).

Learn about how to teach math properly and a little bit about the mathematical content itself. I believe that these expectations have been met (student B).

In the analysis of the second category, the answers were divided, but most considered that they are not fit, as they would need further training or another mandatory subject. According to students:

I believe so. I believe that for an initial training, the UFC pedagogy course fulfills its role well. I believe that continuing education is an excellent option to fill possible gaps in initial training (student A).

In part, because new knowledge can always be acquired and shared in order to improve our classroom practices as pedagogues. For them to be better able, it is important that there is continued training (student B).

No. Much still comes from teaching in this area that is very flawed and a single discipline is not able to fill this gap (student C).

In the analysis of the third category, all students agreed that the studied contents contributed significantly to their pedagogical practices. According to them:

Certainly, because during classes, in addition to learning the content, we learned several ways to work with the children (student A).

Yes, because in classes we learn from activities that can be adapted for children, thus building concepts through reflection and practice (student B)

Yes, because with discipline I was able to improve my knowledge and learn teaching methods (student C).

These results pointed to the effectiveness of the Fedathi Sequence methodology for Teaching Mathematics according to Santos (2017, p. 84) when he says that “in SF the role of the teacher in teaching mathematics, based on a problem situation, is to propose to the student that he has a significant teaching experience based on an expressive mathematical experience ... ”and even though this teacher does not present mathematical knowledge, structured only as intellectual production, but also as a cultural structure that involves his own understanding and meanings of what it is to be a mathematician, with its challenges and difficulties. (SANTOS, 2017, p. 84). It is also clear from the study that if the initial education of the pedagogue continues under the methodological perspectives used, it will be possible, in the near future, to find teachers who are more motivated, more qualified and increasingly prepared to meet their real needs. Although the Fedathi Sequence is not an active methodology but a teacher-centered methodology, it is an important tool to promote meaningful learning.

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