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Constructivism Approach to Improve Students' Achievement and Motivation in Learning Mathematics

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Abstract
This study aims to describe the effectiveness of learning based on a constructivist approach and the effectiveness of learning based on a constructivist approach compared to conventional learning commonly applied at schools to improve students' achievement and motivation in learning mathematics in junior high school. This study is a quasi-experiment with a pretest-posttest nonequivalent group design. The samples were randomly determined to select one class as an experimental class and one class as a control class. To test the effectiveness of learning based on a constructivist approach, the one-sample t-test was used. Then, to test the effectiveness of learning based on a constructivist approach than hands-on learning, the MANOVA was carried out and then continued by the t-Benferroni test. The data were analyzed using the normalized gain score to describe the increase. The results showed that learning based on constructivist approaches and conventional learning that teachers implemented in schools is effective, then learning based on a constructivist approach is more effective than conventional learning. Based on a constructivist approach, the average normalized gain score is higher than improving students' achievement and motivation in learning mathematics in junior high school.

Keywords*: Constructivist; Learning Achievement; Learning Motivation.*

INTRODUCTION

To improve the quality of education, especially in mathematics subjects, educators or teachers must always improve their mathematical knowledge and management of the learning process. Teachers are expected to carry out meaningful, fun, creative, dynamic, and dialogical learning, and always improve professionals, to improve the quality of education. Adawiyah (2021) obtained information that the learning model used by teachers in the learning process is, on average, less varied. Learning that takes place involves fewer students being active in learning, causing mathematics learning to feel boring and difficult to understand so that mathematics learning is less in demand by students. Hence, teachers need to do a variety of learning. The goal refers to students' achievements, so learning achievements must be considered, especially in mathematics. However, the mathematical achievements of Indonesian students are still low.
The low level of mathematics achievements of Indonesian students can be seen from the low scores obtained in Trends International Mathematics and Science Study (TIMSS) and the program for International Student Assessment (PISA) from year to year. The results are consistently below the international average score. The results of the 2015 TIMSS Indonesia survey are ranked 44 out of 49 countries with an average score of 397 mathematics ability which is still below the international average of 500 (IEA, 2016). Indonesian Students' PISA results in 2018 Indonesia are ranked 72 out of 78 countries with an average student math proficiency score of 379, which is also below the International average score of 489 (OECD, 2019). National Exam data in the last few years before the Covid 19 Pandemic also showed the low learning achievement of students at the National Level; mathematics scores were in Classification C. In addition, it was also seen that the scores of junior high school mathematics subjects in Sorong Regency on national exams where the average math score on

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the national exam had a C classification which means that the school's ability is still classified as lacking.

Internal factors in students that are also very influential on the achievement of educational goals and learning outcomes include student learning motivation. Still, the results of pre-surveys with student learning motivation questionnaires that are tested show that the motivation to learn mathematics is mostly among students still lacking in mathematics learning. Another thing from the pre-survey results is identified with the reality seen when the learning process there are some students often rowdy, pay less attention to lessons, talk to friends, engrossed in their activities, students are less active in solving problems that are challenging and additional tasks, and some are even sleepy. This condition impacts the acquisition of student learning results in mathematics lessons that have not been achieved as expected in both the semester exam results and the national exams.

The word motivation comes from the Latin verb "movere" or "to move," which means to move (Arends & Kilcher, 2010). In English, the word is then absorbed and turned into "motivation" and absorbed again in Indonesian as a motivational word. But in its development, motivation is interpreted differently from the meaning of the word "movere."As stated by Hook & Vass (2001); Uno (2008); Slavin (2006); Winkel (1999); Ormrod (2003); Woolfolk (2007), learning activation is an internal and subjective impulse that arouses, directs, and maintains student behavior logically to follow learning activities well as the implementation of desires actively, and expectations to achieve learning goals. From the above understanding, it is clear that motivation is the reason that causes a person to do something and every motivational action has a purpose. The purpose of motivation is to move or arouse a person so that his desire and willingness to do something arises and he can get results or achieve certain goals. Elliot (2000) further stated that learning and motivation are equally important factors for achieving performance.

Learning makes learning possible to learn about new knowledge and gain skills, while motivation is a driving force according to learning. This means learning and motivation are two important factors in realizing the success of the learning process. Schunk, Pintrinch, & Meece (2010) state that "motivated learning is to acquire skills and strategies rather than perform the task." Learning motivation is the motivation to have skills and strategies instead of to perform tasks. In learning, there is a need for motivation. Learning outcomes will be more optimal if accompanied by high motivation. The more appropriate motivation given, the more successful the lesson. This is also reinforced by Middleton and Spanias (2013), whose research showed that success in mathematics is strongly influenced by motivation for achievement. A more detailed explanation of motivation in learning was put forward by Biggs & Tang (2007) because motivation has two meanings; namely, the first motivation refers to the prior to the lesson, and the second mean of motivation refers to maintaining a bond (spirit) during learning.

This study's motivation to learn consists of intrinsic and extrinsic motivation. Intrinsic motivation consists of the desire to succeed (Hook & Vass, 2001), the presence of encouragement and needs in learning (Winkel, 1999; Schunk, Pintrich, & Meece, 2010), and the hopes and ideals of the future (Santrock, 2011). While the extrinsic motivation in this study consists of rewards in learning (Schunk, Pintrich, & Meece, 2010), the existence of interesting activities in learning (Williams & Williams, 2010), the existence of a conducive learning environment (Williams & Williams, 2010), and the competition to succeed (Cohen & Swedlik, 2005; Deci & Ryan in Woolfolk, 2010).

Proper learning and tailored to learning goals resulted in learners' better understanding of the material delivered by teachers. But many teachers still use a conventional approach to every learning process where learning is still teacher-centered with structured and repetitive interactions. This will affect the information process that will become long-term memory (Dell'Olio & Donk, 2007; Borich, 2000; Killen, 2009).

In the curriculum applied in schools, teachers in learning must facilitate students with various activities so that students get a meaningful learning experience. Students' lack of motivation and learning achievement can be facilitated by applying appropriate learning. The approach to education that is expected to increase student learning capacity and achievement is Constructivism learning.

Constructivism understands that knowledge is the construction (form) of people who know something (Schemata). Galserfeld (Paul, 1997) suggests several abilities needed in the process of constructing knowledge, namely: 1) the ability to remember and re-express experience; 2) the ability to compare

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and make decisions about similarities and differences; 3) the ability to prefer one experience over another. Constructivism learning is a learning process that explains how knowledge is arranged in humans. Based on the learning of consensus, in the learning process, educators do not necessarily transfer knowledge to students in a perfect form because everyone has their scheme of what he knows. In other words, learners must build knowledge based on their respective experiences. The characteristics of consumerist learning are: (1) Allowing learners to build new knowledge through their involvement in the real world; (2) Encouraging learner ideas as a guide to designing knowledge; (3) Support cooperative learning; (4) Encouraging and accept the efforts and results obtained by learners; (5) Encourage learners to ask questions and dialogue with teachers; (6) Regard learning as a process as important as learning outcomes; (7) Encourage the process of student inquiry through studies and experiments (Thobroni & Mustofa, 2011). For constructivism learning to run well in the classroom, J. Piaget and Vygotsky provide the design or design of learning models as follows: identification of prior knowledge and misconceptions, preparation of learning programs, orientation and quality of reflection, reconstruction of ideas that include challenges, cognitive conflicts, and class discussions, rebuilding conceptual frameworks, applications and reviews. One of the learning models that are in accordance with the design or design of the learning model is problem-based learning.
Based on the description above, the purpose of this research is to describe whether constructivism learning is effective and to describe which is more effective in mathematics learning using the constructivism learning approach or learning that teachers usually do in the classroom judging from the achievements and motivations of learning mathematics junior high school students.

METHOD

This research is a quasi-experiment with a pretest-posttest nonequivalent comparison-group design. This research was conducted in junior high school. In accordance with the study's design, the samples in this study were determined by stratified random sampling techniques. The strata intended in this study are categories of achievement of learner competence, selected two classes, namely one class is given learning treatment with a consumerist approach as an experimental class and one class as a control class given the usual learning treatment in schools. The instrument used to measure students' math learning achievements is a learning outcome test consisting of 25 multiple choice questions and 5 description questions. The instrument used to measure students' math learning motivation is a student mathematics learning motivation questionnaire consisting of 25 statements in the form of a checklist.

To test whether learning with a constructivism approach is effective against motivation and mathematics learning achievements in junior high school used, a one-sample t-test. To test the initial ability before treatment, the MANOVA test is performed to see if there is a difference in initial ability between the two sample groups. Once it is known that there is no difference in initial ability between the two sample groups, then for the test results and questionnaires after treatment, the test is carried out to see if there is a difference in effectiveness by using the MANOVA test formula. Once it is known that there are differences in effectiveness, the t-Benferroni test is carried out to see if learning with a constructivist approach is more effective than learning that is usually done in schools and is reviewed from both aspects (Stevens, 2009). In addition to using the independent sample t-test to see the improvement, the normalized Gain score test is also used to avoid conclusion results that will cause bias in the study. This is because the initial test scores of the two research groups are already different (Meltzer, 2012). To attribute the quality of the improvement in motivation, interest, and learning outcomes, students can be seen based on normalized gain scores with the classification of Normalized gain values of $0.7 \leq [<g>]$ for High interpretation, $0.3 \leq [<g>] < 0.7$ for Medium interpretation, and $[<g>] < 0.3$ for Low interpretation.

However, before conducting the above analysis, an assumption test was conducted on the motivation scores and mathematical learning achievements of junior high school students, namely the multivariate normality test and the variance-covariance matrix homogeneity test, both for the results of research before and after treatment. The multivariate normality test is performed using the Mahalanobis

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distance test (with d_i^2) the decision criterion that the population is said to be generally distributed if about 50% has a value $d_i^2 < \chi^2_{(p;\,0,5)}$ (Johnson & Wichern, 2007). The variance-covariance matrix homogeneity test is performed using Box's M test with the decision criterion that the population is said to be homogeneous if the significance value F is greater than 0.05 (Rencher, 1998).

RESULT AND DISCUSSION

The description of the implementation of learning is an overview obtained during the research to support the discussion of research results. The initial and final conditions of each variable studied will be seen in this picture. Based on the results of the descriptive statistics analysis showed, the average results of the initial test and the final test in the experimental group and the control group both increased. The average learning achievement of both groups has met the minimum completion standard of 75. From the results of *the pretest* and *post-test* of the experimental class, students have met the minimum completion standard, with the number of completed students amounting to 98%, while in the control class, with an increase of 95%.

For the experimental and control groups, descriptions of learning motivation obtained information as a whole. The average motivation score of students increased both in the experimental group and in the control group. The average motivation score in the experimental group before the treatment of 78.76 was in the very high category, and after the average treatment increased to 81.86 with the category remaining at a very high range, where the average score obtained by students increased by 3.10. In the control group, the average motivation score before the treatment of 76.17 was in the very high category. After the treatment, the average increased to 79.03, with the category fixed in the very high range, where the average increased by 2.86 lower than the increase in the n experiment group.

Tests of assumptions of normality and homogeneity of student learning achievement and motivation before and after treatment for both the experimental group and the control group, the results can be seen in the following table.

Table 1. Normality Test Results

Group	$d_i{}^2$ Before Treatment	$d_i{}^2$ After Treatment
Experiment	51,72%	51,72%
Control	50,00%	50,00%

The table above shows that about 50% have, so it can be said that the motivation $d_i{}^2 < \chi^2_{(0,5;3)}$ and students' learning achievement for the experimental and the control groups came from a normally distributed multivariate population.

Table 2. Homogeneity Test Results

	Before Treatment	After Treatment
Box'M	12,467	11,587
F	2,019	0,9889
Significance	0,59	0,081

The results of the homogeneity test shown in the Table 2 obtained information that the significance value F is greater than 0.05; in other words, the covariance variance matrix of the learning group in the experimental group and the control group both before and after treatment has fulfilled the assumption of homogeneity.

The test results to determine the effectiveness of learning are reviewed from the aspects of motivation and mathematics students' achievement, which can be seen in the table below.

Table 3. *One Sample t-test* Results

Aspects	Group	t_{hit}	t_{tab}	Itself
Learning Achievements	Experiment	13,95	2,002	0,00
	Control	8,22	2,001	0,00
Motivation	Experiment	14,40	2,002	0,00
	Control	11,88	2,001	0,00

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Because the value of significant aspects of motivation and learning achievement in both groups is smaller than 0.05 and the value, this means that$\boldsymbol{t_{hit}} > \boldsymbol{t_{tab}}$ learning-based constructivism approaches are effective for increasing the motivation and achievement of learning mathematics of junior high school students.

Based on the decision criteria on the *one-sample t-test* learning test with an effective constructivism approach reviewed the motivation and achievements of learning mathematics students. This is because in the learning process with a constructivist approach, the knowledge obtained by students is not simply transferred from the educator's mind to the learner's mind, meaning that the learner must actively build his knowledge structure based on cognitive maturity. The main principle in constructivism learning theory is that knowledge cannot be obtained passively but actively by the student's cognitive structure. Cognitive function is adaptive and helps organize through real experiences that children have (Nur, 2002; Trianto, 2011; Dahar, 2011). In addition, constructivists are not the only source of learning for students, but interact with the environment, the atmosphere that makes students responsive to existing problems so that they record or solve the problem, educators only as mediators, then independent learners or active groups to solve the problems given so that they build their knowledge (Busnawir, 2013). This leads to learning with an effective constructivism approach based on students' motivation and learning achievements. Learning based on an effective constructivism approach is reviewed from students' motivation and learning achievements, also in line with the theoretical studies and research results conducted by Hasnawati and Ardin (2010); Rafiola et al. (2020); Nouren, Arsyad, & Bashira (2020); Anastasya & Movitaria (2019)

The results of the test on whether there were differences in initial ability between the two sample groups before being treated and the difference in effectiveness in the aspects of motivation and learning achievement of students can be seen in the following table.

Table 4. MANOVA Test Results

	Before Treatment	After Treatment
F_{-hit}	2,606	16,713
F_{-tab}	2,769	2,684

From the table above, it can be seen before and$F_{hit} < F_{tab}$ after the value treatment$F_{hit} > F_{tab}$. That is, before being given treatment, the two groups have equal initial abilities, but after being given treatment, there is a difference in the effectiveness of learning with a constructivist approach judging from the motivation and achievements of learning mathematics in junior high school students.

Once it was discovered that there were differences in the effectiveness of learning in both groups, a *follow-up independent sample t-test* with *Bonferroni* criteria was conducted to see which variables contributed to the difference in effectiveness. In summary, *the independent sample t-test* can be seen in the following table.

Table 5. *Independent Sample t-test* Results

Aspects	t_{hit}	t_{-tab}	Itself.
Learning achievements	3,858	2,429	0,000
Motivation	4,860	2,429	0,000

Based on the *Independent Sample t-Test* test shown in the Table 5 obtained a value with a significance value of less than 0.017 so that it can be concluded that $t_{hitung} > t_{tabel}$learning with a constructivism approach is more effective in improving the motivation and achievement of learning mathematics students compared to the usual learning of teachers in schools.

In addition to using *the independent sample t-test* to see the improvement, the *gain score* test is also used normally. The difference in average normalized gain <g> of the experimental and control groups for aspects of motivation and learning achievement is presented in the following table.

Table 6. Average *Gain Score* <g>

Aspects	Experiment		Control	
	Average <g>	Criterion	Average <g>	Criterion
Learning achievements	0,7032	Tall	0,6620	Keep
Motivation	0,1021	Low	0,0816	Low

Table 6 shows that the average normalized gain score of the experimental group is higher than that of the control group. In addition, both groups have normalized gain score categories, namely medium and low. Thus it can be said that learning with a constructivist approach in experimental groups can improve students' learning achievements and motivation better than conventional learning teachers usually do in schools.

The results of the t-test with Benferoni criteria show that learning with a constructivist approach is more effective than direct learning that is commonly applied in schools, judging from the achievement of competency standards and motivation in learning mathematics students. In addition to using *the independent sample t-test* to see the improvement, it is also based on the gain test. The description of the achievement data on the standard achievement of competence and motivation learning shows that the initial abilities of the two groups are different, the improvement of the initial test and the final test of the two groups are different, as well as the difference in the standard deviation of the initial test before learning and the final test after learning shows that the control group is more homogeneous, it is necessary to conduct a normalized *gain score* test. *Normalized gain scores* are used to avoid biased research results in research this is because the initial test scores of the two groups are already different Research results show that mathematics learning by applying learning with a constructivist approach is more effective than mathematics learning by using conventional learning to improve students' motivation and math learning achievement. The results of this study are also in line with Schunk's theoretical study (2012), which reveals learning that uses a constructivist approach demands that an educator be able to create learning in such a way that learners can actively engage with the subject matter through social interactions that are established in the classroom. Student activities in learning constructivism can be done by observing phenomena, collecting data, formulating and testing hypotheses, and collaborating with others to improve participants' learning achievements and motivation.

Learning followed by students in groups who study with a conventional approach has less effect on the motivation and achievement of learning mathematics students; this is possible because the implementation of learning is dominated by teacher lecture activities in which teachers as the main information provider. Conventional learning refers to a learning pattern that consists of the teacher's explanation of a new concept or skill to students in a large group or class, giving exercises accompanied by teacher instructions, and encouraging students to continue exercises to test students' understanding, in this mode the development of mathematical skills is carried out through the completion of problem exercises (Joyce, Calhoun, &Weil, 2004). In learning mathematics using conventional approaches, the main activity lies in learning mathematics through teacher lectures. All mathematical concepts that students must learn are conveyed orally by the teacher. As a deepening of learning, students are only given examples and practice questions (Gilstrab & William, 1975). According to researchers, students are not encouraged to learn the competencies delivered because there is no follow-up to the competencies they learn. As a result, students become bored, inactive, and uncreative during the learning process. Students only learn if given time to complete the problem practice. When the questions given are different from the questions used as examples by teachers, students have difficulty solving problems and need more guidance from teachers. This causes the teacher who followed students in the control group to have less effect on the motivation and achievement of learning mathematics students because the learning carried out does not spur students to learn because all mathematical concepts that students must learn are conveyed orally by the teacher. Then students do activities in the classroom according to the full direction of the teacher. Whereas in learning with a constructivism approach, students are given the opportunity to construct their understanding and associate their understanding with the understanding that will be obtained through a natural *inquiry* process that allows the improvement of learning achievements, and one of the characteristics of constructivism learning there is social interaction and dialogue that has an important role in the learning process allows Students' learning motivation increases.

This is in line with previous research conducted by Prayitno (2011), which stated that the use of constructivism in learning affects teachers' achievement, liveliness, and ability to manage learning. Furthermore, research by Rafiola et al. (2020) on learning with a constructivist approach *of blended learning* models increases student motivation. The study was conducted by Noureen, Tahsin, & Bashira (2020), which stated that the constructivism teaching approach is effective in improving

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learning outcomes as well as student learning motivation as well; research by Busawir (2013) states that the constructivist approach to learning is more effective than the conventional approach that teachers usually take in schools and affects student learning outcomes and motivation.

CONCLUSION

Learning based on an effective constructivism approach and constructivism-based learning is more effective than conventional learning in improving junior high school students' mathematics learning achievements and motivation.

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