



Meta Analysis of Mathematical Learning Participants According to Piaget Theory

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Abstract

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The purpose of the study was to analyze 11 studies related to mathematical learning according to the phase of solving the piaget theory, namely: (1) At the sensory stage, it was possible to coordinate the experiences of the senses with movement and gain an understanding of the permanent object (2) pre-operational, the students understood the reality While some students are not yet at the stage to use logical thinking or formal operational thinking, many participants have not been able to use concrete operations to form more complex operations. Thus it can be concluded that in the piaget stage, students often cannot face when solving mathematics and learning problems are in concrete operational and formal operational stages. Meanwhile, in the motor and pre-operational stages, students did not experience any obstacles. Therefore, it is hoped that further researchers can pay more attention to the stages of piaget theory in mathematical learning.

Keywords: a defense of mathematics, the theory of piaget, Meta-Analysis

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INTRODUCTION

Mathematics is one of the subjects taught at all levels of education. The goal of mathematics in school is to provide students with the ability to live a community life and continue to study higher levels until students can apply them in their daily lives. Mathematics is one of the requirements that students must meet to continue their studies.

But whatsoever is in the vicinity of the human being is of great use to another human being, if he is able to use his reason. So when a child already knows how to use the concept of thinking, then the job of education is to develop it. Without cognitive domain, it is difficult to imagine a child capable of thinking (Juwantara, 2019). Meanwhile, Marinda, (2020) in her research, explained that cognitive development is the syntax of life changes that people experience to understand, know, analyze received information and solve problems. Cognitive can be understood as the child's ability to think in a more complex way when it comes to reasoning and problem solving. The existence of cognitive abilities can facilitate the child's mastery of other common knowledge, thus enabling the child to communicate well in society.

Cognitive development has a profound impact on the child, which is not unrelated to the contributions of psychologists who have devoted their time, energy and thoughts to studying the developmental phenomenon. The psychologist is Jean Piaget where Jean Piaget has successfully conducted research combining psychology, logic and biology to explain how each child can gain



knowledge easily through elaborately explored, constructed, and manipulated (Hanafi & Sumitro, 2019).

Based on the theory of the child world, Jean Piaget explained that the concrete operational stages of the child (7–12 years) differ from the perspective of the parent world. Rahmaniar & Mahegau, (2022) in his research results explained that each child has a different way of looking at developmental processes, with each child at this age not only thinking concretely, but being able to achieve thinking at a formal operational level. Therefore, teachers must be able to guide children in the formation of relevant concepts especially in relation to mathematical learning. Because the current state of mathematical learning is shaped by cognitive learning theory, the two have an important relationship.

Based on the results of a study conducted by Yudo Dwiyono and Hesty Kala' Tasik concluded that attempts by class teachers to overcome difficulties in learning arithmetic operations usually reduce students' mistakes in understanding multiplication as repeated summaries by reminding them of the necessary requirements: skill development. The study of mathematics moves from concrete to abstract objects (concrete, semi abstract, abstract) (Dwiyono & Tasyk, 2021).

Then continued with the research done by Juju Junengsih, and Sutirna concluded that there were still many students who had difficulty answering the exponent problem, and that there were still many students who did wrong when completing both tasks, so that students lacked control or understood the exponential material, especially on the exponential problem. The film was released on November 1, 2022 (Junengsih & Sutirna).

Then followed by a study conducted by Nadia Zulfa Kosasih, Supratman, and Redi Hermanto concluded that the mistakes made by the students were caused by many factors, starting from internal factors caused by each student and external factors caused from outside the student it self (Kosasih et al., 2018). Then followed by a study conducted by Herfa Maulina Dewi Soewardini, and Meilantifa concluded that another factor affecting children's cognition was the use of models, methods and variants of learning presented according to the age level of the child (Maulina & Soewardini, 2017).

Then continued with research done by Geri Syahril Sidi, Ade Maftuh, and Moh Salimi concluded that there is difficulty learning math in students ages 6 to 8 in the form of difficulty understanding problems, difficulty doing calculations, and difficulty distinguishing calculations of addition and subtraction (Sidiket al., 2021). Then continued with research conducted by Indrie Noor Aini, and Nita Hidayati concluded that students' mathematical understanding based on 7 logical operations shows that in proposition types, the mean serialization and logical multiplication of male students are sufficient while classification, compensation, probability, and correlation types are sufficient. Not enough understanding. The average female student in proposition, seriation, compensation, and logical multiplication is sufficient, while the classification, probability and correlation types are not sufficient (Aini & Hidayati, 2017).

Then continued with research done by Ejen Jenal Mutaqin concluded that there are generally five empirical learning patterns of number multiplication in the lower classes of elementary schools namely: modeling with concrete objects, modeling with images, summaries, and BSE textbook patterns (Mutaqin, 2017).

Then continued with research done by Handika, Teti Zubaidah, and Ramdhan Witarsa concluded that children's cognitive levels in mathematics learning have differences in their age stages (Siswa, 2017).

Then continued with a study conducted by Nungki Anditiasari, and Nuriana Rachmani Dewi concluded that out of the seven children, there were 2 children unable to complete some concrete operational stages according to the cognitive development of piaget (Anditiasari & Dewi, 2021). Later, the research was carried out by Feri John, and Sutriyono concluded that high-availability subjects reached evaluation levels (Evaluation), low-availability subjects reached application levels (Application), and low-availability subjects reached knowledge levels (Knowledge) (John & Sutriyono, 2018).

Then continued with research conducted by Ridho Agung Juwantara concluded that the cognitive development of children at the concrete operational age (7-12 years) in mathematics studies varies almost every stage of their age (Juwantara, 2019).

Meta-analysis is a statistical method that searches for trends in effect sizes observed in various quantitative studies, all under the same research problem. Meta-analytic research is a form of research that can be used to investigate, evaluate, and analyze interpreting several studies that are considered to fit the needs of the researcher or on specific topics and events desired by the researcher. This research meta analysis is a qualitative approach to meta analysis. Analysis is qualitative descriptive, with a content analysis method that adapts to the purpose of the study.

This research is a meta-analysing study that analyzed articles about students' difficulties based on Piaget's theory of thinking. The difference between these studies and previous studies is that previous researchers only looked at the difficulties students face and the factors that cause difficulties in solving math problems. In this study, researchers intended to meta-analyze several research articles and describe the difficulties students face in solving mathematical problems based on Piaget's problem-solving steps.

Based on the explanations described above, the purpose of this study is to analyze studies related to the analysis of students' difficulties in solving math problems in the form of verbal problems. The analysis examines the difficulties students face when solving mathematical problems according to the degree of completion..

METHODS

This study is a study with a meta-analysed design from previous research results. A meta-analysis study is looking at several research results on the same problem.

The data analysis technique used in this study is to collect articles related to mathematical learning analysis in students based on the stages of piaget theory: motor-sensory, pre-operational, concrete operational, formal operational. The sample used in the study consisted of 11 articles

Cognitive activity is central to the aspects of sensory and motor devices, and the problem of piaget theory is that it can be seen at the motor sensor stage. During this phase, from birth to age two, infants learn about themselves and their

world through the development of their senses through motor activity. It means that in this phase the child can represent his environment only through his feelings and gestures. This state is the basis of cognitive development, motor-sensing activity is formed through the process of adapting physical structures as a result of interaction with the environment.

In the preoperative stage, the child exhibits cognitive activity of processing things outside of himself, and although his thinking activity does not yet have a clear and organized system, the child uses symbols and signs to interact with the environment. The thinking of children at this level is unsystematic, contradictory, and illogical. It is characterized by the following characteristics:

1. Transductive reasoning, which is a way of thinking that is not inductive or deductive but not logical
2. Unexplained causal relationships, i.e., children know causal relationships logically
3. Animism, which is to assume that all things live like themselves
4. Artificialism, the belief that everything in the neighborhood has a human-like soul
5. Personally bound, that is, children judge things based on what they see or hear
6. Mental experiment is that the child tries to do something to find the answer to the problem he is facing.
7. Centration, i.e., the child focuses on something that is most interesting and ignores other traits

By the concrete operational stage, the child has lost its tendency towards animism and artificialism. His selfishness has declined and his ability in protective duties has increased. However, without physical objects, the child still has great difficulty in accomplishing logical tasks in the real action phase.

Formal operational stage, from the age of 12, a new operation emerged. During this time, children can use their concrete operations to form other more complex or complex operations. Child development at this time is that they don't have to think in the framework of objects or concrete events, they have the ability to think in the abstract framework. The child can already understand the form of the statement and is not confused with the sides of the statement, therefore called operational formal.

RESULTS & DISCUSSION

Results

Table 1. Search for sources used for research

No	Researcher Name	Research Subject	Analysed aspect	Source	Years
1.	Yudo Dwiyono dan Hesty Kala' Tasik	elementary school	Characterizing in-depth knowledge of the difficulty of learning	Articles	2021

					multiplicative computation operations		
2.	Juju Junengsih, dan Sutirna	vocational school	high	Difficulty in working on exponent matter	Articles	2022	
3.	Nadia Kosasih, Supratman, dan Redi Hermanto	junior school	high	Error in solving problems about algebraic matter	Articles	2018	
4.	Herfa Dewi Soewardini, dan Meilantifa	junior school	high	Difficulty learning heavy lines in triangles	Articles	2017	
5.	Geri Syahril Sidi, Ade Maftuh, dan Moh Salimi	elementary school		Difficulty in understanding the operations of addition and subtraction on the matter of numbers	Articles	2021	
6.	Indrie Noor Aini, dan Nita Hidayati	junior school	high	Examining Piaget's cognitive development stage for junior high school students	Articles	2017	
7.	Ejen Mutaqin	elementary school		unravel the empirical learning pattern of the concept of multiplication in the lower grades of elementary school	Articles	2017	
8.	Handika, Teti Zubaidah, dan Ramdhan Witarsa	elementary school		children's cognitive development in mathematics based on the Jean piaget theory at the elementary school level	Articles	2022	
9.	Nungki Anditiasari, dan Nuriana Rachmani Dewi	elementary school		complete concrete operations by the cognitive development stage of the pipeline	Articles	2021	
10.	Feri Yohanes, dan Sutriyono	junior school	high	an understanding of the concept of solving the problem of the circumference and area of a triangle	Articles	2018	

11.	Ridho Agung Juwantara	7-12 year olds	further study the theory developed by Jean Piaget on the study of mathematics according to the child's level of thinking at the concrete operational age (7-12 years old)	Articles	2019
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Table 1. Shows the results of the search for the source of the study that was conducted. The information presented is the name of the researcher, the subject of the study is the education level, the aspect to be analyzed, the source, the year of the study.

Table 2. Analysed Learning Data on Participant Piaget Theory

No	Nama Peneliti	Judul Penelitian	Tahapan Teori Piaget				
			Tahap sensori-motor	Tahap pra-operasional	I Tahap operasional konkrit	II Tahap operasional formal	V
1.	Yudo Dwiyono dan Hesty Kala' Tasik	Analysis of Difficulty Learning Operation of Mathematical Multiplication of Class IV of Elementary School 019 Samarinda Ulu	All students can discuss this stage	All students can discuss this stage	All students can discuss this stage	some students have difficulty	
2.	Juju Junengsih, dan Sutirna	Analysis of Students' Difficulties in Working on Exponential Matter	All students can discuss this stage	All students can discuss this stage	All students can discuss this stage	Some students have not been able to think logically	
3.	Nadia Zulfa Kosasih, Supratman, dan Redi Hermanto	An analysis of students' mistakes in solving problems in algebraic materials based on Jean Piaget's theory (Research on students in class VIII of Islamic Junior High School Al-Azhar 30 Kota Tasikmalaya)	All students can discuss this stage	All students can discuss this stage	Several students have not been able to discuss this stage	Many of the students have not been able to discuss this stage	

4.	Herfa Maulina Dewi Soewardini, dan Meilantifa	Difficulty Learning Triangle Weight Lines Based on Student Activities and Piaget Theory	All students can discuss this stage	All students can discuss this stage	All students can discuss this stage	Many of the students have not been able to discuss this stage
5.	Geri Syahril Sidik, Ade Maftuh, dan Moh Salimi	Analysis of Mathematical Learning Difficulties in Students ages 6-8	All students can discuss this stage	All students can discuss this stage	Several students have not been able to discuss this stage	Students have not been able to discuss this stage
6.	Indrie Noor Aini, dan Nita Hidayati	The Mathematical Cognitive Development Stage of Junior High School Students VII Based on Piaget Theory Reviewed Gender Differences	All students can discuss this stage	All students can discuss this stage	All participants were able to discuss this stage well	Most of the students have not been able to discuss this stage
7.	Ejen Jenal Mutaqin	Mathematical Learning Trajectory Analysis in the Concept of Multiplication of Numbers in Elementary School Low Class	All students can discuss this stage	All students can discuss this stage	Several students have not been able to discuss this stage	Students have not been able to discuss this stage
8.	Handika, Teti Zubaidah, dan Ramdhan Witarsa	Jean Piaget's Analysis of Cognitive Development Theory and Its Implications for Mathematical Learning in Elementary School	All students can discuss this stage	All students can discuss this stage	Many students have not been able to discuss this stage	Many of the students have not been able to discuss this stage
9.	Nungki Anditiasari, dan Nuriana Rachmani Dewi	Analysis of Piaget's Cognitive Development Theory in 11-Year-Olds in Brebes	All students can discuss this stage	All students can discuss this stage	Several students have not been able to discuss this stage	Students have not been able to discuss this stage
10.	Feri Yohanes, dan Sutriyono	Analisis Pemahaman Konsep Berdasarkan Taksonomi Bloom Dalam Menyelesaikan Soal Keliling Dan Luas	All students can discuss this stage	All students can discuss this stage	Several students have not been able to discuss this stage	Students have not been able to discuss this stage

Segitiga Bagi
Siswa Kelas VIII

11.	Ridho Agung Juwantara	Analisis Perkembangan Kognitif Pada Anak Operasional Konkret Tahun Pembelajaran Matematika	Teori Piaget Tahap Usia 7-12 Dalam	All students can discuss this stage	All students can discuss this stage	Several students have not been able to discuss this stage	All students can discuss this stage
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Table 2. shows the results of the study of mathematics experienced by the students from the completion stage according to Piaget's theory. The data presented in Table 2 include: the name of the researcher, the title of the study and the stage of Piaget theory.

DISCUSSION

The meta analysis used in the study is to analyze mathematical articles on mathematical learning that students face according to the stage of piaget theory. There are 11 research articles on mathematical learning that will be sampled in this study. Based on Table 2 it can be seen from several studies on the mathematical learning of students according to the stage of piaget.

Of the eleven articles analyzed in general at the motor-sensory stage 11 the study showed that students could already at this stage, because at this stage they were demonstrated from birth to age 2 years old, namely understanding the world by coordinating indigenous experiences with movements. Later in the pre-operational stage, the research results showed that the students could already at this stage, because at this stage it was shown that the child had understood reality in the environment using symbolic functions.

Furthermore, the phase shows that the operational concrete, 7 studies on the study show that most of the students are not yet at the operational concrete stage because the child is able to sort the balls by size from the largest to the smallest. However, children have difficulty solving the same problem without any real object (concrete). Only 4 studies have shown that students can go through this stage.

At the last formal operational stage the study showed that at the formal operational stage almost all students had difficulty. This is because children's abilities are not yet complex by not being able to work on complex problems, such as root surgery and operating high-nominal numbers (thousands and millions).

An analytical instrument in mathematical learning is a documentation for obtaining analyzed information. In this study, it requires an important systematic approach here., the selection of instruments is based on aspects that must be taken into account in meta-analyses.

Based on the purpose of the study, the results from the studies that have been examined by the 11 previous studies described above according to the stage of piaget theory, the most dominant of which students have experienced is at the stage, the average result of the study being analyzed is at this stage many of the students can already understand the problem of learning.

In the pre-operational stage, students can already force learning at this stage. The concrete operational stage and the formal operational stage, at this stage, students who experienced many difficulties, were constrained when performing mathematical calculations, they did not understand what was known and asked in problems and students were not able to answer mathematical questions when given questions The students also have difficulty understanding mathematical concepts while working on problems.

CONCLUSION

From the results of Meta-Analysis research on several studies that have been studied by 11 previous researchers show that in general, it can be concluded that many students can understand mathematical learning and given problems. Furthermore, in the pre-operational phase II, students can still understand mathematical learning and the given problems. Furthermore, in phase III concrete operations, almost all of the students have difficulty answering mathematical problems if given problems in different forms and numbers. And step IV, the students almost all have difficulties during formal operations, at this stage, the most difficult difficulties that children's abilities have not been able to solve complex problems, such as root operations and operating high-nominal numbers (thousands and millions). Based on the above description, it can be concluded that the difficulties most often experienced by students experiencing assimilation by not modifying the experience.

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