Sinergias Educativas

Article

The "multiplicative honeycomb" an inclusive strategy for strengthening mathematical reasoning and problem solving skills.

El “panal multiplicativo” una estrategia inclusiva para el fortalecimiento de habilidades de razonamiento y resolución de problemas matemáticos

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Abstract

The research project mentioned above was aimed at improving reasoning and problem solving skills through the design of a ludic-pedagogical strategy called "Multiplication Honeycomb", which contributed to the improvement of the teaching-learning processes and the exercise of the aforementioned skills. The research took place in the Municipal Educational Institution Nuestra Señora de Guadalupe, located in the village of Catambuco, Botanilla - Nariño, with fourth grade students, some of

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Sinergias educativas
January - March Vol. 7 - 1 - 2022
http://sinergiaseducativas.mx/index.php/revista/
eISSN: 2661-6661
revistasinergias@uteq.edu.ec
Page 15- 28
Received: July 09, 2021
Approved: November 30, 2021

whom present certain restrictions in the mathematical skills previously mentioned, detected by means of the results of tests carried out in their classes. The methods and types of research, were linked to quantitative research, of quasi-experimental type and descriptive scope; understood these as conjunctural forms, which comprise from dynamics of the context and the need to implement strategies validated in applied exercises, allowed to visualize realities and their superior results in mathematics from the boys and girls of the Educational Institution. One of the fundamental results that emerged was related not only to a better understanding and mathematical skills, but also to the strengthening of coexistence and socioemotional skills that arise from learning by doing and the appropriation of the exercise of construction of this tool from the boys and girls.
Key words: Teaching and learning strategies, multiplicative honeycomb, mathematical skills, social-emotional skills and integration.

Resumen

El proyecto investigativo mencionado tuvo como, la mejora de las habilidades de razonamiento y resolución de problemas mediante el diseño de una estrategia lúdico – pedagógica denominada "Panal de Multiplicación", está contribuyó en el mejoramiento de los procesos de enseñanza – aprendizaje y en la ejercitación de las habilidades mencionadas. La investigación se dio lugar en la Institución Educativa Municipal Nuestra Señora de Guadalupe, ubicada en el corregimiento de Catambuco, vereda Botanilla – Nariño, con los estudiantes de grado cuarto, algunos de los cuales presentan ciertas restricciones en las habilidades matemáticas anteriormente señaladas, detectadas mediante los resultados de pruebas realizadas en sus clases. Los métodos y tipos de investigación, estuvieron ligados la investigación cuantitativa, de tipo cuasiexperimental y alcance descriptivo; entendidas éstas como formas coyunturales, que comprenden a partir de dinámicas propias del contexto y la necesidad de implementar estrategias validadas en ejercicios aplicados, permitieron visibilizar realidades y sus resultados superiores en matemáticas desde los niños y las niñas de la Institución Educativa. Uno de los resultados fundamentales, que emergieron, fue lo relacionados no sólo a una mejor comprensión y habilidades matemáticas sino al fortalecimiento de la convivencia y habilidades socioemocionales que surgen del aprender haciendo y la apropiación del ejercicio de construcción de esta herramienta desde los chicos y chicas.
Palabras clave: Estrategias de enseñanza aprendizaje, panal multiplicativo, habilidades matemáticas, habilidades socioemocionales e integración.

Introduction

The Guadalupe Municipal Educational Institution, main office is located in the Municipality of Pasto, Catambuco, perimeter road

sector, in the urban area of this sector. It is composed of 27 elementary school teachers at the main office and 812 elementary school students of which 425 are male and 387 are female, these students belong to low socioeconomic strata and with reduced conditions in their social-emotional environments, which make it difficult for them to interact proactively in the comprehensive educational process.

Low performance in mathematics is a constant, presenting the loss of the subject, without reaching the expected level. This problem lasts until adulthood, having a considerable impact on the development of everyday situations. The economic and social repercussion involved with this phenomenon, is fundamental to understand the processes implicit in the learning and execution of mathematics Cragg & Gilmore (2014). In this sense, it is relevant to mention that it not only has an impact on the issues mentioned by the authors, but also generates frustration and therefore a reduction in the motivation to enter higher education of boys and girls in the IEM.

Within the comprehensive reading of the context through the non-participant observation and what was referred by the teachers, it was evidenced that, regarding the learning of the multiplication process, it was necessary to strengthen the reasoning and problem-solving skills, since most of the students presented difficulties in this aspect. Taking into account the above and in order to generate a change in the population, a strategy was designed to provide a solution to this problem, strengthening the teaching-learning processes in the exercise of reasoning and problem solving skills through didactic material from a playful approach; for this purpose, the limitations that the students had in the classroom in the development of these skills were first identified and this led to the design of a playful strategy through the multiplicative honeycomb.

As mentioned, through the construction of the multiplicative honeycomb for the use and practice of mathematics in the fourth grade of the IEM, it was possible to demonstrate the difficulties that students have for a good performance in mathematics, as well as the strategies to be used collectively that make possible, not only the strengthening of this competence but also integral aspects of the teaching-learning process, such as coexistence and personal skills in each of the participants.

As a great result, it was identified that through research processes such as the one proposed, it is possible to show skills that are not very visible, due to the number of students inside a classroom, not seen in the school day; proposing strategies that make it possible to

demonstrate socioemotional and formative changes in children where didactic strategies such as the multiplicative honeycomb are used.

Materials and methods

In the teaching-learning process, it is worth highlighting the importance of didactic resources within this process, as it could be said that "without resources there is no learning". (Romero, 2016, p.45). Didactic resource refers to any material that has been elaborated with the intention of facilitating the teacher's function and that of the student. It can be said that the didactic material is an instrument that the teacher elaborates with the purpose of improving the teaching-learning process in order to awaken the student's interest in learning. Didactic material refers to those means and resources that facilitate teaching and learning within an educational context, stimulating the function of the senses to easily access the acquisition of concepts, abilities, attitudes or skills.

The proposed methodology, after conducting an analysis of the boys and girls, as well as a conceptual understanding of the definitions, the researchers assumed quantitative research, understood as the set of instruments that enable the objective definition of the intervention, as well as the reliability of the resulting statements at the end of the mathematical exercises proposed for the improvement of mathematics in the fourth grade.

(Gamboa et al., 2019); von Feigenblatt (2020) The type of research assumed is quasi-experimental, since it articulates previous knowledge, team and participatory work, as well as the need for a previous and subsequent diagnosis to understand the achievements of the instruments applied before, during and after the implementation of the multiplicative honeycomb.

The scope of the results found is descriptive; that is, the understanding and teaching of mathematics to fourth grade students made it possible to propose a comprehensive training strategy that could possibly be implemented in other contexts, under similar trends for the achievement of objectives that enable progress in the learning of mathematics.

The population and participants were 10 students (6 boys and 4 girls) of fourth grade of the IEM Nuestra Señora de Guadalupe, between

the ages of 7 and 8 years, in the Botanilla - Nariño district; they are located in a rural area, which as mentioned, are of strata between 1 and 2 in levels up to lower.

For the collection of information, a field diary was developed in which the interactions between the students and the teacher, derived from the process of development of mathematical skills, will be recorded. Zurbano (2014) In addition, a semi-structured interview will be used, where, depending on the development of the interview, open questions of interest for the research will arise. This interview will focus on the mathematics teacher and will also be applied to other teachers working in the same grade.

It is expected that this research project has strengthened the skills of reasoning and problem solving in multiplication for fourth grade students of the I.E.M. Nuestra Señora de Guadalupe de Catambuco - Nariño; with the report obtained, the results of the research were contributed to the educational and scientific community through an article published to date.

Results

The results presented below are based on the following population sample.

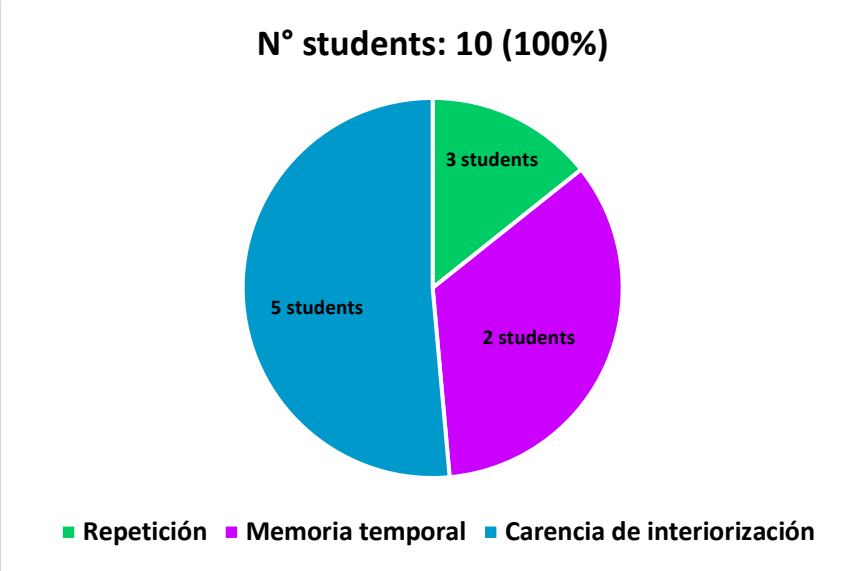
Table 1. *Description of the unit of analysis (sample).*

EDUCATIONAL INSTITUTION	CONTEXT	LEVEL	NO. OF STUDENTS	H	M
I.E.M. Our lady of Guadalupe	Rural	Primary	**10**	**6**	**4**

Source: this research. 2021

When reviewing the field diary, with respect to the difficulties that arose with the children in fourth grade of the IEM, the following stand out: repetition, temporary memory and lack of internalization of concepts. A quantitative analysis of the evaluated guide revealed the following:

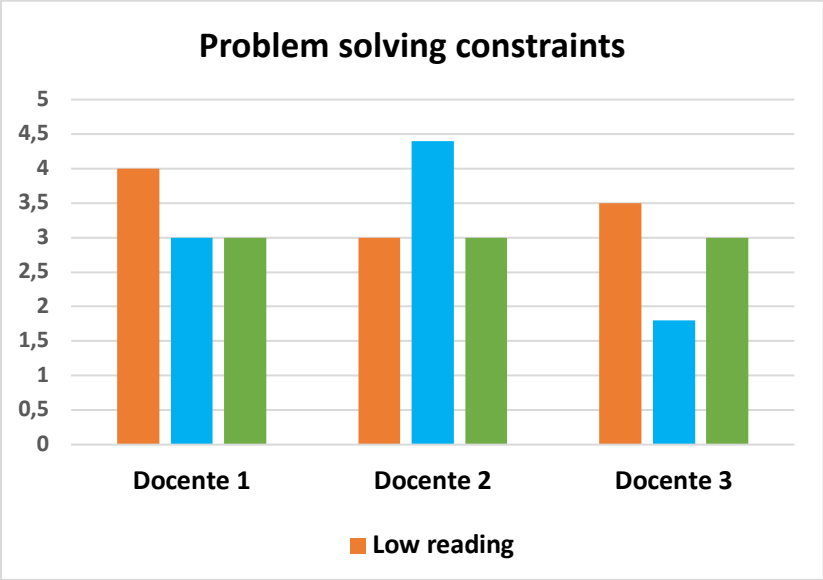
Figure 1. Difficulties presented in students.



Source: this research. 2021.

According to the diagnostic and/or perception interview conducted with fourth grade teachers of the educational institution, the following limitations in the problem-solving process were unified, among others, poor reading, not looking for a strategy to solve the case and not using didactic material to pose the problem.

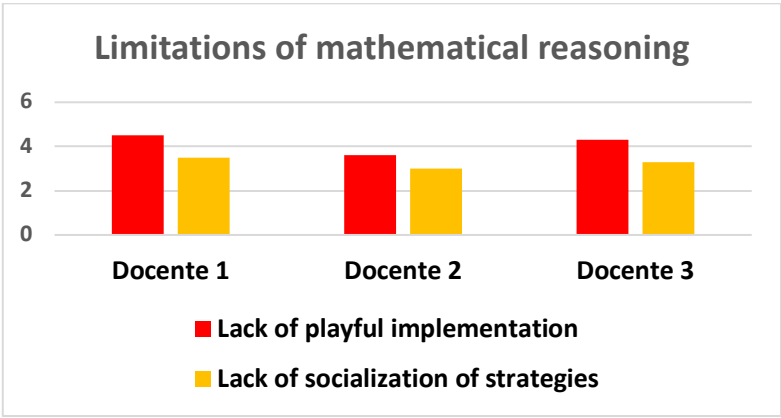
Figure 2. Constraints analyzed by the teachers interviewed



Source: this research. 2021.

It was also identified regarding the mathematical reasoning process, in fourth grade children: the lack of implementation of playful-pedagogical strategies, the socialization of such strategies and chaining of processes that manage to link the student in the process of mathematical reasoning.

Figure 3. Constraints on mathematical reasoning analyzed by teachers interviewed.



Source: this research. 2021.

The above allowed us to infer that there are clear, repeated and transcendental problems in the teaching and learning process in general and in mathematics, which are deep and serious and are reproduced in the other grades, in educational institutions such as

those mentioned, with low levels of dedication and academic recognition in the municipality of Pasto. Now, according to the interview conducted with fourth grade teachers from different educational institutions in the municipality of Pasto, the following limitations in the process of problem solving were unified:

> Reading is fundamental for the complete formation of students, and the acquisition of a reading habit is crucial for their educational development. A major strategy for learning and teaching is to encourage thinking and understanding the text. Reading comprehension and the development of intellectual skills is based on the interpretation of the text and the contextualization of the problem (Frías, 2015, p. 30).

The context in which a mathematical problem is developed and its correct interpretation is involuted by the use of technological tools, based on diffuse and poorly argued literature extracts. The reading habit in the population sample of this study is impaired, thus leading to consequences in the approach of mathematical problems with simple solutions based on a correct interpretation of the text.

Limited resolution strategies, according to Meneses and Peñaloza (2019) "the resolution of each problem brings with it a great discovery, the problem must challenge curiosity and induce to bring inventive faculties into play".

Therefore, the learner must apply a learning procedure in a relevant way, which implies possessing the basic skill that allows it, knowing the procedure in question (procedural knowledge) and being able to apply it appropriately when conditions make it advisable, according to an objective (strategic use of the procedure).

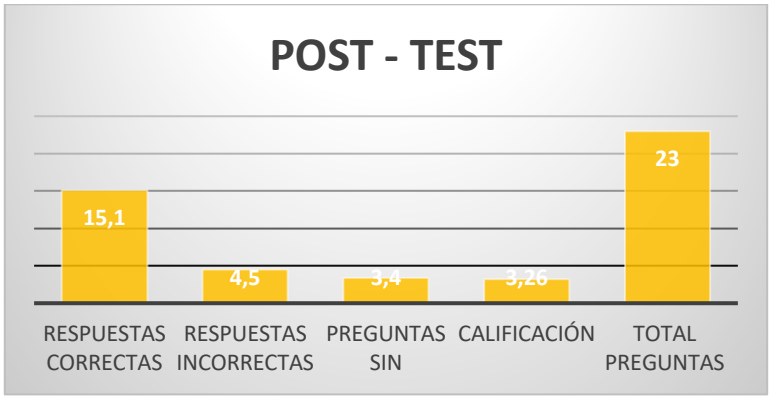
With this scenario, the working group decided to adopt from its construction, the implementation of the multiplicative honeycomb as a training strategy that, as conceptually defined, enables the spontaneous, participatory and playful learning qualification, from and with the dynamics of the boys and girls present in the exercises. This made it possible to identify, initially, the difficulties of the students in the development of the exercise; one of them did not respond correctly to the results of the first exercise, allowing the researchers to determine the need to integrate the strategies of socialization of the exercise to the levels of understanding of the students.

In this sense and as mentioned by Mora, the possibility of employing systematic methods in the evolution of mathematical reasoning is

determined throughout the development of education. In early childhood education, it favors the child's search for objects, which could be translated into the use of numerical location methods motivated by intuition. In Primary Education, playful procedures would be applied, firstly, to numerical symbology, using alphabetical sorting, and then to other reference works and guides based on numerical or alphanumerical sorting (Mora 2014, p. 23).

After the construction of the multiplicative honeycomb, together with its use in the mathematical exercises proposed in the research, the students remained happy, they assumed the equations, numerical results, mathematical concepts, multiplications through this tool; assuming a proactive disposition, caring for their constructed material, as well as understanding the alternatives in the teaching and learning process derived from the multiplications through the multiplicative honeycomb.

Figure 4. *Post-test results with students*



Source: this research. 2021

Discussion

The present research proposal is circumscribed within the framework of the research line in inclusion, understood as the educational process through which the university contributes from the academic production, in the processes of inclusive transformation in children of school age and that make possible the integral formation in their educational environment.

The elements proposed for the implementation of the exercises, as well as the analysis based on these comprehensions, made it possible to identify the need to encourage the study of teaching and learning strategies in all areas; however, for this research, it is necessary to

prioritize the implementation of these strategies in the comprehension of mathematics.

The elements to highlight then, are related to the teaching and learning strategies of mathematics, the diagnosis or initial tests that allowed us to observe the initial and/or problematic elements to transform through the results after the application of the multiplicative honeycomb, the resulting elements after the exercise, the strengthened mathematical skills, as well as emerging elements not identified in the formulation of the research, related to motivation and coexistence that were enriched during the research process with the students of the educational institution.

The theoretical reference was based on the following terms. Teaching - Learning Process: this process is defined as "the movement of the cognitive activity of students under the direction of the teacher, towards the mastery of knowledge, skills, habits and the formation of a scientific conception of the world." (Tobón, 2019, 78). In this process, the three elements of the educational cause are combined (students, teachers and the object of knowledge), where each element plays a different role depending on the methodological moment of this academic training process, and where this conjugation will result in the instruction to be able to solve and understand various situations that arise in the life of both actors. "Teaching - learning is a process, because such training takes place in a systematic and progressive way, by ascending stages, each of which is marked by quantitative changes that lead to qualitative changes in students, in the cognitive, volitional, affective and behavioral aspects". (Marchán-Carvajal & Sanmartí, 2015, p 90)

In other words, training on the need for the multiplicative honeycomb in a participatory manner and with the manual interaction of the students, allowed generating greater skills in the understanding, reflection and subsequent participation of the children in the exercises formulated for their development and analysis.

The teaching and learning strategies should therefore integrate the context, the skills of listening and execution of an exercise, the use and participatory integration of all children in the exercises, enabling the participation, inclusion and use of the resources present in their environment, as well as the friendly interrelationship with their peers.

For Brito-Orta & Espinosa-Tanguma (2015) defines: "teaching aids are all those components of the teaching-educational process that serve as material support for teaching methods to enable the achievement of the objectives set" p. 56. In this definition, teaching aids are recognized as visual and auditory media as well as real objects, textbooks, laboratories and all the material resources that support the teacher's work.

It is vital then, that the means for meaningful teaching and learning exercises are provided; these must consider the context, the alternative difficulties for those who cannot use them or have psychomotor difficulties, alternatives for the creation and completion of this, as well as the significant needs where they will see their final results reflected.

Regarding Mathematics Teaching-Learning: both students and teachers have a determining influence on the success of the mathematics teaching-learning process. Teacher and student are responsible for the development and results of the didactic practice. Both have to accept their strengths and weaknesses. The difficulties in learning mathematics are largely related to the little action that students have during the realization of mathematical activities. We are in the presence, then, of a didactic problem, which can be solved by means of a progressive conception of pedagogy.

Mathematical reasoning develops on the basis of executive functions, where mathematical skills use a transversal correlational design, in which working memory is implicit, involving verbal and written calculation, as well as mathematical problems in the form of statements. The numerical information received by humans from an early age is directly affected by working memory and its gradual development. This particular correlation involves the training of the executive functions of the brain and its specific domain. Several investigations coincide in a theoretical model that predicts the relationships between executive function skills and the components of mathematical knowledge Cragg & Gilmore (2014), These two conceptual understandings, allow us to land the particular need for this research, the use of the multiplicative honeycomb as a strategy to strengthen mathematics in elementary school boys and girls, who have limitations in the development of skills for numerical reasoning.

The very fact of making this tool with their own hands allowed us to identify the appropriation, motivation and need for natural

understanding not only of the exercise, but also of mathematics by making use of this tool created by themselves.

It could be argued that the learning of mathematics only takes place, outside or inside school institutions, if students actually participate in the development of mathematical concepts and ideas. Mathematics is learned, just like other areas of scientific knowledge. In general, the teaching of mathematics begins with a brief motivating introduction, which enables students' interest and action, according to their previous knowledge, personal intuition and learning methods known to them as a result of their intra- and extra-mathematical socialization process. (Abreu et al., 2018, 90)

It is significant for the researchers to understand the progress made in the implementation of these activities in a participatory and inclusive manner, understanding inclusion as "making the right to education effective requires guaranteeing that all children and young people have, first and foremost, access to education, not just any education, but a quality education with equal opportunities. It is precisely these three elements that define educational inclusion or inclusive education". (Echeita and Duk, 2008, p. 98).

This was reflected in the characteristics that were highlighted in the learning of the research process with the fourth grade children; in this sense, integration exercises are promoted, shared activities, personal reflection without discrimination among them, as well as the recognition of diverse characteristics in people that make possible a diverse learning process that does not exclude others.

With the results described, as well as what was demonstrated in the tests after the exercises, it was possible to identify the transformation in the understanding of mathematics with children in the fourth grade; it is considered that the student achieves learning when he/she can solve problems, some time after the education period and in a wide variety of situations. With regard to teaching, according to the constructivist approach there is no single way, the student should be provided with different atmospheres, scenarios and/or environments that allow him/her to build mathematical knowledge; it is necessary to motivate him/her to explore ideas, make conjectures and then justify them, so that through mathematical reasoning he/she can argue his/her assertions and convince his/her peers and teachers. It is also important to work on problem solving and to include real-world applications.

As described, the use of the multiplicative honeycomb, since its creation spoiblit an additional motivation in the understanding of mathematics; according to Maslow, referred to in the Manual of Psychology and Educational Development volume 1, 2008 by Herrería Valero: "children learn by playing, without worrying about the nature of learning" (p.53). Ángel (2006) states: "the child learns from action on objects". This refers to the fact that the child learns by maneuvering objects in order to discover and register his environment. It is not the same for him to discover as for the teacher to impose on him what he should do and how he should do it; the educator should be a guide to improve his expectations of the topics presented and make the teaching-learning process more interactive.

In this sense and in defense of strategies such as the multiplicative honeycomb, Sánchez Macías, a graduate in Mathematical Sciences, stresses his uneasiness about the design of materials that help to provide an adequate follow-up of teaching-learning of mathematics from early ages until their university life, which implies that teachers of all areas and mainly of the first grades, should have a similar sense of concern with the purpose of creating and implementing new ways that lead to a meaningful and attractive learning in students through playful-pedagogical practices.

With the observational data practiced with students, there are good inventive faculties, however, they are mostly not cohesive with mathematical skills.

According to the data collected in the observation of the population sample, as well as in the interviews conducted with the different teachers, it is observed that there are not enough didactic alternatives to support mathematical concepts, especially those centered on multiplication.

The second criterion compiled is the consideration of procedures as contents; that is, as culturally organized forms of knowledge that have epistemological relations between them. In this sense, in the teaching of two synthesis procedures, elaborating schemes and constructing concept maps, we could put the former before the latter, which is based on their requisite relations. The construction of maps involves great difficulty if the student has not previously been taught to group a set of ideas in a schematic way.

The positive effects of the observation and analysis led to the creation of the "Multiplicative honeycomb", not only as a didactic strategy but also as the central object of study of this proposal.

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