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Piaget's Theory in Mathematics Education in Elementary School

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ABSTRACT

Since the passing of Law No. 2 of 1989, the landscape of education in Indonesia should be distinguished by the consistency of its system, thus by a series of adjustments. Some possible adjustments to the primary school curriculum to the high school level include (1) imbalances in the effective learning offered. This is supported by the fact that, since the implementation of the national exam (in elementary schools), the field of mathematics studies has one of the lowest average values among national exam subjects. (2) The ongoing curriculum's requirements not fit with students intellectual development. This study will employ theory of learning based on Piaget's intellectual development from a variety of learning theories based on cognitive theory. According to Piaget's hypothesis, a child's development progresses over the course of 4 sequential phases, consisting :(1) Sensory motor period (ages 0 to 2 years), (2) per-operational period (ages 2 to 7 years), (3) concrete operational period (ages 7 to 11 years), and (4) formal operational period (ages 11 and onwards).The purpose of this research is to determine the level of effectiveness in teaching geometry unit math based on the conservation aspects of Piaget's theory. These goals can be summarized as follows: 1) Determining the amount of efficacy in teaching geometry unit math using Piaget's theory's conservation components;2) Identifying differences in the influence of age (9, 10, and 11) on receiving geometry unit math teachings based on the conservative aspects of Piaget's theory. To accomplish the study's objectives, the research utilized a per-experimental research design, particularly a pre-test-post-test design with one group. The results indicated that the learning accomplishment of geometry unit math based on the conservation aspects of Piaget's theory did not vary by age (9, 10, or 11 years). The study's findings indicate that there is no interaction effect between the ages of 9 and 10 on math learning achievement, (2.2) that there is no interaction effect between the ages of 9 and 11 on math learning achievement, (2.3) there is no interaction effect between the ages of 10 and 11 on math learning achievement, and (2.4) that there is no interaction effect between the ages of 9 and 10 on math learning achievement.

Keywords: Mathematics, elementary school

INTRODUCTION

The current curriculum is frequently blamed for the poor standard of education in Indonesia. Saparina Sadli (1981:67) argues that this improvement feels like a patchwork, which is why there is pameo saying "change ministers, change policy". After Law No. 2 of 1989 went into effect, no one in charge of overseeing the field of education and teaching would be able to simply exceed their jurisdiction. According to Fuad Hassan (1989), since Law No. 2 of 1989 came into effect, Indonesian education should be distinguished by the reliability of its system, which entails implementing a number of reforms. Among the potential modifications to the primary school curriculum to the high school level are the following: (1) imbalances in the effective learning provided (1989, Fuad Hassan). The fact that the field of mathematical studies is one of the subjects with the lowest average value of the other national exam subjects since the national exam was implemented (in elementary schools) is evidence of this.

(2) Curriculum requirements are not aligned with the intellectual development of students (Ardhana, 1983:2); this is evident in the curriculum of the elementary school; however, there is no evidence that the preparation of curricular material is based on the child's intellectual development. Intellectual readiness is an absolute requirement for children to acquire mathematics (and other subjects as well). By adhering to the theory of intellectual development, the child's abilities are not coerced, so the child learns mathematics with a pleasant and logical attitude. This sensation of enjoyment is a motivation to study mathematics with greater enthusiasm.

This research will apply learning theories based on Piaget's intellectual growth, which are derived from a variety of learning theories based on cognitive theory. In his theory, Piaget proposed that child growth progresses through four distinct stages: (1) the sensorimotor period, 0–2 years, (2) the pre-operational period, 2–7 years, (3) the concrete operational period, 7–11 years, and (4) the formal operating stage, 11 years and above. Piaget suggested that the order of the periods is fixed for everyone else, however, the chronological age at which an individual enters each period of higher thinking differs from person to person (Ardhana, 1983:35; Dahar, 1988:185; and Kusrini, 1987:35). According to Piaget, children aged 7 to 11 are engaging in concrete activities. These children have logical operations on concrete problems (Dahar, 1988:35); children with concrete operations are able to use logical operations to solve problems involving concrete objects or events (Herman Hudoyo, 1979:87). These stages are essential to study because the operations in issue are closely related to primary school mathematics instruction.

Thus, Piaget's proposed stages of child cognition are relevant to the development of elementary school mathematics curricula, particularly the fourth-grade geometry curriculum. Based on the reasoning mentioned in the problem's context, the primary issue in this study is: at what age did children perform well when receiving geometry unit math instruction based on the conservation aspects of Piaget's theory? This problem can be broken down into two separate formulae in order to be solved, the first of which asks the question, "Is it effective to teach geometry unit math based on aspects of Piaget's theory in order to improve the learning outcomes of students in Grade IV of elementary school?" (2) Is there a difference in geometry learning performance with children between ages 9, 10, and 11 when learning geometry unit math? Specifically, the purpose of this study is to determine whether there is a distinction between the learning performance of a younger child and that of an older child. If there is a difference, what is the optimal age? The goals of this study are to (1) determine the degree of success that can be achieved by instructing the geometry unit math based on the preservation aspects of Piaget's theory, and (2) determine the degree to which the influence of age (9, 10, and 11 years) differs in the process of receiving geometry unit math lessons based on the preservation aspects of Piaget's theory.

In order to address problems 1 and 2, two (two) working hypotheses were developed and evaluated in this study. These hypotheses are as follows: (1) The results of student learning progress prior to receiving lessons and after receiving lessons differ. This indicates that the achievement of students' learning progress prior to receiving lessons differs considerably from the achievement of students' learning progress subsequent to receiving lessons. (2) The mathematical achievements of children aged 9, 10, and 11 will differ. In other terms, academic achievement will be higher for older children.

Information on the issues faced by students in the teaching of geometry unit math (the application of which) based on the conservation aspects of Piaget's theory can be useful to: (1) Provide the possibility of implementing research comparative levels of effectiveness, and the attractiveness of students in using mathematics teaching based on principles of the Piaget theory with mathematic teaching that can be done, (2) Provide consideration to make mathematically teaching strategies in relation to the age difference of the child. (3) Add consideration materials for the development of the Elementary School mathematics curriculum, which concentrate on geometry topics. The assumptions underlying this study are as follows: (1) Students who are the subject of this study have worked as hard as possible on the subjects given at the end of each meeting (5 meetings), final test and filling the questionnaire; and (2) the evaluated teaching materials have yet to be stable. This is due to an inadequate amount of instruction. If this assumption is valid, then the conclusion applies.

These are the limitations of this study: (1) All of the research participants attended Ranowangko II Public Elementary School in Tombariri District, Minahasa Province. Thus, the conclusions that can be derived are limited to the aforementioned school. (2) The field of study under investigation is mathematics, with the subject of geometry pertaining to the area of flat shapes. So that the only conclusions that can be drawn pertain to these instructional materials.

Tuddenham (in Ardhana, 1983, p. 34) asserts that Piaget's theory of intellectual development levels is perhaps the most well-known of his works. According to Piaget, every person undergoes four distinct phases of intellectual development. According to chapter I, the four periods are as follows: (1) sensory-motor period, 0–2 years; (2) pre-operational period, 2–7 years; (3) concrete operational period, 7–11 years; and (4) formal operating period, 11-adult. The age noted after each period is only an estimate (approximate/approximate). Every child must experience each period, albeit at varying rates. For example, a five-year-old child is in the concrete operational stage of intellectual development, whereas an eight-year-old child is still in the pre-operational stage of intellectual development; however, the progression of intellectual development is the same for all children.

Sensory-motor period, 0–2 years. This stage is achieved by children up to the age of 2 years. Even though a baby is still very dependent and helpless when he is born, some of his sensory organs can function immediately. A clear example can be seen in the baby's "ability" to cry, the sucking motion when the mouth is touched by something (e.g., the mother's nipple). Babies not only passively receive stimulation of their sensory organs, but can also provide answers to stimuli, which are movements, as a result of direct reactions. It is clear that the direct reaction shown by the baby is not an ability that arises from learning outcomes in relation to the environment. In this period, the child does not yet have awareness of the concept of a fixed object. With the functioning of the sensory organs and the ability to perform motor movements in the form of reflexes, the baby is ready to make contact with the world. In other words, the abilities developed at the sensori-motor stage are the basis for later cognitive development. (Wadsworth, 1971: p. 3).Pre-operational period, 2–7 years. Compared to the previous period, the child's intellect is qualitatively more developed during this stage. This period is also referred to as the symbolization stage because the capacity to utilize symbols distinguishes it from the previous period. This time period was marked by significant advancements. For instance, language has been used to express an object. Concrete operational period. This period is distinguished by the emergence of logical mathematical thinking. The basis of their logical reasoning is the tangible manipulation of objects. In other terms, the operational period is a bridge between the pre-operational period and the operational period. Children in the concrete operational period begin to embrace the perspectives of others, their language is communicative, and they are capable of transformation (composition, conservation of groupings). Formal operational period The infant is capable of using the deductive hypotitis method. From these types of propositions, he can employ "if-then" logic.

The subjects of this research were elementary school students in the fourth grade. In Indonesia, fourth-grade secondary school students are between 9 and 11 years old. In accordance with Piaget's proposed stages, the measure of intellectual development of fourth-grade elementary students corresponds to the concrete operational stage. Children at the level of concrete operations are capable of transformations, are no longer egocentric, are able to embrace the perspectives of others, and their language is socially communicative. Children at this stage are able to solve conservation problems that were intractable during the previous period (Wadsworth, p. 94) This study assesses the application of Piaget's theory with regard to the conservation of area of flat shapes. In the Outline of the Elementary School Curriculum Teaching Program, the geometry sub-topic of the area of flat shapes in mathematics is listed in grade four, so that in conveying subject matter that uses the principles of Piaget's theory, the steps contained in stage three are from the stage of the development of the child's intellect (concrete operations), namely by manipulating abstract mathematical concepts into concrete objects.

Given that mathematics is a science that is concerned with the logical deduction of the consequences of the fundamental premises, the process of teaching mathematics must be of a deductive nature in order to be effective. Mathematics does not accept conclusions based on observation, only proof. However, in order to facilitate thinking, it is frequently important, particularly in the beginning phases, to make use of particular examples or geometric illustrations. Mathematics studies regular patterns, and organized structures. Mathematical prerequisites must be thoroughly mastered in order to comprehend more advanced concepts. In the course of this study, the cognitive developmental learning theory developed by Jean Piaget will be applied, specifically in reference to the conservation aspect of compiling material on geometry and teaching it to children in the fourth grade of elementary school.

MATERIALS & METHODS

Research Subject

Forty students participated as research subjects in this investigation. In this investigation, the authors assigned only one elementary school: public elementary school I Borgo in the Tombariri sub-district of the Minahasa province. The material is about the conservation of the area of flat shapes and is intended for fourth-grade students aged 9 to 11. The description of the number of children (sample size) and their ages can be found in Table 1.

Table.1: Description of the sample size according to the children's ages

Age	Sum
9 yo	10
10 yo	16
11 yo	14
Total	40

The total number of samples collected from children aged 9 was 10, from children aged 10 was 16, from children aged 11 was 14, and from children aged 12 was 18. The total sample size is 40.

Research Strategy

The research design is a pre-experimental design, specifically a pre-test-post-test design with one group (Ary, 1982: 350). This research methodology is depicted in chart.1 below.

Chart 1. Pre-test-post-test design with one group

PRETEST	EXPERIMENTAL TREATMENT	POST- TES
Y_1	X	Y_2

The implementation of the pre-test-post-test design in this study aims to evaluate the effectiveness of teaching fourth-grade elementary school students geometry unit math based on the conservation aspects of Piaget's theory. In its implementation, a preliminary examination is administered before the subject matter is taught. The subject matter is divided into five sections: (1) calculating the area of a flat shape; (2) comparing the area of a flat shape; (3) calculating the area of a rectangle using a unit square; (4) a series of pentagrams or tengrams; and (5) calculating the area of a flat shape using diagrams or tengrams. At the conclusion of each subject, a test is administered to assess the students' initial comprehension of the material (Dick, 1985, p. 139).

In order to determine the efficacy of the design and development process in the "application of Piaget's theory in teaching mathematics in geometry class IV Elementary School" process in the field, a pilot test must first be conducted. Dick and Carey (1985, p. 196-221) propose three phases of assessment for making revisions so that teaching can be enhanced. Individual assessment, small group assessment, and field assessment are the three stages of assessment.

1. **Individual Assessment.** The purpose of the individual assessment is to identify the greatest teaching flaws for further revision, as well as to obtain an initial response to the intended curriculum. The focus of this evaluation is the effectiveness of the time used to convey the material. This study employs an interactive methodology, with each student conducting their own research in order to acquire the necessary data. As part of the small group evaluation and research implementation, the following five meetings are scheduled. The duration of each meeting is 2 40 minutes, including 40 minutes for presenting the material, 25 minutes for the post-test, and 15 minutes for completing the survey.

2. **Small group assessment.** The focus of this assessment is to collect data from students, which is then used as review material to make the instructional design more effective. Dick and Carey (1985:198) suggest that small group assessment pertains to the number of students who are the subject of research, specifically eight to twenty youngsters. In practice, the assessment at this stage was the focus of the study; there were 20 children with the following information: ten students rated their ability to study mathematics as above average, while ten students rated their ability to teach mathematics as below average. Fourth-grade students at State Elementary School I Borgo, located in the same village as State Elementary School II Ranowangko, were the subjects of this study.

3. **Field assessment (research implementation).** According to Dick and Carey (1985: 203), the goal of the field assessment was to determine the success of the modified instruction in the small group assessment. The field assessment was designed to solve the research question, which was to determine the age level in grade IV elementary school pupils who accepted the teaching of geometry unit math based on the conservation feature of plane shapes for future development.

The findings of a descriptive investigation of educational material evaluations According to Suharsimi (1988: 32), the subject matter provided to students is at least 80% comprehensible and receives a correct score of at least 55% on all given tests. In this investigation, it was tested before being distributed to students. The outcomes of the trials pertaining to the subject matter are detailed in Table.2 below.

Table 2: Percentage of students who successfully used and implemented instructional materials

SUBJECT	STUDENTS ANSWER (%)	QUESTIONNAIRE				
		1	2	3	4	5
Find the area of a flat shape	Difficult Not Difficult	30 70	20 80	20 80	15 85	5 95
Compare the areas of flat shapes	Difficult Not Difficult	15 85	10 90	0 100	5 95	0 100
III. Calculate the area of a rectangle using the squares unit	Not Clear Clear	15 85	10 90	5 95	5 95	0 100
IV. A series of pentagram or tengram flat shapes	Not Clear Clear	20 80	15 85	0 100	0 100	0 100
V. Finding the area of a flat figure with the help of pentagrams or tengrams.	Difficult Not Difficult	5 95	20 80	0 100	0 100	0 100

Elucidation: Questionnaire no. 1: Having trouble following lessons.;
Question 2: Difficulty completing worksheets; Question 3: Clarity of worksheet instructions; Question 4: Clarity of worksheet instructions; and Question 5: Difficulty utilizing props.

Table 2 shows that students were given questionnaires to fill out about the problems they were having with learning tasks five times. This shows that: (a) 70–95% of students said they had no trouble following the lesson. (b) 20%–95% of students said they had no trouble working on student worksheets. (c) 80%–100% of students said the instructions for the student worksheets they worked on were comprehensible. (d) 85–100% of students gave clear answers to the examples given. (e) 95%–100% of students said they had no trouble using the teaching aids provided.

Thus it can be interpreted that there are no significant difficulties for students who are used as trials in using and implementing teaching materials compiled based on the conservation aspects of Piaget's theory. So it can be concluded that the steps for delivering subject matter can be used to obtain data in conducting research.

Research Instruments

The researchers themselves prepared the research instrument using the following procedures: (1) compiling steps for delivering the material to be taught; (2) compiling test items according to the subject matter; (3) conducting trials; (4) analyzing the results of the trials; and (5) revising steps in conveying material that were deemed inappropriate. There are three types of research variables, namely (a) pre-test, which is used to determine students' initial abilities before attending lessons whose material is prepared based on the conservation aspects of Piaget's theory, (b) a test at the end of each subject, p. which is used to determine student learning achievement from the beginning in subsequent lessons in accordance with conservation aspects, and (c) Final test (post-test), which is measured by a test that has been prepared according to the purpose.

Data Collection Procedures

The gathering of data took place throughout a single semester, specifically the second semester of the 2021/2022 academic year for a total of six sessions with specifics, including five sessions for the delivery of materials and one session for the final test. During the process of providing the content, the researcher acts in the capacity of a mathematics teacher and is assisted by an academic instructor. Students are provided with a questionnaire to fill out at the conclusion of each and every meeting.

Data analysis technique

Two forms of data analysis were used to determine the results of the data collection. Specifically (1) the t test is used to compare the pre-test average value to the post-test average value. The formula contained in Ardhana's book (1982: 81) and Ary's book (1982: 218), namely:

$$t = \frac{2D}{\sqrt{\frac{n\ \ D^2 - (\Sigma D)^2}{n-1}}}$$

Analysis of variance in one direction. This study employs a pattern of one-way analysis of variance or simple analysis of variance (Ardhana, 1982, p. 90; and Ary, 1982, p. 266). Every time a test is administered, this method is used to determine the impact of age differences (9, 10, and 11 years) on student performance.

RESULT

Description of Test Results

Table 3 describes the outcomes of the tests performed twice, namely the test before the subject matter was presented (pre-test) and the test after the subject matter was given (post-test).

Table 3: Pre-test and post-test score descriptions, sigma pre-test score, average pre-test score, sigma pre-test score quadratic, sigma post-test score, post-test average score quadratic, sigma difference between pre-test and post-test scores -test and sigma score difference quadratic.

AGE	n	PRE-TEST		POST-TEST		Σ_D	ΣD^2
		Σ_X	X^2	Σ_Y	ΣY^2		
9 yo.	10	84	740	135	1837	-51	275
10 yo.	16	143	1331	190	2344	-47	171
11 yo.	14	137	1403	167	2075	-30	84
SUM	40	364	3474	492	6256	-128	530

This research will test two hypotheses that are currently in use. In order to facilitate the testing of each of the aforementioned hypotheses, research data will be presented for each.

B.1. First hypotheses

This first hypothesis reads as follows:

H_1 : The results of student learning progress prior to receiving lessons and after receiving lessons are distinguishable. In other terms, the average score before lessons (pre-test) differs significantly from the average score after lessons (post-test scores).

H_0: There is no correlation between the average score of learning progress results before lessons and the average score of learning progress results after lessons.

This first hypothesis is examined using the t test, which examines the difference between two average scores that are correlated. The results of the analysis indicate that the average score of learning progress results after receiving lessons organized in accordance with the conservation aspects of Piaget's theory is higher than the average score of learning progress results prior to receiving lessons.

Table.4 displays the results of an analysis of the difference between the two average scores for the findings of learning progress before the lesson (pre-test) and after receiving the lesson (post-test).

Table 4: the average value, sample size, t-value, degrees of freedom, and significance level of the difference in the effect of the test treatment on the learning progress outcomes.

AGE	$\overline{x_1}$	$\overline{x_2}$	Σ_D	ΣD^2	df	t	Note
9 yo.	8,4	13,5	-51	275	9	-12,53	Sig 1%
10 yo.	8,94	11,88	-47	171	15	-7,93	Sig 1%
11 yo.	9,79	11,93	-30	84	13	-6,51	Sig 1%
Grade. IV	9,1	12,3	-128	530	39	-11,52	Sig 1%

All t values for the age levels (9, 10, and 11 years) are significant at the 0.01 level, as shown in Table 4. Likewise for the t value obtained from the class IV sample pooled together. Once t's value falls between -6.51 and 12.53, the absolute value equals 6.51 to 12.53. Thus, we can reject H... and conclude that the results of student learning progress prior to receiving lessons have an impact on the results of student learning progress after receiving lessons arranged according to the conservation aspects of Piaget's theory. In other words, the geometry unit math content that is organized based on the conservation aspects of Piaget's theory is "effective" for enhancing the learning outcomes of students in grades IV in elementary schools.

B.2. Second hypotheses

In this investigation, four kinds of interaction effects must be considered. The four categories of interactions include (1) interactions between children ages 9 and 10, (2) interactions between children ages 9 and 11, (3) interactions between children ages 10 and 11, and (4) interactions between children ages 9, 10, and 11. First order interactions refer to the first three categories of interactions, while second order interactions refer to the fourth type of interaction. Formulate the following hypothesis to test whether there is an interaction effect between the three variables:

Hypotheses 2.1 : On mathematics learning achievement, there is an interaction effect between the ages of 9 and 10 years.: On mathematics learning achievement, there is no interaction effect between the ages of 9 and 10 years.

The results of hypothesis analysis 2.1 are listed in Table 5.

Table 5: Sigma quadratic, degrees of freedom, estimated variance between group and within-group variance sources, and F scores for children ages 9 and 10 who are learning mathematics through presentation.

VARIANCE SOURCE	SIGMA QUDRATIC	Df	ESTIMATED VARIANCE	F SCORE	LEVEL SIGN.
Between group	16,25	1	16,25	3,814	T.Sig.
Within Group	102,25	24	4,2504		
Sum	118,5	25			

From table 5 it can be seen that the value of f = 3.814. Degrees of freedom = 1/24

The value of F on the list of values attributable to F with a significance level of 5% and 1/24 degrees of freedom is: 4.26. Because F count <F table, it means that the test is meaningless. Thus, it can be concluded that the mathematical achievement of 9-year-olds and 10-year-olds is not substantially different.

Hypotheses 2.2

H1: There is interaction effect between 9 and 11 years of age in relation to mathematics learning achievement.

H0: There is no interaction effect between 9 and 11 years of age in relation to mathematics learning achievement..

The results of the analysis of hypothesis 2.2 are described in table 6 from table 6. It can be seen that the F value obtained is equal to 3.253. Degrees of freedom equal to 1/22. The F value on the list of F distribution values with a significance level of 5% and 1/22 degrees of freedom is: 4.30. Because F count < F table, it means that the test is meaningless. Thus it can be interpreted that the mathematics learning achievement of 11 year old children is not significantly different.

Table 6. Sigma quadratic, degrees of freedom, estimates of variance derived from sources of variance between and within groups, and F scores for mathematics achievement between 9 and 11 years of age.

VARIANCE SOURCE	SIGMA QUATRATIC	DF	ESTIMATED VARIANNCE	F SCORE	LEVEL SIGN
Between Group	14,405	1	14,405	3,253	T.Sign
Within Group	97,429	22	4,429		
SUM	111,833	23			

Hypotheses 2.3

H1: there is an interaction effect between the ages of 10 years and the ages of 11 years on mathematics learning achievement.

Ho: there is no interaction effect between the ages of 10 years and the ages of 11 years on mathematics learning achievement.

Table 7 displays the results of the analysis of hypothesis 2.3 Sigma quadratic, degrees of freedom, estimates of variance from sources of variance between and within groups, and F scores for mathematics learning achievement between 10 and 11 years of age

VARIANCE SOURCE	SIGMA QUATRATIC	DF	ESTIMATED VARIANNCE	F SCORE	LEVEL SIGN.
Between Group Within Group	0,021 170,679	1 28	0,021 170,679	0,003	T.Sign.
SUM	170,7	29			

From table 7. it can be seen that the value of F = 0.003.
Degrees of freedom=1/29

The F value on the list of F Distribution Values with a significance level of 5% and 1/29 degrees of freedom is: 4.18. Because F count <F table, it means that the test is meaningless. Thus, it can be concluded that there is no significant difference between the math achievement of students aged 10 and 11 years old.

Hypotheses 2.4.

H1: there is an interaction effect between the ages of 9 years, ages 10 and ages 11 years on mathematics learning achievement.
Ho: there is no interaction effect between the ages of 9 years, 10 years and 11 years on mathematics learning achievement.
Results of hypothesis analysis 2.4. described in table .8.

Table 8. Sigma quadratic, degrees of freedom, estimates of variance derived from sources of variance between groups and F scores between ages 9 years, 10 years and 11 years with achievement in mathematics.

VARIANCE SOURCE	SIGMA QUADRATIC	DF	ESTIMATE VARIANCE	SCORE F	LEVEL SIGN.
Between Group.	12,68	2	6,3402	2,5417	T.Sign.
Within Group	92,295	37	2,4945		
SUM	104,975	39			

From table 8., it can be seen that the value of F = 2.5417.
Degrees of freedom=2/37.

The F value in the list of F distribution values with a significance level of 5% and 2/37 degrees of freedom is: 3.23 because F count <F table, means the test is meaningless. Thus, it can be concluded that there is no significant difference between the math achievement of students aged 9,10 and 11 years old

This research deals with the question, "At what age do children receive systematic geometry unit math instruction based on aspects of Piaget's theory and achieve success?" Specifically, this problem formulation is divided into two problem formulations: (1) Does the form of teaching geometry unit math based on the conservation aspect with Piaget's theory enhance the learning outcomes of elementary school students in the IV grade? (2) Is there a difference between 9-year-old, 10-year-old, and 11-year-old children's geometry unit math learning performance? If there is a difference, which age it is? To answer concerns 1 and 2 in the problem formulation, the following two working hypotheses are developed. (a) the results of student learning progress prior to receiving instruction differ from the results of student learning progress subsequent to receiving instruction, (b) learning mathematics for children aged 9, 10, and 11 years will be different, i.e. older children will have greater learning achievements .

These findings can be summarized as follows. (1). The first hypothesis, the difference in average scores, yielded highly consistent results. At the 1% significant threshold, all age levels (9, 10, and 11 years) give substantial value. Similarly, the t value from the combined sample indicates that the working hypothesis is accepted with high confidence, There are four kind of interactions analyzed for the second hypothesis regarding differences in learning achievement between children aged 9, 10, and 11 years. The four kinds of interactions are (a) interactions between 9 and 10 years of age, (b) interactions between 9 and 11 years of age, (c) interactions between 10 and 11 years of age, and (d) interactions between 9, 10 and 11 years of age. All four of the previously mentioned hypotheses have insignificant F values. Thus, it is possible that the rejection of the working hypothesis signifies that the null hypothesis is adopted. There is no interaction effect between ages 9 and 10 on mathematics learning achievement, (2.2) there is no interaction effect between ages 9 and 11 on mathematics learning achievement, (2.3) there is no interaction effect between ages 10 and 11 on mathematics learning achievement, and (2.4) there is no interaction effect between ages 9 years, 10 years, and 11 years on mathematics learning achievement.

CONCLUSION AND SUGGESTIONS

Conclusions

Since this study was conducted at Ranowangko II Public Elementary School, Tombariri District, Minahasa Regency, the conclusions can only be applied to this school. Consequently, the following are the conclusions that can be drawn from this investigation.

Teaching geometry unit math based on the conservation aspects of Piaget's theory is effective for enhancing the learning outcomes of students in grade IV of elementary school. In other words, the results of student learning progress prior to receiving lessons that are organized in accordance with the conservational aspects of Piaget's theory have a significant impact on the achievement of learning outcomes after receiving lessons. This influence is statistically significant, with a significance level of 1% for each age group.

Based on the conservation aspect of Piaget's theory, there is no significant difference between children aged nine, ten, and eleven in their learning achievement of the geometry unit math. In other words, older children's achievement in learning is comparable to that of younger children. The researcher who acts as a teacher during research is the researcher himself, whereas the class instructor acts as a companion and observer during the implementation of learning.

The conclusion that can be derived from this study is that geometry unit math learning achievement based on the conservation aspects of Piaget's theory does not differ with age (9, 10 and 11 years). The conclusion of this study supports the null hypothesis, it is commonly regarded as a negative conclusion. The results of this investigation, however, support Piaget's theory, particularly the conservation aspect as stated by Piaget in Sund (1976: 39 and 40).

Suggestions

The concepts of Piaget's theory are best suited to the creation of geometry resources for elementary school mathematics curriculum.

It is vital for teachers to reproduce tangible examples with the assistance of visual aids while they are instructing students in the geometry section of mathematics.

It is required to conduct out additional research on Piaget's theory that is more in-depth, especially when taking into consideration the fact that Indonesia has not seen a significant amount of this type of research.

For researchers who wish to use the results of this study, it is preferable if the research variables are added, such as the educational level of parents, parents' employment status, school status (public, private, equated to private, recognized, and registered private), and the material must be expanded so that it becomes several subject areas.

Declaration by Authors

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