

## Levels of mathematical performance in preschoolers

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### Resumen

La presente investigación tuvo como objetivo determinar el Nivel de Desarrollo del Pensamiento Matemático que presentan los niños de cinco años. El enfoque de la investigación fue cuantitativa de tipo básica, se empleó el método descriptivo simple con un diseño no experimental de corte transversal. La muestra estuvo conformada por 80 niños. El instrumento utilizado para la recolección de datos fue la ficha de observación. La validez del instrumento se hizo a través de juicios de expertos con un resultado aprobado – aplicable y la confiabilidad se determinó a través del alfa de Cronbach. Finalmente, los resultados fueron el 64,10% de los niños de 5 años se encuentran en un nivel de proceso, mientras que el 20,51% se encuentra en un nivel de inicio y el 15,38% en el nivel de logro, en consecuencia el nivel que predominó, es el de proceso, lo cual implica elevar un mayor nivel de estimulación y refuerzo para lograr desarrollar el pensamiento matemático en la gran mayoría de niños

Palabras clave: Desempeño matemático, intuitivo concreto, prescolares

### Abstract

The objective of this research was to determine the level of Mathematical Thought Development that children of five years present. The focus of the research was quantitative of basic type, the simple descriptive method with a non-experimental cross-sectional design was used. The population consisted of 80 children where non-probabilistic sampling was carried out. For data collection, an observation form used as an instrument was applied. The validity of the instrument was made through expert judgments with an approved - applicable result and the reliability was determined through Cronbach alpha. Subsequently, the collected data were processed in the database of the SPSS program. Finally, the results were 64.10% of the children of 5 years are in a process level, while 20.51% is in a level of initiation and 15.38% in the level of achievement, consequently, the predominant level is the process level, which implies raising a higher level of stimulation and reinforcement in order to develop mathematical thinking in the vast majority of children.

Keywords: Mathematical performance, concrete intuitive, pre-schoolers.

## 1. Introduction

Mathematical thinking is built progressively from the experiences, experiences that the child has. First part of the interaction and exploration with his body, later with the objects around him and finally reach an abstract level that comes to make the written representation of the numerical symbols. This interaction allows the child to accumulate information that will be assimilated in his mind and then transformed into knowledge, which develops in the first instance in schools, forming from an early age through the active, creative and guided participation of the teacher. Added to this, Piaget (1987) referred that mathematical knowledge is not achieved through memory data, such as learning numbers in a mechanized way, but to get the child to understand and interpret reality in order to intervene in a conscious about it.

In the international context, the OECD (2016) explained that in Latin America a total of 617 million children around the world obtained a minimum level in mathematics and communication, Brazil with 44.1%, Colombia with 38.2%, Argentina with the 14.5% of children are below average performance in mathematics. On the other hand, the Ministry of Education (2013) conducted a study of 3520 five-year-old children, including public institutions and PRONOEI, 14.3% have a level of mathematical performance adequate to establish differences between objects when performing various activities such as: serialize, order, compare and solve problems proposed according to their age. However, 72.2% of children have an average performance level since it only establishes some relationships between objects (classifies, compares, orders and solves problems) without giving reasons on how it was done, and finally 13.5% is in a low level for not performing simple activities according to their age. Faced with this panorama, the Educational Institution "Santa Rosa" is not absent, obtaining as a result; Teachers do not schedule their class sessions according to the established date, failure to comply with the agreements established in the meetings, little innovation, strategies to carry out their class session and adequate materials for the achievement of children's learning, limitations on activities to existential and concrete level both in the area of mathematics and communication. It is for this reason that children in class sessions, specifically in the area of mathematics, there is no learning that starts from the needs and interests of the child since they do not manipulate concrete objects, questioned by memory situations when using contents of application sheets where the child knows mechanically. Therefore, taking into account the approaches outlined above and extracting information on the problems that are evident in educational institutions, it was convenient to support the study of research through various sources in order to obtain reliable and truthful information on the subject

## 2. Literature Review

### Mathematical Thinking

Piaget (1987) affirmed that mathematical knowledge in children occurs in the first instance through the senses. The various experiences that the child may have in relation to the objects, transfers to his mind facts and ideas that become knowledge when relating to new experiences, these develop in many ways. For example: ordering, gathering, adding, removing, among others. That is to say, for Piaget the biological maturation and the diverse experiences that the child has with the objects of his environment are factors that influence the development of mathematical thought. In this regard, Piaget (1987), mentioned that children's thinking is classified into four periods that are: Sensomotor, Preoperative, Specific Operations and Formal Operations, which shows the preoperative level table.

Table 1. Level of children's thinking according to Jean Piaget (2 to 6 years old)

Steps	Life period	Characteristics
Preoperative	The age extends from 2 years to 6 years	The child uses language to understand the world. His thinking is egocentric, the child understands his world from his own perspective. Intuitive reasoning. Work with symbols and representations

Note: Pre-operative level performed by Jean Piaget, covers from 2 to 6 years.

This table has been adapted from "Logical - abstract thought as support to boost cognitive processes in education", by Jaramillo and Puga, 2016.

For his part, Bruner (1984) indicated that an important element for the development of children's thinking is representation. He defined that it is the way the child interprets and understands their environment, these are: The representation in action, the iconic and the symbolic. In the case of representation in action, Bruner (1984), said that the child gives meaning to things through the actions he performs. For example: when we refer to a knot, the first thing the child learns is the action of making the knot and then once it is mastered, this action becomes habitual where it can even be related to other actions. In effect, the representation in action makes reference that the child constructs his knowledge by means of the actions that he carries out which implies that he touches, explores, manipulates and experiments with the objects of his environment.

However, the iconic representation, Bruner (1984), explained: it is when the child has in his mind the action he has previously performed, capturing the forms, the details, according to his interest. At this level, the child develops an autonomous thought, the action he performed represents it through images. Thus, when the child makes a drawing of a car, this relates to the previous action he has had with this object, either because he has traveled on it or gave him a toy car and has manipulated it. Finally, Bruner (1984) argued that symbolic representation is manifested through language or symbols that represent reality. That is, at this level, the child develops a more abstract representation of his reality which implies a higher level of complexity.

In general, these authors agree that children do not have a finished mathematical thought but that it evolves progressively. Children should feel a liking for mathematics, starting from the game, experimentation, socialization when performing various procedures, taking into account that they must first begin with their body and then with the various concrete materials of their environment, accompanied by the teacher who will provide the Strategies and develop the methodology that will make the child arouse interest and taste, this must occur from the preschool stage.

#### **Levels of Development of Mathematical Thought**

Intuitive level - Concrete: Melendrez (2012) argued that in this stage the child forms his own concepts through the experiences he has with the concrete material. The child builds his primary knowledge based on the relationship he establishes with concrete and experiential experiences through the actions he carries out and his perception.

In addition, Melendrez (2012), mentioned that the mathematical knowledge in the child does not originate in the subject or object, but in the interaction between both. That is why, to teach

mathematics should be based on the game, their own real or significant experience where the child is the protagonist of their learning. In effect, free play will allow the development of learning by interacting directly with concrete materials and the environment; It also establishes relations between objects, grouping them by color, shape, texture or size in this way the child is building his mathematical thinking.

**Representative level - Graphic:** Melendrez (2012), defined that is the ability to transfer knowledge or skills that, knowing the object, the child has internalized and then move it to the graphic activity. This representation can occur in different ways depending on the age of the child. That is to say, the child transfers all the mathematical knowledge that he has been developing at that moment to a paper, cardboard, or any object, making his thought transmit it to something concrete.

Likewise, Melendrez (2012), explained that at the representative level, the child makes marks on a paper (graphic signifier) allowing to replace the objects. This refers to marking strokes on a paper or any other surface that lends itself to it, these substitute objects being to give meaning or interpretation of what is replaced

**Conceptual Level - Symbolic:** According to Melendrez (2012), is the ability to represent these concepts through mathematical symbols, ensuring the final process, where the child has successfully assimilated the concept to apply it easily to their daily lives. However, this level is not developed if it has not gone through the aforementioned levels since its process is more symbolic and abstract. For example, to know the number 8, the child is presented with the number of objects mentioned which he is allowed to play and discover through them (intuitive level), then he must represent the quantity by means of the graphic level and finally, if He manages to understand the relationship between quantity and numeral, is that he reached the conceptual level.

### 3. Methodology

The design was non-experimental descriptive because the variable mathematical thought was not manipulated but it was observed how it manifests in children of 5 years in their natural context. The population was constituted by all the children of 5 years of Educational Institution No. 87 "Santa Rosa" of the district of Callao, obtaining a total of 78 children in the three classrooms of 5 years, two classrooms in the morning and one in the late. The sampling was non-probabilistic-intentional, since the population was selected according to the criteria of the researcher and according to the objectives of the investigation.

The validity was given through the opinion of three expert judgments, all of them professionals with Doctorates in Education, for which their opinions were significant and important when considering that the instrument has high validity since it responds to the objective of the investigation. For the reliability of the instrument, the Alfa Cronbach coefficient was used through a pilot test carried out on a sample of 19 five-year-old children from the educational institution "Santa Rosa" in the district of Callao, where a confidence level of 0.942 was obtained. through the SPSS V22 program, which indicates that the instrument with its 26 items distributed in three dimensions is applicable and reliable for the research work.

#### 4. Results

In Table 2 is shown the mathematical thinking achievement in 15.4%, in process in 64.1% and start in 20.5%.

Table 2. Frequency distribution of the variable Mathematical thinking in children of five years of the I.E. N ° 87 Santa Rosa, Callao

Mathematical Thinking					
		Frequency	Percentage	Valid percentage	Accumulated Percentage
Valid	Start	16	20,5	20,5	20,5
	Procces	50	64,1	64,1	84,6
	Achievement	12	15,4	15,4	100,0
	Total	78	100,0	100,0	

In Table 3 is shown the Intuitive – concrete Level achievement in 29.5%, in process in 46.2% and start in 24.4%.

Table 3. Frequency distribution of the dimension according to the intuitive level - concrete in children of five years of the I.E. N ° 87 Santa Rosa, Callao

Intuitive – concrete Level					
		Frequency	Percentage	Valid percentage	Accumulated Percentage
Valid	Start	19	24,4	24,4	24,4
	Procces	36	46,2	46,2	70,5
	Achievement	23	29,5	29,5	100,0
	Total	78	100,0	100,0	

In Table 4 is shown Representative – graphic Level achievement in 26.9%, in process in 53.8% and start in 19.2%.

Table 4. Frequency distribution of the dimension according to the representative level - graph in children of five years of the I.E. N ° 87 Santa Rosa, Callao

Representative – graphic Level					
		Frequency	Percentage	Valid percentage	Accumulated Percentage
Valid	Start	15	19,2	19,2	19,2
	Procces	42	53,8	53,8	73,1
	Achievement	21	26,9	26,9	100,0
	Total	78	100,0	100,0	

In Table 5 is shown Conceptual – symbolic Level achievement in 26.9%, in process in 57.7% and start in 15.4%.

Table 5. Frequency distribution of the dimension according to the conceptual - symbolic level in children of five years of the I.E. N ° 87 Santa Rosa, Callao

Conceptual – symbolic Level		Frequency	Percentage	Valid percentage	Accumulated Percentage
Valid	Start	12	15,4	15,4	15,4
	Procces	45	57,7	57,7	73,1
	Achievement	21	26,9	26,9	100,0
	Total	78	100,0	100,0	

## 5. Discussion

By means of the obtained results it has been demonstrated that the variable mathematical thought in the children of five years is located in a level of process obtaining a 64.10%, while the 20.51% is in the level of beginning and the 15, 38% on the level of achievement. These results indicate that the great majority of children from the Educational Institution No. 87 Santa Rosa, Callao are at a process level regarding the development of their mathematical thinking when performing interactions and operations with the concrete material, transferring everything learned to graphic activity and reach an abstract level that allows you to understand and understand the mathematical symbols (number). Given these arguments, these results coincide with what was expressed by Idone and Zárate (2017), who carried out a descriptive study regarding the level of mathematical logical thinking in five-year-old children, resulting in the vast majority of children located at the level of process obtaining a 77.3%, while 11.4% is at the level of achievement and start. In the same way, these results agree with what Carrasco et al. (2012), who carried out a descriptive study on the level of achievement of children aged 3 to 6 years with respect to basic mathematical concepts, which resulted in referring specifically to children of 5 years of age that the vast majority is in a medium high level obtaining a 79% with respect to mathematical logical thinking based on the correct and incorrect answers that these gave in the pre-calculus test, so the researchers suggest that teachers innovate diverse activities in order to reach a higher level , this must be done according to the child's age, allowing him to expand his knowledge to understand, understand and face problems that arise in his daily life. Therefore, all the investigations supported above are based on what Piaget described, which in general lines indicated that mathematical thinking is achieved through experiences, experiences, interaction, exploration, manipulation of objects and the environment; in such a way that when obtaining a new knowledge this will be enriched and reinforced, which will last for a lifetime.

On the other hand, regarding the Intuitive Level - concrete dimension corresponding to the mathematical thought variable, it was obtained that 46.15% of children of five years of the Educational Institution No. 87 Santa Rosa, Callao are located at the level of process, while 29.49% are located at the level of achievement and 24.36% at the beginning level. In this regard, these results show that the vast majority of children are in the process of carrying out activities and mathematical operations with the specific material such as: grouping, classifying, ordering and counting. Therefore, teachers must develop an intentional work that allows them to improve their level of process through experiential activities and manipulable with various objects in the environment. These results are similar to the study conducted by Solis (2016) in his thesis on

mathematical logic and its influence on the development of thinking in children of 5 years where he says that the vast majority of children perform mathematical activities with concrete material but they do not dominate it in their totality when they develop sequences, notion of order, to relate the quantity of objects with the numeral, among others. Therefore, this study concludes that there is no adequate use of mathematical logic in the level of development of thinking in children, so the author suggests a greater interest in carrying out activities related to the constant use of concrete materials to achieve an optimal development of mathematical thinking. Likewise, the results of the same dimension coincide with the study conducted by Ramos, Santa and Titto (2015) in their thesis on the relationship between educational material and development of mathematical thinking in children of 5 years, was obtained as a result that the great Most children are in a middle level with 71.7%, followed by a high level with 20% and a low level with 8.3% with respect to free manipulation of the concrete material according to their criteria, grouping together, counting, among others, what affects in the development of his mathematical thinking by 74%. In this sense, this study concluded that there is a significant relationship of educational material for the development of mathematical thinking in children. Therefore, the results demonstrated by the intuitive - concrete dimension and supported by the studies presented above are based on the contributions of Piaget (1987) who expresses that the concrete material is indispensable in the work with the children since through their interaction the child discovers its properties and relationships as: color, size, weight, texture, which motivates their curiosity, develops their cognitive capacity, observation and understanding.

With respect, the representative level - graphic dimension corresponding to the variable mathematical thought was obtained as a result that 53.85% of children of five years of Educational Institution No. 87 Santa Rosa - Callao are located at the process level, while 26.92% are located at the achievement level and 19.23% at the beginning level. In this sense, these results show that the vast majority of children of five years are in the process of graphically representing everything previously experienced and manipulated with the specific material, since they do not perform it in its entirety, evidencing some errors when transferring the information towards graphic activity. These results agree with what was proposed by Ramos, Santa and Titto (2015) in their thesis entitled The relationship between educational material and mathematical thinking development in children of 5 years, obtaining as a result that the vast majority of children are in the process of making their drawings when developing a mathematical activity, which is located at a medium level to obtain 55%, then 33.3% high level and finally 11.7% low level. In addition, he adds that the graphic representation starts from the experiences, experiences that the child has had with the objects of his environment and then represents it through his drawings. Similarly, the results of the same dimension are contrasted with what Cañellas and Rassetto (2013) put forward in their research article entitled Representaciones infantiles sobre los notaciones digitales, explaining that 100% of children aged 5, 25.6 % develops graphic representations when making his drawings very similar to the objects used and the rest that is equivalent to 74.4% of children make their graphic representations without considering the qualities or characteristics of the objects that he used but is related to the established amount, considering himself , that the vast majority of children are in the process of making their graphic representations correctly. In addition, he argues that when the child is making his graphic representations he develops his thinking, because the ideas that the child is representing move him towards the numerical symbols. Therefore, by virtue of the results demonstrated by the representative - graphic dimension and supported by the research presented above, we can say that they are based on the contributions of Bruner (1984) who explained that when the child has in his mind the action that he has done previously, that is, capturing the forms, the details according to his interest with the object, he represents it by means of images.

Regarding the conceptual level - symbolic level corresponding to the mathematical thought variable, it was obtained that 57.69% of children of five years are located at the process level, while 26.92% are located at the level of achievement and 15.38% at the start level. Therefore,

these results show that the great majority of children of five years of educational institution No. 87 Santa Rosa - Callao are in the process of recognizing and representing mathematical symbols (numbers), relate the amount with the numeral and perform operations with the previous experiences of the concrete and graphic material. These results are equivalent to what was proposed by Carrasco et al. (2012), In his thesis entitled Determine the level of achievement of children from 3 to 6 years with respect to basic mathematical concepts, obtaining as a result specifically in children of 5 years, that the vast majority of children is at a level of process regarding the recognition and reproduction of numbers, which is located at a low level of achievement when obtaining 77%, based on the correct and incorrect answers provided in the pre-calculation test. In addition, he adds that it is important that children understand the relationship of quantity with the numeral, that is, teachers must teach the numbers not only by graphing them but that the child relates it to their quantities, their values, this will contribute to the process of construction of the number. However, the results of the same dimension differ with what was stated by Pumasupa, Ruiz and Carrasco (2014) in their research entitled Use of pedagogical materials and learning in the curricular area of mathematics in children of 5 years, was obtained as a result the vast majority of children are at an achievement level with 90.7%, followed by a level in process with 5.6% and a start level with 3.7% with respect to the dimension of number and relationship, which implies that children of 5 years identify and establish relationships between quantity and number, allowing them to know the numbers and their values when they carry out their operations. Therefore, the results demonstrated by the conceptual - symbolic dimension and based on the studies presented above, we can say that it is based on what was described by Piaget (1987) who indicated that the number is of fundamental importance for children, these are the base on which all mathematical knowledge is based that in life will have to build. (p.101) That is to say, at the conceptual - symbolic level, the child develops a more abstract and complex level, which is replaced by a concrete reality where the child identifies and performs the operation with the numbers more easily, allowing him to develop his mathematical thought.

## 6. Conclusions

- It is concluded that the level of development of mathematical thinking in five-year-old children of Educational Institution No. 87 Santa Rosa, Callao - 2018, occurs most often at a process level reaching 64.10%, followed by a starting level obtaining 20.51% and an achievement level of 15.38%. Proving this, that most children need to raise a higher level of stimulation and reinforcement to develop their mathematical thinking.
- The Intuitive level - concrete in the five-year-old children of the Educational Institution No. 87 Santa Rosa, Callao - 2018, is at a process level reaching 46.15%, followed by an achievement level of 29, 49% and a start level of 24.36%, showing that the majority of children are in the process of carrying out activities and mathematical operations with the concrete material such as: grouping, classifying, ordering and counting, since they do not do it in its entirety
- The representative level - graph in the five-year-old children of Educational Institution No. 87 Santa Rosa, Callao - 2018, is at a process level reaching 53.85%, followed by an achievement level of 26, 92% and a start level of 19.23%, demonstrating that most children are in the process of graphically representing everything experienced and manipulated previously with the concrete material, since they do not perform it in their entirety, evidencing some errors in the moment of transferring the information to the graphic activity.
- The conceptual level - symbolic in the five-year-old children of Educational Institution No. 87 Santa Rosa, Callao - 2018, is at a process level reaching 57.69%, followed by an achievement level of 26, 92% and a start level of 15.38%, demonstrating that most children are in the process of recognizing and representing mathematical symbols, relating the quantity with the numeral and performing operations with the previous experiences of concrete and graphic material.

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