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The understanding of mathematical notions for the cognitive development of students

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***Abstract*---**The research was based on the understanding of mathematical notions for the cognitive development of upper basic students of the "Colón Arteaga García" Educational Unit of the Chone Canton, in the period 2021 - 2022. The results of the research are shown, applied to students through a survey, to make known how they interact with a variety of disciplines in their comprehensive development, including Mathematics. Cognitive development is closely related to executive functions as a cognitive process and the relationship of its functioning applied to learning and problem solving. The objective of this research is to check the understanding of mathematical notions and their impact on the cognitive development of students, to achieve this purpose a bibliographical analysis was carried out taking as reference observations made in the Unit. The research has a qualitative approach, in addition to the inductive, deductive, analytical, synthetic, bibliographic and statistical method. It is concluded that the basic notions of mathematics have a positive impact on the cognitive development of students and the ability to learn to learn, achieving meaningful learning.

***Keywords*---**Mathematical notions, cognitive development, students, learning

Introduction

The research was based on contributing that the students of the Upper Basic, through the comprehension of the mathematical notions, develop their cognitive level in the learning of this science. It is for this reason that the basic notions of mathematics are acquired by children through the environment that surrounds them and plays an important role in learning this science, which leads to the development of cognitive processes of mathematics in children. students with the help of the teacher.

During the course of their learning, students interact with a variety of important disciplines in their comprehensive development, including Mathematics. From the educational teaching process of this area, cognitive processes can be enhanced in them.

The complexity of mathematical knowledge, how to teach Mathematics in primary education is a fascinating world. The scope of this subject in the development of the intellect is vast, its importance for life makes it relevant. Flexible contemplation of different strategies for solving a problem, self-evaluation of performance, giving a special place not only to what is learned, but also to how it is learned, reflecting before responding, are the learning that transcends in the classroom, and they are incorporated into life and the future (Suárez, 2015).

In Mathematics classes it is possible to carry out exercises that involve the transfer of already known calculation procedures to new situations, as well as to develop problem-solving activities that enhance school reflection. For the development of these, the interrelation of cognitive processes such as voluntary attention, thought, memory, language, but also the expression of cognition is necessary (Rico, 2016).

Metacognition is a multidimensional construct, according to (Sastre, 2016), "metacognition is closely related to executive functions as a high-level cognitive process, which is usually related to the control and regulation of cognitive functioning applied to learning and resolution of problems" (p. 12).

Cognitive skills according to (Frías, Haro, & Artiles, 2017), the student must possess cognitive skills are those that allow the person to know, think, store information; organize and transform it to generate new products, perform operations such as establishing relationships, formulating generalizations, making determinations, solving problems, achieving lasting and significant learning.

The thought and its applications rest on the study of the mind, the stimulation of the intellect, the phenomena that accompany the mental act, contributing to the study and understanding of some processes of the human mind such as perception, knowledge representation, information processing and modification. cognitive (Amestoy, 2016).

The mathematical notions according to (Arteaga & Macías, 2016), express that the child from birth begins to interact using his senses. For this, he relates what he

understands with the environment that surrounds him. As he grows, he experiences different situations, in which he will develop his mathematical thinking more and more, this is as he practices, he achieves new knowledge and thus enriches his knowledge.

The objective of the teaching-learning process of mathematics is not only for students to learn the traditional arithmetic rules, units of measurement and some geometric notions, but its main purpose is that they can solve problems and apply mathematical concepts and skills to function in everyday life.

Materials and methods

Research on mathematical notions at the cognitive level will be of an exploratory level, since it seeks to analyze the phenomenon under study, with the recognition and identification of the problem, its causes and consequences (Valle, 2009), in this way, analyze the real aspects that involve it with an in-depth investigation of the object of study, thus allowing the development of the investigation.

The applied methodology has a qualitative approach, because it responds to the criteria of the variables, which are subject to a statistical process to accept or reject the hypothesis, allows to investigate, analyze and understand, from the disciplinary and didactic perspective of the reality of a group. of students through their actions and thoughts in front of their context of the Educational Unit of study.

As a qualitative approach in research that studies didactic phenomena, Quintana (2006) points out that education has to do with human actions, where the reality that is going to be the object of analysis is studied in its natural context that characterize learning difficulties, having Keep in mind that education has to do with human actions.

Some quantitative contributions based on the use of statistical techniques were valued to know certain aspects of interest about the population that is being studied, such as the collection of information through surveys and the analysis of the data through descriptive statistics, the phenomenon of study was characterized, applying the heuristic method, in order to find and solve a problem; the inductive method, because in the course of information processing new concepts were introduced to perceive the results with a certain level of generality (Hueso, Cascant &2012).

The researcher sees the scenario and the people from a holistic perspective, trying to understand them within the frame of reference of themselves (Tamayo, 2001), the inductive, deductive, analytical, synthetic and statistical method was used where the route to follow through a series of operations, rules and procedures set in advance in a voluntary and reflexive manner, to achieve a certain result that may be material or conceptual (Ander-Egg, 1995) (Pulido, 2015).

Analysis and discussion of the results

Mathematics teaches to understand reality in a logical, coherent and simple way, it helps others in solving problems and, therefore, in making the right decisions. In this regard (Creamer, 2016), he maintains that the student understands better if he relates mathematics to daily life, where it is used when distributing, giving, receiving, sharing, buying, selling, counting, among other things, being necessary to connect the theory with daily practice, especially in the first years of basic education, using concrete and manipulable objects of verbal, oral and written language, so that the student can understand concepts and their abstract representation, in this sense mathematics is not only learning numbers, but it is to develop logical, critical and creative thinking.

The results shown are the data obtained from the survey designed to know the difficulties that students have due to the lack of basic knowledge of mathematics in the cognitive development of the Higher Basic of the Educational Unit of the Chone Canton. in the period 2021 - 2022, being able to know the causes of problems.

Understanding of mathematical

notions Mathematical notions according to (Arteaga & Macías, 2016), express that the child from birth begins to interact using his senses, for this he relates what he understands with the environment that surrounds him as he grows up he experiences different situations, in which he will develop more and more his mathematical thinking, this is in accordance with the practice where he is achieving new knowledge and thus enriches his knowledge.

Education in the area of mathematics contributes to building meanings and finding meaning in people's daily actions, such as: seeing the time, shopping, making a table, selling fish, keeping accounts, among others (Terán, 2017).

The child needs the support of a person so that he can continue with his learning and discover what is new in his environment. Being valuable to know how children develop depending on their age and offer them different opportunities in which to develop their mathematical thinking with the environment that surrounds them and with all their senses (Alsina, 2016).

The basic notions of mathematics are experienced by children with all their senses through daily experiences when classifying, relating, differentiating shapes and dimensions, discovering relationships, these will always allow the understanding of number (Rencoret, 2017).

The basic notions are acquired by children through the environment that surrounds them unconsciously, in the first place there is the body that is the referent of the spatial notion, since with it the tonic respiratory control, posture, balance, structuring of space and time, which leads to the formation of the body scheme; Secondly, they are acquired through play, during the teaching-learning process, and they develop logical thinking, interpretation, reasoning, and

understanding of number, space, geometric shapes, and measurements (Andrade, Pilco, & Valdiviezo, 2016).

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Importance of cognitive development in learning

The importance given to mathematics in the cognitive development of students, which through a series of mental operations that take place in the brain, processes through which students can capture, analyze , encode and store information, allowing adaptation to the social world, which is also useful and significant for students; because without this, they will not be able to understand the problem or the theoretical basis taught by the teacher, in this line various authors have referred.

According to (Resabala, 2019), this reflects on the processes that allow the information that comes through the senses to be solved, which is stored, manipulated, retrieved and interacts with the world, which allows it to be learned Other authors such as (Chóez, 2018), suggests that they are processes that constitute each of the ways to organize an action, developing one's own intellectual capacities, in relation to the function that a task requires, directing thought processes towards problem solving; It is also stated that the cognitive abilities known as skills contribute to the process of acquiring knowledge that is recognized, potentiated and reinforced in teaching-learning (Ariza, 2019).

To acquire a cognitive skill, three moments need to be executed: The first is that the person is unaware of the skill; the second is the actual process of acquiring the skill and developing it through practice; the third moment, the skill is already independent of the knowledge, because it has been internalized in such a way that its application in simple cases is fluid and automatic (Ramos, Herrera, & Ramírez, 2019).

Considering the above, it must be considered at all times that the learning of mathematics constitutes the foundations of thought, observation, intuition and imagination of the logical reasoning of the capacities, which will always affect the establishment of relationships of inducing, infer, deduce and apply a meaning to a symbology that operates to develop capacities (Arteaga & Macías, 2016).

To demonstrate the objective of the research and verify that the understanding of mathematical notions is essential for the cognitive development of High School students, a survey was applied to have clear elements of what students think about different aspects.

The types of strategies used by teachers for a better understanding of students in classes were investigated, the results can be seen in table 1.

Table 1. Types of pedagogical strategies used by teachers during class hours

Alternatives	Frequency	Percentage (%)
A. Cognitive Strategies	42	87.5
B. Playful Strategies	6	12.5

As can be seen, the students surveyed have answered literal A almost in its entirety, 87.5%, where it is shown that teachers use cognitive strategies for a better understanding and development cognitive, only 12.5% answered option B, which was related to the pedagogical strategies used by the teacher.

The second query was related to the understanding of teachers by students in the teaching-learning process of mathematics, showing the results in table 2.

Table 2. Teachers make themselves understand the explanation in class hours

Alternatives	Frequency	Percentage (%)
A. Yes	38	79.2
B. Sometimes	8	16.6
C. Never	2	4.2

In the survey of students, 79.2% answered literal A, demonstrating in this case that the majority of students indicate that teachers make themselves understood during class hours, 16.6% of the students who sometimes make themselves understood the explanation and 4.2% indicated that they never make themselves understood, showing that the teachers do make themselves understand the explanation in class hours. This shows that there is a small group of students who do not understand the teacher who, together with those who sometimes understand him, continue to be the minority of the group.

was investigated for learning, showing the results in table 3, through a basic mathematical problem: A computer printer has a system of four cartridges: three cartridges of different colors and one black. The color and black cartridges contain 12.5 ml of ink each. To refill the color and black cartridges, there are four 62.5 ml containers. How many refills of a color and black cartridge can be made with the four containers?

Table 3. Basic notions of mathematics

Alternatives	Frequency	Percentage (%)
A. 5 reloads	35	72.9
B. 6 reloads	10	20.8
C. 4 reloads	3	6.3

As can be seen, the students surveyed have answered three aspects related to the basic notions of mathematics for better learning. Literal A had the highest percentage. As can be seen, the response given indicates that 72.9% answered correctly, indicating in this case that in a cartridge there are 5 color and black

refills to be made with each of the four containers, which means that most of the students have basic notions of mathematics, 20.8% answered literal B and consider that the cartridges have to make 6 refills of each one, and only 6.3% answered that in each cartridge there is for make 5 reloads, demonstrating that the understanding of the basic notions of mathematics favors significant learning.

The fourth question was able to verify the reasoning of the students, where they could demonstrate their knowledge, for this they were asked a question about a student named Jaime, who wants to make a wooden frame for a painting of his sister Andrea. The frame should be in the shape of a square that encloses the area of 900 cm^2. What is the side of the square? showing the results in table 4.

Table 4. Calculation of the side of a square

Alternatives	Frequency	Percentage (%)
A. 40 cm	2	4.2
B. 25 cm	1	2.1
C. 30 cm	44	91.7
D. 35 cm	1	2.1

As can be seen in the results obtained in the question related to the calculation of the side of a square, the largest number of students, 91.7%, answered literal C, which is the correct answer, being clear about the logical reasoning of the topic discussed, 2.1% answered literal B and D and only 4.2% answered literal A, most students are capable of logical reasoning.

A question related to the mental development of the students was applied, in table 5 the results obtained from the following problem are shown: What is the perimeter of an equilateral triangle, if its base measures 12 cm?

Table 5. Development of mental ability of students

Alternatives	Frequency	Percentage (%)
A. 36 cm	28	58.3
B. 32 cm	4	8.3
C. 49 cm	6	12.6
D. 72 cm	10	20.8

It was obtained as a result that of the students surveyed, 58.3% correctly answered answer A, that the perimeter of the triangle is 36 cm and since it is an equilateral triangle its sides are equal, in other words, 42% of the students answered in the wrong way, in this sense it can be verified that they have difficulties in mental abilities.

To enhance the student's skills, the teacher must apply exercises that involve pointing out the order of the mathematical operations to be performed, the organization of data by the student of a problem that is presented in various ways to reach the solution, these elements will help so that students can easily insert themselves into cognitive learning and logical reasoning, managing to check the understanding of mathematical notions and their impact on the development of students.

Conclusions

The understanding of mathematical notions directly affects the cognitive development of students, when the teacher applies cognitive strategies to enhance reasoning in problem solving. When analyzing the results of the students surveyed, it was possible to show that teachers play a decisive role in student learning, and it is essential that students develop mental skills through the solution of exercises.

The knowledge of the pedagogical content of the teacher contributes to the cognitive development in the resolution of mathematical problems of the students of basia superior. The understanding of mathematical notions affects cognitive processes, understands and analyzes, which is used in solving mathematical problems, it is evident that the process includes knowledge of the pedagogical content that teachers have, and the process understands that students use for resolution of mathematical problems.

The teaching-learning process of mathematics points to the application of logical reasoning, in which not only knowledge and skills are involved, but also discovery and internal dialogue that builds reflective analysis and creative thinking.

References

Alsina, A. (2016). *How to develop mathematical thinking from 0 to 6 years old.* Barcelona: Octahedron. https://octaedro.com/libro/como-desarrollar-el-pensamiento-matematico-de-0-a-6-anos/

Amestoy, M. (2016). *Research on the development and teaching of thinking skills.* Retrieved from https://bit.ly/2ZCEpCS.

Ariza, G. (2019). *An innovative strategy for strengthening intellectual abilities.* National Pedagogical University. https://repositorio.uta.edu.ec/bitstream/123456789/32863/1/trabajo%20de%20Titulacio%CC%81n%20Bosquez%20Jhoselyn.pdf

Arteaga, M., & Macías, J. (2016). *Didactics of Mathematics in Early Childhood Education.* Spain: First Edition. https://reunir.unir.net/handle/123456789/3684

Chóez, M. (2018). *Playful techniques in the cognitive process.* Retrieved from: https://bit.ly/3dAIksd.

Creamer, M. (Quito, Ecuador, 2016). *How to work critical thinking in the classroom?* Quito, Ecuador: Santillana. https://isbn.cloud/9789978297308/como-trabajo-el-pensamiento-critico-en-el-aula/

Frías, M., Haro, Y., & Artiles, I. (2017). *Cognitive skills in the information professional from the perspective of projects.* Retrieved from: https://bit.ly/3sdFuxt.

Bone, A. and Cascant, M. (2012). "Methodology and quantitative research techniques". (1was.ed.). Editorial Polytechnic University of Valencia. https://openlibra.com/es/book/metodologia-y-tecnicas-quantitativas-de-investigacion

Maria, AS, Pilco Montoya, EF, & Valdiviezo Cácerez, JG (2016). *Basic notions and learning deficiencies in boys and girls aged 5 - 6 years of the first year of*

Parallel Basic Education "C", of the Basic School "Dr. Nicanor Larrea León", from the city of Riobamba, province of Chimborazo, academic period 2014-2. Riobamba, Ecuador: UNACH - National University of Chimborazo. http://dspace.unach.edu.ec/handle/51000/2371

Puebla, C. (2010). *Hypothetical Deductive Method.* Chile: University of Valparaiso. https://mbeuv.files.wordpress.com/2010/09/4-metodo-hipotetico-deductive.pdf

Pulido Polo, M. (2015). Ceremonial and protocol: methods and techniques of scientific research. https://www.redalyc.org/pdf/310/31043005061.pdf

Quintana, A. (2006). Qualitative scientific research methodology. In A. Quintana & W. Montgomery (Eds.), Psychology: Current Topics (pp. 47–84). Lima, Peru: National University of San Marcos (UNMSM). Available at: https://goo.gl/pyfsXC. http://www.ubiobio.cl/miweb/webfile/media/267/3634305-Metodologia-de-Investigacion-cualitativa-A-Quintana.pdf

Ramos, D., Herrera, G., & Ramírez, M. (2019). Development of cognitive skills with mobile learning: a case study. *Investigations*, 2. https://www.redalyc.org/pdf/158/15812481023.pdf

Rencoret, M. (2017). *Mathematics initiation: a model of teaching hierarchy.* Santiago, Chile: Editorial Andres Bello. https://books.google.com.pe/books/about/Iniciacion_matematica_Un_programa_de_Jerar.html?id=yrBRXwAACAAJ

Resabala, L. (2019). *Cognitive processes in academic performance.* https://bit.ly/2NwF8mT.

Rico, P. (2016). *Learning tasks and procedures in a developer process. In P. Rico, EM Santos, and R. Martín. Developer learning process in primary school. Theory and practice.* Havana: People and Education. https://issuu.com/utnuniversity/docs/ebook-aprendizaje-basado-en-problemas/s/11955330

Sastre, S. (2016). Metacognitive functioning in gifted children. *Rev Neurol, 52(1)* , 11-18. Retrieved from http://www.neurologia.com/pdf/web/52s01/bfs01s011.pdf.

Suarez, C. (2015). *Didactic Structuring for the identification of mathematical problems in primary education. In: J. Albarrán, C. Suárez, D. González, M. Bernabeu, E. Villegas, E. Rodríguez et.al. Didactics of Mathematics in Primary School. (pp57-91).* Havana: People and Education.

Tamayo, M. (2001). The process of scientific investigation. Mexico: Editorial LIMUSA, SA de CV, https://cucjonline.com/biblioteca/files/original/874e481a4235e3e6a8e3e4380d7adb1c.pdf

Terán, Y. (2017). *How to work the first year of Basic General Education?* Guayaquil, Ecuador: Santillana. https://santillana.com.ec/

Valle, E. (2009). *Research methodology*. Retrieved from Retrieved from https://es.slideshare. net/usmac2005/research-methodology-degree-project-12506310