Improvement of student mathematics learning outcome on polyhedra topic by applying generative learning model in the class

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Abstract. Aiming of this research was to improve student learning outcome in mathematics Grade VIII SMP Negeri 11 Kota Bengkulu by applying Generative learning model in the class management. The design of this research was classroom action research with the steps were: planning, acting, observing and reflecting. The subject of this research was 32 students of Grade VIII B SMP Negeri 11 Kota Bengkulu on even semester academic year 2018/2019. Data collection was done by using step 4 application in student worksheet and cycle test sheet. The generative model steps in this research were step 1 preparation, step 2 focusing, step 3 challenge and step 4 application. Class management with applying generative learning model improved student learning outcome by: (1) step 1 preparation trained student to remember the topic; (2) step 2 focusing trained student to construct the concept by them self; (3) step 3 challenge trained student to solve the real problem using concept that they got; and (4) step 4 application trained student with the exercises. The average of student learning outcome improved from first cycle to third cycle were: 66.48; 74.70; 83.75 with classical learning outcomes were: 43.75%; 62.50%; 87.50%.

1. Introduction
Mathematics was one of the important knowledge in the world. Mathematics learning outcome was often used to measure the extent of students' abilities. This could be seen from the fact that in entering the levels of schools and colleges, mathematics learning outcome was a requirement for entering these institutions. The achievement of learning objectives could be seen from the learning outcome obtained by students after ended [1]. In this case, the intended completion was after being given actions that support to improve student learning outcome.

Learning outcome were classified into three domains needing to be considered in every teaching and learning process that was cognitive, effective and psychomotor [2]. In this research, the intended learning outcome was learning outcome achieved by students in the cognitive domain (memory, knowledge and intellectual ability).

The ability to understand a subject matter is an important skill or competency that students need to learn and be able to apply mathematics through problem solving [3]. In fact, mathematics learning outcome nationwide still need to be improved. Data from the Program for International Student Assessment (PISA) showed the learning outcome in mathematics of 15 year old students in Indonesia on 2015 was 386 and ranked Indonesia 62nd out of 69 countries [4]. In addition, data from the Trends
in Mathematics and Science Study (TIMSS) ranked Indonesia 45th out of 50 countries in the mathematical abilities of students with a score of 397 [5]. Based on data from Kementerian Pendidikan dan Kebudayaan Republik Indonesia the average learning outcome of the mathematics exam of junior high school students decreased from 2017 which was 52.69 to 31.38 in 2018 [6]. This showed that the mathematics learning outcome of students was still low and needed to be improved.

This problem also happened at SMP Negeri 11 Kota Bengkulu. This indicated by the average learning outcome of the mathematics final exam for students Grade VIII SMP Negeri 11 Kota Bengkulu in the odd semester of the 2018/2019 academic year was 39.78. This score had not yet reached the minimum completeness criteria set by the school that equals to 75. One solution that might be used to solve these problems was to apply a generative learning model.

Generative learning was a learning model that emphasizes active integration between new material or knowledge obtained with schema [7]. The generative learning model was a learning model that giving students the opportunity to develop new material concepts independently by activating students' knowledge to produce elements of memory, integration, organization and elaboration [8]. Generative learning theory has its roots in Bartlett (1932) view of learning as an act of construction, in which people invest effort after meaning by integrating new experiences with their existing knowledge structures or schemas [9].

The steps of the generative learning model were as follows: (1) The orientation, (2) The expression of ideas; (3) Challenges and restructuring; (4) Application [10]. The following figure showed illustration of generative learning models’ concept:

![Figure 1. Illustration of generative learning models’ concept](image)

The concept map in Figure 1 is illustrative of our conceptualization of the ideas presented in Wittrock’s writings (1974a,b, 1985, 1990, 1991, 1992) and in Grabowski’s (2004) concept map regarding the progression of generative learning [11]. According to Farouk A and Elfateh A [12], when learners generate their own knowledge, they need to create relationships between new information and their prior knowledge. Therefore, prior knowledge is another key aspect of the theory that should be considered.

Generative learning theory suggests that learning occurs when learners are both physically and cognitively active in organizing and integrating new information into their existing knowledge structure.
From the well-known concept of scientific management, school adopts a linear and close educational system based on thoroughly timed curriculum oriented at result [14]. This research tried to maximize the process for the result. The steps of the generative learning model used in this research to improve student learning outcome consisting of 4 steps: (1) Step 1 preparation, at this step students were given the opportunity to express their initial knowledge about the material to be discussed, (2) Step 2 focusing, at this step students could link the initial information with the information to be discussed, (3) Step 3 Challenge was the step of drawing conclusions by recording or writing down the results of discussions conducted in groups and making presentations in front of the class, and (4) Step 4 Application was the step of applying the mathematical concepts of the findings and discussions that have been carried out. The features of the learning included the following: (1) provide a learning environment that enables the collaborative process of knowledge construction and sharing; (2) provide a learning environment that supports the construction of knowledge collaboratively; (3) learners are active participants and partners in constructing their knowledge; (4) learners are able to interpret their learning and build their mental model collaboratively and individually to represent their knowledge; (5) learners are required to construct knowledge collaboratively through learning aids such as the contents organizer that engages them in critical thinking [15]. The aim of this research was to know how to manage a class by applying the generative learning model to increase students learning outcome on mathematics class VIII SMP Negeri 11 Kota Bengkulu.

2. Methods
The design of this research was Classroom Action Research (CAR) with the steps were: planning, acting, observing and reflecting [16]. Classroom action research was the research that oriented on applying the action with the aim to improve the quality of solving the problem to a group of subject and observed the result and effect of the action, to give the perfectly action or adaptation with the condition and situation to reach a good result [17]. This research focus to improve student learning outcome using generative learning model.

As for school learning, the researchers measured two aspects of learning which are organizational learning process and organizational learning outcomes [18]. The research instrument used in this research was the student worksheet and student learning outcome test. The student worksheet and student learning outcome test were used to measure student learning outcome. The material used in this research was the polyhedra.

The data analysis carried out was the data on the step 4 application in student worksheet at each meeting and the learning outcome result in every cycle. Each application and learning outcome test had a maximum score 100. The learning outcome analysed using the following formula (1) [19]:

\[ \bar{x} = \frac{20\% \bar{APP} + 80\% T}{\sum N} \]  

Information:
\( \bar{x} \): Average learning outcome
\( \bar{APP} \): Average of step 4 application
\( T \): Learning outcome test
\( \sum N \): Total number of all students

Next, calculated the percentage of classical learning outcome. The class was declared passing the classical learning outcome criteria with ≥80% (26 students) got score ≥75 and the cycle would be stopped. The percentage of classical learning outcome calculated using the following formula (2) [19]:

\[ \bar{x} = \frac{20\% \bar{APP} + 80\% T}{\sum N} \]
Information:

\( p \): percentage of classical learning outcome
\( NP \): total number of student pass the minimum criteria
\( N \): total number of all students

3. Results and discussion
In the 1st cycle, the material studied by students at the 1st meeting was surface area of cube, 2nd meeting was surface area of rectangular prism, 3rd meeting was surface area of triangular prism and 4th meeting was surface area of rectangular pyramid. In the 2nd cycle, studied by students at the 1st meeting was volume of cube, 2nd meeting was volume of rectangular prism, 3rd meeting was volume of triangular prism and 4th meeting was volume of rectangular pyramid. The material studied by students in 3rd cycle was the problem of surface area of polyhedra (1st meeting), the area of polyhedra combination (2nd meeting), the problem of volume of polyhedra (3rd meeting) and the volume of polyhedra combination (4th meeting). Student learning outcome from 1st cycle to 3rd cycle could be seen in the following Table 1:

| Cycle | Average Learning Outcome | Classical Learning Outcome | Information     |
|-------|--------------------------|----------------------------|-----------------|
| 1st   | 66.48                    | 43.75%                     | Had not pass    |
| 2nd   | 74.70                    | 62.50%                     | Had not pass    |
| 3rd   | 83.75                    | 87.50%                     | Pass            |

According to table 1, in the 1st cycle of learning, the average of student learning outcome was 43.75 with 14 students got score equals or greater than 75 and there were several problems in learning that were carried out. First, students erred in distinguishing the height of the prism and the base of the prism in step 1 preparation at 3rd meeting. The action took by the researcher was to provide a description about height of the prism and the base of the prism on the prism props that would be used at the meeting in 2nd cycle.

Second, students were less precise in understanding the difference between square and rectangle in step 2 focusing at 1st and 2nd meeting in drawing nets of cube and rectangular prism, so there were groups drawing nets of cube using the sides of rectangles at the 1st meeting and there were groups drawing nets of rectangular prism using the sides of squares at the 2nd meeting. The action took by the researcher was to reemphasize that the sides of the cube were square and the sides of the rectangular prism were rectangle for the 2nd meeting. The results obtained that students better understanding the difference between nets of cube and rectangular prism.

Third, students erred in filling the step 2 focusing in the worksheet for the surface area of the prism at 3rd meeting. The action took by the researcher was to remind students to be careful and meticulous in filling the student worksheet so they were not mistaken. The results obtained that students more careful in filling student worksheet at the next meeting. In the step 2 focusing at the 4th meeting, the eight groups filled the student worksheet regarding the surface area of the pyramid correctly.

Fourth, students erred in drawing upright sides of nets of square pyramid with different sizes in step 2 focusing at 4th meeting. The action took by emphasizing the students again that if the pyramid was a square pyramid then the sides upright has the same shape and size. Fifth, students did not understand the instructions in student worksheet to count at step 3 challenge. The action took by clarifying the counting orders for step 3 challenge in the student worksheet in 2nd cycle. Sixth, students erred to measure the rectangular prism that given in step 3 challenge at the 2nd meeting. The action took by reminding students to be more careful in measuring the given props. The results obtained that students trying to be more careful in measuring the given props. Seventh, students were less able to solve problems that were related to algebra. The action took by providing practice questions related to algebra
such as determining the height of the polyhedron that was known the volume and the requirements needed in 2nd cycle.

According to table 1, in the 2nd cycle the average learning outcome obtained by students increased to 74.70% with 20 student got score equals or greater than 75. In the 2nd cycle of learning there were several responses / results obtained from actions took to the problems that exist in 1st cycle. First, students were wrong in distinguishing the height of the prism and the prism base in step 1 preparation at 3rd meeting 3 problem. Actions took by the researcher in 2nd cycle was to provide information about the height of the prism and the prism base on the prism props that would be used at the meeting in 2nd cycle. The results obtained students better understand the parts of the props given.

Second, students did not understand the instructions in student worksheet to count in step 3 challenge problem. The action took by researchers in 2nd cycle was to clarify the calculation orders for step 3 challenges in student worksheet for 2nd cycle. The results obtained students understand the calculation orders requested at student worksheet. Third, students were less able to solve problems that were related to algebra problem. The action took by the researcher in 2nd cycle was to provide practice questions that have to do with algebra such as determining the height of the polyhedron that was known to the volume and the requirements needed in 2nd cycle. The results obtained students still having difficulty in solving problems related to algebra.

During learning in the 2nd cycle, there were several problems in learning. First, there were students who were less precise in drawing a stack of cubes in the step 2 focusing at 1st and 2nd meetings. The action took by the researcher was to remind students to draw the appropriate size. The results obtained that there were still some students who were not quite right in drawing up the polyhedron that requested. Second, there were students who made mistakes in calculating who were supposed to look for the height of the upright side first in step 4 application at 4th meeting. The action took by providing the step of work on student worksheet in the 3rd cycle.

According to table 1, the average of student learning outcome was 83.75 with 28 students got score equals or greater than 75. The results of the 3rd cycle test had met the success indicators set by the researchers. Based on the results of the 3rd cycle test, there were 4 students got score less than 75.

The improvement of students' classical learning outcome from 1st cycle to 3rd cycle could be seen in the following figure 2:

![Improvement of students' classical learning outcome](image)

**Figure 2.** Improvement of students’ classical learning outcome from 1st cycle to 3rd cycle.

According to figure 2, it could be seen that student learning outcome had increased from 1st cycle to 3rd cycle. The increasing of student learning outcome was based on the overall results of students. Meanwhile, the result of each student from 1st cycle to 3rd was quite varied as presented in figure 3 below:
According to figure 3, it could be seen that there were 18 students who’s always increased each cycle. There were 8 students who’s decreased from 1st cycle to 2nd cycle then increased again in 3rd cycle. In addition, there were 6 students who’s increased from 1st cycle to 2nd cycle and then decreased in the 3rd cycle.

Based on the final results of student learning outcomes from 1st cycle to 3rd cycle, the action by applying generative learning models in managing this class helped students to be active in learning and improved student learning outcome. Could be seen that the student learning outcome had increased in each cycle. Even so, there were still students who had not reached the learning outcome criteria until the 3rd cycle. Analysis of learning outcome showed that students had increased learning outcome from 1st cycle to 3rd cycle in general and have reached the indicators.

Aspects in the application of generative learning model that could improve student learning outcome were in step 1 of preparation, students would be trained to remember knowledge related to the material to be learned so that it would helped students to better understand and remember the concepts being learned. In step 2 focusing, students would be trained to conduct experiments and constructed their old knowledge with new knowledge so as to get new concepts that were more remembered by students because constructed by themselves.

In step 3 challenge, students would be trained to try to use the concepts they have acquired with the problems given by researchers and discussed it in front of the class. In step 4 application, students were given exercises so that they could practice their abilities in working on the test questions that were given. In addition, researchers provided motivation for students to study more actively in order to answer the test questions that were given correctly, reminded to students about the unit length, area and volume and emphasizing returning to students when calculating surface area so that all surfaces build calculated area.

Based on the final results of student learning outcomes from 1st cycle to 3rd cycle, applying generative learning models in managing mathematics class helped students to be active in learning and improve student learning outcome. Could be seen that student learning outcome had increased in each cycle. Even so, there were still students who had not reached criteria until the 3rd cycle. Analysis of learning outcome showed that student had increased learning outcome from 1st cycle to 3rd cycle in general and have reached the indicators. Based on the results of research conducted in Grade VIII B SMP Negeri 11 Kota Bengkulu on academic year 2018/2019 by applying a generative learning model in managing classes caused increasing in student learning outcome. Learning with generative learning models could increase the ability of high or low learners where the generative learning process facilitates students to improve their ability to understand a material [8]. The initial knowledge that students have would developed through learning activities.
4. Conclusion

Based on the results of research and discussion, it could be concluded that managing class by applying generative learning model could improve students' mathematics learning outcome by: (1) step 1 preparation improved student learning outcome by helping students to remember subject matter related to the material to be learned; (2) step 2 focusing improved student learning outcome by constructing their own concepts of learning, so it would be easier for students to remember the concept further; (4) step 3 challenge improved student learning outcome by solving problems significantly with the concepts that they got in step 2 focusing together with their group and presented the result in front of the class; (4) step 4 application improved student learning outcome by giving student the problems that they solved by them self. The average of student learning outcome in the first cycle was 66.48 with classical learning outcome 43.75%, the second cycle was 74.70 with classical learning outcome 62.50% and the third cycle was 83.75 with classical learning outcome 87.50%.

Acknowledgments

Thank you to students in the grade VIII B SMP Negeri 11 Kota Bengkulu Academic Year 2018/2019 for joining this research as the participant and for all who gave the contributions in this research.

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