



## Development of Mathematical Skills at the Cognitive Level of Basic General Education Students



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### Abstract

The objective of the research was to evaluate the development of mathematical skills at the cognitive level of Basic General Education students of the Magaly Masson de Valle Carrera Educational Unit in the 2022, that in view of the learning results of the students and that according to national evaluations, the students did not reach the established average according to the evaluations carried out in Ecuador, they present a low cognitive level and a limited development of mathematical skills, for reasons of teacher training in technological and virtual tools, connectivity and the accompaniment of a significant adult at home. In the study, the theory of cognitive development is proposed, who explains how these are developed in the child and how their contribution helps to solve problems, which configure logical connections for the understanding of life situations. The level of the investigation was descriptive and explanatory; the quantitative approach, using scientific, inductive, deductive, analytical, synthetic, and statistical methods. The result was no relationship of mathematical skills in proportion to the cognitive level, in addition to the development of skills in children who had synchronous connectivity was high, who do not accept the virtual class system.

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## 1 Introduction

The objective of the research was to evaluate the development of mathematical skills at the cognitive level of the students of Basic General Education (EGB) of the Magaly Masson Educational Unit of Valle Carrera in 2022, which, given the learning results of the students and then according to national evaluations [References](#)(INEVAL & OECD, 2018). When comparing the results of Ecuador with other countries in the region, there is a significant gap in performance in mathematics, the national score of 377 points out of 1000 in mathematics in the evaluation, shows that there is a great challenge to achieve better results at the educational level. international. (Ministry of Education of Ecuador, 2019), ([MIEDUC, 2020](#)). Probably one of the most outstanding dimensions in the teaching-learning process in the area of mathematics is the development of mathematical skills with performance criteria, proposed in the national curriculum, these are fundamental for the intellectual development of children, it helps to be logical, to reason in an orderly manner and to have a mind prepared for thought, criticism and abstraction ([Merkley & Ansari, 2016](#); [Alloway & Passolunghi, 2011](#)).

The last two years where Ecuador and the world faced a pandemic that forced the educational system prepared or not to undertake distance education and the ministry of education rethought a prioritized curriculum for the emergency with the essential skills in each subject and guidelines for a distance education process is synchronous or asynchronous. Knowledge as such includes those behaviors and exam situations that emphasize the importance of remembering ideas, materials or phenomena, either as recognition or evocation, so that the cognitive level in mathematics is evaluated considering the ability to remember mathematical processes. and apply them in problem solving (Bustios, 2017). The problem is that the students did not reach the average established [according](#) to the EGB in Ecuador, they have a low cognitive level and a limited development of mathematical skills, due to teacher training in technological and virtual tools, connectivity, and the accompaniment of a significant adult at home. The Minister of Education has recognized that 70% of students have difficulty accessing online education, but the data has been there since 2018: the percentage of households with Internet access is 37.17% at the national level and it drops to 16.07% in rural areas, according to the Institute of Statistics and Censuses ([Constant, 2020](#)). Not only do students have difficulty with connectivity, but this modality also represents a challenge for teachers, who in a large percentage do not manage the platforms and applications intended for educational accompaniment ([Bohlmann & Weinstein, 2013](#); [Beiter et al., 2015](#)).

The study raises the theory of cognitive development of Jean Piaget (1896-1980), who explains how cognitive structures develop in children; and the contribution made by ([MIEDUC, 2020](#)), these are developed from problem solving, and that configure logical connections for the understanding of life situations. The level of the investigation was descriptive and explanatory; the quantitative approach, using the methods: scientific, inductive, deductive, analytical, synthetic and statistical. For data collection, 300 parents and 334 children were surveyed, 14 teachers were observed in virtual classes, and a knowledge test was carried out on 97 students. It is estimated that there is no relationship of mathematical skills in proportion to the cognitive level, the development of these in children who had synchronous connectivity was high and that students do not accept the virtual class system. The abilities and skills related in the area of mathematics are those that are developed from the resolution of problems in learning, and that configure logical connections for the understanding of situations of daily life ([MIEDUC, 2020](#)).

The teaching and learning process for the development of skills involves a series of strategies planned by the teacher, the student's attitude and their previous knowledge plus the accompaniment of the parents [Vasquez \(2010\)](#), based on In this direction, each of these variables was analyzed to detect processes that can improve and achieve better cognitive levels in the area of mathematics. Problem solving has been considered one of the skills in the area of mathematics that has presented the greatest difficulty for the student population. Boys and girls are capable of mechanically solving fundamental operations (addition, subtraction, multiplication and division), but they do not know how to apply them to solve a problem, since they have only been taught to act mechanically and repetitively ([Ballesterio, 2008](#)). The teaching method depends on the child, according to [Bruner \(2010\)](#), a pioneer of cognitive psychology, these methods for teaching mathematics must be adapted to the evolutionary development of the child to facilitate the interest and understanding of this area. This implies a progression between the concrete, pictorial and abstract; In addition, teaching mathematics in the most cheerful, entertaining, and fun way, invites the student to participate and wishes to continue with the acquisition of [knowledge](#) ([Garg et al., 2001](#); [Shahiri & Husain, 2015](#)).

Among the basic notions that develop mathematical logical thinking are those of relating, classifying, excluding, increasing, decreasing, reflecting, all these mental operations give way to the development of skills ([Paltan, 2011](#)). Didactic strategies are those actions carried out by the teacher with the purpose of facilitating the formation and learning of students, they are procedures or resources used by teachers to achieve significant learning in students. It

should be mentioned that the use of various teaching strategies allows teachers to achieve an active, participatory, cooperative, and experiential learning process. These strategies must obey a psychological logic, in terms of the way students learn, and a practical logic, in relation to the way students organize themselves for learning, how furniture, resources and spaces are arranged, to respond with the characteristics, motivations, styles and rhythms of the students (Universidad Santo Tomás, 2020). Multi-sensory teaching techniques can help children who are struggling with math, using sight, touch, hearing, and movement to help them understand what numbers and symbols represent. Techniques in socialized teaching or cooperative work are efficient in the development and construction of critical and logical thinking. Problem-solving and reflection techniques can exercise decision-making and mental operations such as analyzing, relating, inferring, excluding, determining, and arguing (López, 2011). Pedagogical accompaniment at home for an effective distance learning teaching process is essential, the quality time provided by parents to their children has great benefits for students. The promotion of good study habits and techniques covers different aspects such as the material conditions, the distribution of study time, the student's personal attitude, the way he studies, the completion of assignments and how he studies for his exams; that must be taken into account to improve study and homework, sometimes it is not because they do not want to do it but because of lack of information and tools in this regard, that is why it is important to guide parents from the educational community (Juliegarfias, 2015).

## 2 Materials and Methods

The focus of this research is quantitative because it uses data collection and analysis to answer research questions and test previously established hypotheses, and relies on numerical measurement, counting, and frequently the use of statistics to establish accurately patterns of behavior in a population (Hernández, 2003). The level of research is descriptive and explanatory; according to Sampieri (2010), it is descriptive, with a field study, since its main objective is to achieve the description or characterization of the event within a particular context, it is non-experimental whose design responds to the non-manipulation of variables and will be transversal because the data was collected at a single moment and in a single time (Hernández et al., 2000). The inductive, deductive, analytical methods are used, the synthetic is directly related to the specifications of the study and will be used to detail the summary of the research, the introduction and the conclusions that according to (Sampieri, 2010). The techniques to be used are the collection of field data, to support the criteria of the directing or indirect authors who are the object of study, according to Sampieri (2010), in addition to observation, survey, questionnaire and knowledge test. An observation sheet for 14 teachers in math classes at different times and sublevels, to detect the strategies and techniques in teaching math used by teachers in learning, a survey of 300 parents to analyze connectivity and pedagogical support in the home in the development of tasks, a survey of 334 students with the purpose of describing the emotional connection of the students for the subject and the activities in class. The knowledge tests measure the candidates' mastery of an area of theoretical or practical knowledge that is essential for the job and that is included in the technical selection profile and has the characteristic of being valid, objective, and reliable (Alvarez, 2000). This knowledge test will be applied to 97 fourth, seventh and tenth grade students of the Magaly Masson De Valle Carrera Educational Unit to determine the basic notions of mathematical logical operations of knowledge in each educational sublevel (Ivari et al., 2020; Korucu & Alkan, 2011).

## 3 Results and Discussions

The cognitive level is that which belongs to or is related to knowledge, in turn, is the accumulation of information that is available thanks to a learning process or experience (Gardey, 2008). Piaget and Vygotsky coincided in articulating speeches opposing the associationist and functionalist proposals of the behaviorism of their time. They agreed on the idea that cognitive development is not the result of the acquisition of responses but of a process of active construction by the subject (Rodríguez Arocho, 1999). In Mathematics classes it is possible to carry out exercises that imply the transfer of already known calculation procedures to new situations; as well as developing problem-solving activities that enhance school reflection. For their development, the interrelation of cognitive processes such as voluntary attention, thought, memory, language, but also the expression of metacognitive faith is necessary. Rico (2004), refers that the possibility of teaching the student from the first grades to create problems and rework relationships between data constitutes an essential element for their development. One of the basic aspects that streamline reasoning and develop the different ways of thinking in learning mathematics, is based on the construction of logical notions that the

child spontaneously develops in interaction with his environment, for initiation to mathematics considers that the development of knowledge arises to the extent that the child tries to find a solution to problems of daily life the role of the teacher is to stimulate the child to verbalize their own questions and to allow them to discover logical knowledge through their personal reflection, The more the construction of logical-mathematical notions is strengthened, the more motivation and quality of learning mathematics are improved (Castro, 2018). Work was carried out at the level of the development of mathematical skills to improve the cognitive level in the basic general education students of the Magaly Masson Educational Unit of Valle Carrera 2022, for which the development of skills in the subject at the cognitive level of the students. From the knowledge test applied to 97 fourth, seventh and tenth grade students, the following data was obtained, shown in figure 1.

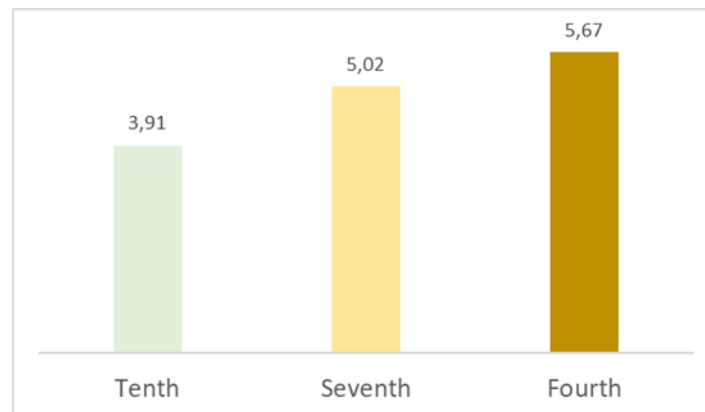


Figure 1. Averages by levels

In general, we can observe that the averages in the knowledge scale are insufficient in relation to those considered essential in the prioritized curriculum, when analyzing the graph, it is observed that as the sublevels in basic general education progress, the students present more difficulties. The results obtained when applying the observation form in the virtual classes to 14 mathematics teachers are shown in table 1.

Table 1  
Initial activities

PROGRESS CRITERIA	YES	NO
Provides the class plan to the observer	10	4
Starts his class on time	8	6
Show a confident and enthusiastic attitude.	12	2
Receives or reviews assignments sent home.	0	14
Makes the purpose or objective of the class known to the students	7	7
Presents the topic relating it to the reality of their environment	10	4
Carries out a diagnostic activity or relationship with previous knowledge	9	5

Of the initial activities, the one that is not meets in the class process is the reception and revision of tasks in which the students had difficulties to develop them at home, losing the opportunity for feedback. The development activities are shown in table 2.

Table 2  
Development activities

EVALUATION CRITERIA	YES	NO
Take previous experiences to carry out reflection activities on the subject.	9	5
Uses concrete, multisensory material or implements technological resources.	7	7
Employs strategies for active participation.	2	12
Follow the method and know the technique proposed for the construction of knowledge.	4	10
Assign class activities that students manage to execute successfully	6	8
Use cooperative work strategies, so that students advance faster.	1	13
Reinforces the explanation to students who show difficulty in understanding processes or conceptualizing.	4	10
Ask questions to check if the students understood what was explained in class.	8	6
Provides verbal or gestural encouragement to students during class work, valuing their participation.	12	2
Treats students with respect and kindness	13	1
Manages virtual spaces (chat, platforms)	3	11

Thinking development activities, or in group work and active participation strategies, is generally an explanation of how to carry out a mathematical process without contextualizing it with the needs in everyday or interdisciplinary life. In Table 3, the closing activities will be shown.

Table 3  
Closing activities

EVALUATION CRITERIA	YES	NO
At the end of the class, perform a summary or an application activity according to the performance criteria.	3	11
Send clear assignments related to the skills developed in class.	10	4
Captures the attention and interest of students during class.	5	9
Detects processes that need reinforcement or new strategies for their consolidation.	3	11
Maintains discipline in the classroom.	13	1

Due to lack of time at the end of the class they do not carry out application activities, nor do they motivate autonomous learning. Table 4 shows the handling of connectivity.

Table 4  
Management of connectivity

EVALUATION CRITERIA	YES	NO
When developing the class, use the technological tool effectively.	3	11
Send the adapted activities with different strategies according to the connectivity tool. (Synchronous, asynchronous)	2	12
Monitors the development of activities week by week.	1	13

In handling the platform and the applications, they present difficulties and do not make major adaptations to the activities sent asynchronously, but they attach explanatory videos, the difficulty increases for students who do not have devices to watch the videos of the class (McGill et al., 1992; Schnotz & Bannert, 2003). Analyzing these data, it can be said that teachers have not been prepared to address distance education, their greatest difficulty is in implementing varied and multisensory strategies and techniques, using technological tools, they are making a great effort to take on the challenge of educating synchronously and asynchronously in virtuality due to the pandemic. From a survey applied to 300 parents to analyze connectivity and pedagogical accompaniment at home in the development of tasks, the results are observed in Figure 2.

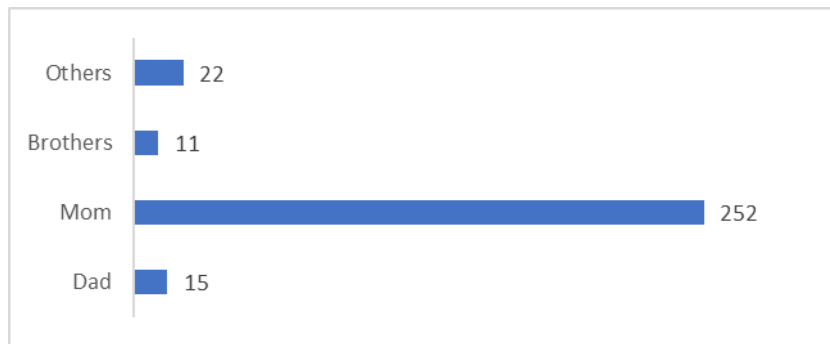


Figure 2. Parents who provide pedagogical accompaniment

As can be seen, mothers are the most representative in this activity, since they are the ones who spend the longest time at home, it is significant to see how there are others who are part of the relatives who are accompanying the students in their homework. Figure 3 will show the types of connectivity that students have had.

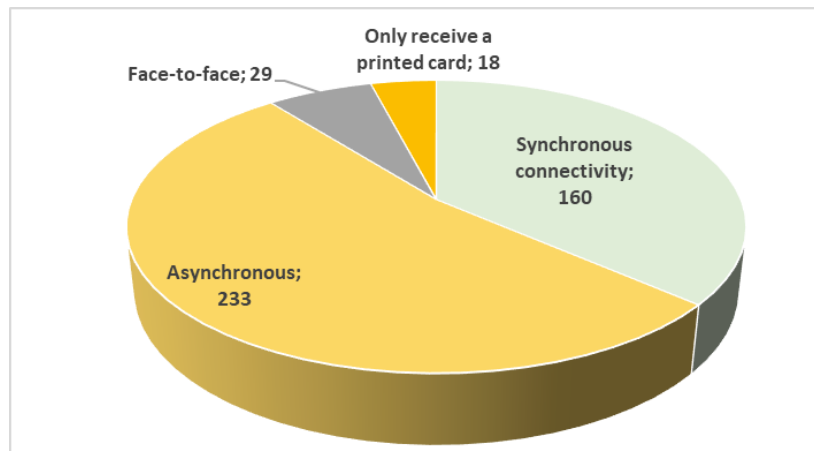


Figure 3. Types of connectivity

As can be seen, most of the students have an asynchronous connection, but there are others who only receive a technical sheet and face-to-face, this result also influences the cognitive process of the students. One of the evaluated aspects was related to the emotional connection, for which they were asked about their emotions in the mathematics subject, the results are shown in figure 4.

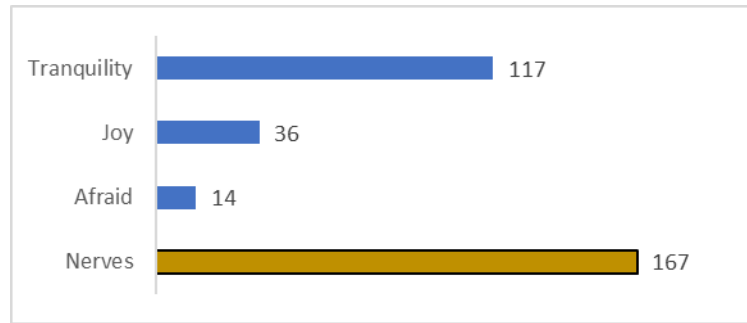


Figure 4. Feelings of the students in the mathematics

Subject note that most of the students are nervous when they start classes in the subject and others are afraid, this negatively influences the academic performance of the students, so the teachers who teach this subject must change their methodology and work strategies that allow them students have confidence and improving their academic performance. They were asked what their favorite subject was, as can be seen in figure 5, the results will be shown.

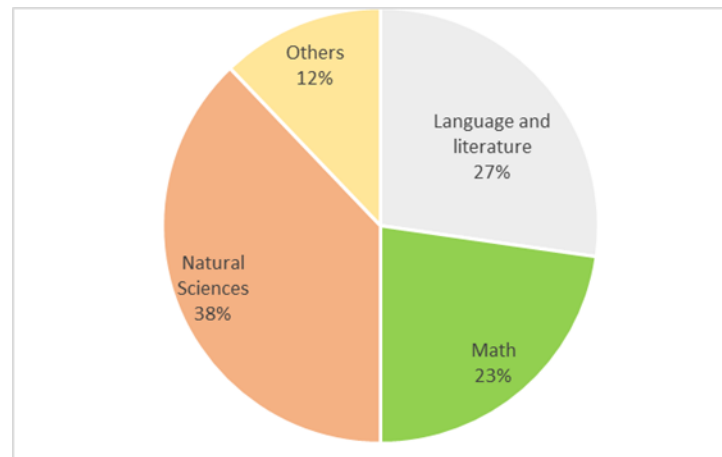


Figure 5. Preferred subjects

As it is observed, mathematics is not in their preference, here too teachers must reflect and look for methods that make students learn this subject in a pleasant way. It was consulted which activities they like to do more in the math class, the results are shown in figure 6.

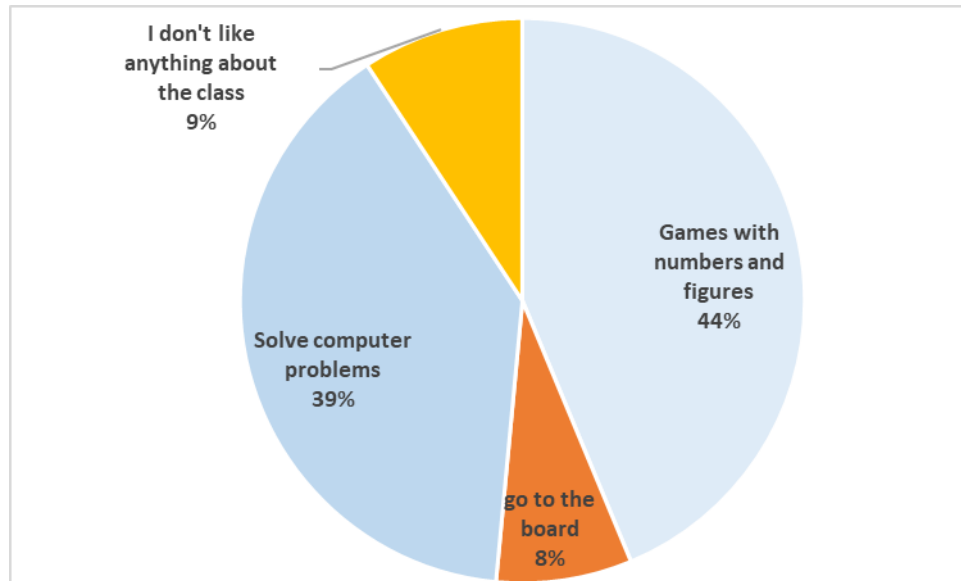


Figure 6. Activities that they like the most in the math class

As can be seen, there are two activities that the students like to do, one of them is related on the didactic games and the other in teamwork, in this sense the teachers must develop strategies that allow these activities to be carried out by changing their methods, which would improve the interest of the students and have better performance in the subject (Arip et al., 2018; Widiartini & Sudirtha, 2019).

#### 4 Conclusion

The development of mathematical skills at the cognitive level of the students of Basic General Education of the Magaly Masson Educational Unit of Valle Carrera in 2022 was evaluated, where it is evident that the assignment is not one of the predicted by the students, noting in several results, in order to solve this difficulty, teachers must change their didactic strategies to teach this subject and use techniques that are to the delight of the students, such as didactic games and group work, that would help improve the knowledge level of the students and they would improve their skills in the subject improving their academic performance.

##### *Conflict of interest statement*

The authors declared that they have no competing interests.

##### *Statement of authorship*

The authors have a responsibility for the conception and design of the study. The authors have approved the final article.

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