The Effectiveness of Scientific Approach with Scaffolding through Interactive Media According to Mathematics Achievement

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Abstract. This study is aimed to describe the effectiveness of scientific approach with scaffolding through interactive media according to mathematics achievement. The method used in this research was quasi-experiment with the pretest-posttest control and experiment group design. The subject were students at 8th grade. The validity of test were the content validity by expert judgement and the construct validity with good qualification, while the reliability of test was 0.742 with good qualification. To test of hypothesis in this research used t-test. The average and the std. deviation of posttest experiment class are 82.73 and 11.38, while posttest control class are 79.3 and 14.16. The result of this research shows that scientific approach with scaffolding through interactive media as effective as teacher scaffolding according to students' mathematics achievement.

1. Introduction

In general, students need a support from a teacher or someone who has more knowledge in learning process until they can reach a higher level of knowledge. Several important ideas in learning process [1] involves behavior and such as: 1) The zone of proximal development (ZPD) is a distance between what students can achieve with their abilities and what they need a support of teacher and peer to reach new knowledge; 2) Contingent teaching or scaffolding is a process provided by a teacher and knowledgeable peer to help students move from actual to potential knowledge or provide sufficient assistance; and 3) Self-regulation prefers to students can start thinking about independence with their thinking. Thus, scaffolding is assistance provided by teacher to guide and facilitate students to develop a higher level of knowledge or achieve a potential knowledge and maintain students’ self-regulated which is an important component in the learning process.

Scaffolding process [2] that enables a child or student to solve a problem, carry out a task, or achieve a goal in learning with its unassisted efforts. Scaffolding [3] is assistance or support in learning and problem solving which include instruction, reminder, encouragement, problem solving through steps, providing example, or everything to allow students for developing into independent students. Scaffolding [4] refers to when a student is unfinish to understanding or confused in the lesson, teacher can support adequately to ensure students complete the task. One step in providing scaffolding is Scaffold verbally or through action to provide possible ways to solve a problem” means scaffolding can be given verbally or by action.
In addition, teachers [5] may provide scaffolding for students by writing for them until they have the ability to record their ideas. Scaffolding [6] also means of helper or supporter who has potential to provide something that is possible to assist in gaining knowledge process and developing understanding. There are two scaffolding in learning process called planned scaffolding and unplanned scaffolding that based on improvisation according to the teacher’s knowledge. Three ways to provide scaffolding are teacher, peer, and computer.

It is necessary to arrange a scaffolding strategy for achieving goals. Teachers [7] have to do such as: 1) recognizing students’ mathematical reasoning; 2) recognizing how students’ ideas to get their potential and contribute in mathematical goals; 3) recognizing all of students’ ideas (true or false) are relevant to develop students’ understanding of mathematics; and 4) selecting carefully what contributions should be made to the situation.

Teacher has a role to make planning and implementing scaffolding for functional and effective in teaching and learning in the classroom. In the context of learning, there [8] are several scaffolding strategies called modeling, bridging, and schemes building. Modeling is a scaffolding strategy that provides examples or models to solve mathematical problem. Students who are gave examples or model can compare, analyze, interpret, and evaluate the context of the mathematical problem. Bridges is a scaffolding strategy to recall students' knowledge and understanding of the concept that already exists that will be used in understanding new concept/problem. Meanwhile, scheme building is a scaffolding of schemes, diagrams in problem situations, and maps concept which relate to problem situations.

The quality [9] as a teaching and learning scaffolding are: a) enable the students to carry out the task and manage on their own, b) be intended to bring the students’ competence which will enable them to complete a task on their own, and c) be aware of the results of learning experience. The emphasis of the experts on the definition of scaffolding is on collaboration between the teacher and the student to construct the knowledge and skills. Thus, scaffolding is important in constructing knowledge and helping to solve problems in the learning process. Scaffolding can be given when teacher help students to construct new concepts and solve problems in the learning process, especially for mathematics learning.

This is consistent in constructivism theory [6]. The theory based on the general idea that students have to build their own understanding on their life and developing experience. So, students can choose and change information from the past to become new personal knowledge, understanding and experience. Scaffolding [10] was related to increased students' understanding when it was poor. Previous contingent research shows that scaffolding can support to improve student' achievement and also scaffolding is not unequivocally effective because effectiveness depends among other things, independent working time of the groups and students' task effort. So, we need data related to the effectiveness of learning using scaffolding in constructing new knowledge and solving problems.

There was a research [11] that focuses on metacognitive scaffolding through interactive multimedia in a learning. Metacognitive scaffolding through interactive multimedia is a scaffolding that is gave to students for solving problems only. The form of scaffolding are questions, direction, or commands to guide students in problem solving. The result of research is the students who learn with metacognition scaffolding process have ability to solve a problem better than students who learn with direct approach. The other research [12] that focuses on effectiveness of using scaffolding techniques to improve students’ mathematics achievement. The result of research showed that using scaffolding techniques can improve students’ mathematics achievement.

There are several important points in the flow of the teaching and learning, the teacher must learn to provide verbal scaffolding based on level by do not help students directly but using many obstacles to build students' knowledge. It is good for a scaffolding as an obstacle or things that can build students' knowledge. One of the form is questions. Scaffolding [3] is assistance or support in learning and problem solving which includes instructions, reminders, encouragement, solving problems through steps, providing examples, or anything that allows students to develop into students’ independent. The six ways of scaffolding [13] in supporting student learning activities can be divided
into: a) feeding back b) giving instructions, c) commands, d) explaining or explain, e) modeling or demonstration and f) questioning or questions. In the question involves asking questions that require active linguistics and cognitive answers. So, it is important to have data related to the effectiveness of learning using scaffolding which is devoted to questions related to knowledge building and problem solving.

Scaffolding with interactive media is assistance or support of written questions that have been planned in interactive media provided to students in expanding new knowledge and solving problems that arise when students need or difficulty in processing learning materials, so that students can develop and be able to solve problems. It is different from scaffolding through teachers, generally assistance or support of verbal questions that are not planned or depended on teacher knowledge. Scaffolding through interactive media in scientific learning lies in the scaffolding function that will be given especially four stage of the scientific approach so that students can be helped in building materials and solving problems using a combination of modeling strategies, bridging and scheme building. Scientific learning with scaffolding through interactive media contains in four stages are observing, asking, collecting information, and reasoning.

In observing [14], students have the opportunity to do such as: seeing, listening, and reading about objects. At this stage, scaffolding that is provided in interactive media is the form of modelling such as examples and non-examples so that students can compare, analyze, interpret and evaluate the context of the mathematical problems in the lesson.

In questioning [14], students have the opportunity to ask questions about information or something that are unknown from previously observed or questions to get additional information after observing. At this stage the scaffolding is given in the form of modeling questions such as what, where, why, how, and why. The questions posed by students are not just questions related to appearance “what” but a higher question “why”. In mathematics learning, the students’ questions are not only about concrete objects, but also abstracts about concepts and procedures. In general learning at this stage, teachers rarely provide scaffolding. In collecting information [14], students are guided to explore and collect information from various sources that relative to lesson. This stage is a follow-up to ask questions. Scaffolding through interactive media serves to guide students, so that the strategy is bridges, to recall the previous knowledge to construct new knowledge.

Teacher [6] constructs a “scaffold” around the area so that students have direct access to the chosen focus, with nothing allowed to get in the way”. In reasoning [14], students are allowed to: 1) to process information that is collected from observing and collecting information; and 2) to process the information that is collected to gain knowledge deeply from various sources, find a connection of information, and find the patterns with group. In the curriculum 2013, the achieved competencies are related to knowledge about understanding of concepts and skills as problem solving. Scaffolding strategy is used to understand about concepts with bridge model, while the scaffolding strategy for achieving skills competencies in problem solving is used to scheme building. Scaffolding with scheme building is related to problem solving in the Polya. Scaffolding in Polya is asking questions about what is known, what is asked, and how connection between the those to get answers.

2. Research Method
The type of research was quasi-experiment with all of learning group were students at the formed classes in the school. The independent variables were scientific approach with scaffolding through interactive media and scientific approach with scaffolding through teacher.

Research Design [15] was the pretest-posttest control and experimental group design. The design presented in Figure 1 below:

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Experiment  RO1  X1  O2
Control     RO2  X1  O4
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**Figure 1.** Research Design.
This research was conducted in one of Junior High School in Yogyakarta which uses the curriculum 2013 of revised 2017. So, students had a much time in the school based on applying the Full Day School Policy. The students’ Interval in the National Examination Value was 282.0 up to 303.5.

The instrument of study was a test to measure the students’ mathematics achievement of 8th grade in Cartesian Coordinate. The test was multiple-choice item with 14 questions. The instrument validity based on content validity and quality instrument that has difficulty level and index of difficult question. The validity result based on point biser was good qualification. While, reliability refered to a consistense of test to measure students’ mathematics achievement. The reliability result was 0.742 with good qualification.

Techniques of analysis data were descriptive analysis and inferential analysis. Descriptive analysis aimed to describe the result of the learning process based on posttest after giving treatment for mathematics achievement. The data consisted of average, standard deviation, achievement of maximum and minimum values. Inferential analysis aimed to describe the result of using t-test. Mathematics learning in scientific approach with scaffolding through interactive media and scientific approach with scaffolding through teacher were effective based on Minimum Value Criteria was 80. The decision criteria refused $H_0$ if $t > t_{n-1, \alpha}$, $\alpha = 0.05$. In addition, $H_0$ was accepted. Or criteria refused $H_0$ if sig value < 0.05 and received $H_0$ if sig. value $\geq 0.05$. The test statistic was used to compare the effectiveness of two groups of learning models with one dependent variable was the independent sample t-test. The decision criterion refused $H_0$ if $t > t_{n-1, \alpha}$, $\alpha = 0.05$ and $p = 2$. Or decision criteria refused $H_0$ if sig. value < 0.05 and received $H_0$ if sig. value $\geq 0.05$.

3. Result
The description data of students’ mathematics achievement of Cartesian Coordinate in experimental classes and control classes based on Minimum Value Criteria. The result data presented in Table 1 below:

| Description       | Research Result | Experimental Posttest | Control Posttest |
|-------------------|-----------------|-----------------------|------------------|
| Sum of students   | 63              | 64                    |
| Sum of score      | 5207            | 5071                  |
| Mean              | 82.73           | 79.3                  |
| St. Deviation     | 11.24           | 14.04                 |
| Max. Score        | 100             | 100                   |
| Min. Score        | 57              | 50                    |

Tabel 1 showed that mean score of posttest in scientific approach with scaffolding through interactive media is higher than the average of posttest score in scientific approach with scaffolding through teacher.

Hypothesis test by using One sample t-test is to do the value of mathematics learning achievement with effective criterion if the average of posttest score in scientific approach with scaffolding through interactive media is higher than the average of posttest score in scientific approach with scaffolding through teacher. The result of one sample t-test can be seen in Table 2 below.
Table 2. One-Sample Test.

|               | Test Value = 80 |       |       |       |
|---------------|-----------------|-------|-------|-------|
|               | t               | Df    | Sig. (2-tailed) | Mean Difference | 95% Confidence Interval of the Difference |
| Experimental Posttest | 1.904 | 62    | .062 | 2.730 | -.14 | 5.60 |
| Control Posttest | -3.97 | 63    | .693 | -2.730 | -4.24 | 2.84 |

Table 2 showed that the result of experimental class or scientific approach with scaffolding through interactive media was effective according to mathematics achievement. The result of control class or scientific approach with scaffolding through teacher was effective according to mathematics achievement.

Hypothesis test by using independent sample t-test is to compare the effectiveness from two of design instruction. Comparising are between scientific approach with scaffolding through interactive media and scientific approach with scaffolding through teacher. The result of independent sample t-test is in Table 3 below.

Table 3. Independent Samples T-test.

| Levene's Test | t-test for Equality of Means |
|---------------|-----------------------------|
| F             | Sig. | t     | df | Sig. (2-tailed) | Mean Diff. | Std. Error Diff. | 95% Confidence Interval of the Difference |
| Equal var-    | 2.244 | .137 | 1.50 | 125 | .135 | 3.433 | 2.283 | -1.084 | 7.951 |
| assumed       | 4     |       |     |     |     |      |       |       |       |
| Equal var-not | 1.50  | 120.18| .135 | 3.433 | 2.279 | -1.078 | 7.945 |
| assumed       | 7     | 9     |     |     |     |       |       |       |       |

Table 3 showed that the F value was 2.244 and the sig. value was 0.137 > 0.05. It means two classes have equal variances assumed. Thus, the t-test of different test analysis uses equal variances assumed with the sig. (2-tailed) value is 0.135 > 0.05. Hence H_0 is accepted which means the mean final score of mathematics achievement experiments compared with control classes were equally significant.

4. Discussion
The effectiveness of learning a scientific approach with scaffolding through interactive media is not more effective by learning scientific approaches with scaffolding through teacher but still has advantages. The use of scaffolding through interactive media supported by scientific stages is highly recommended in the world of education. The first stage, observing [16] is paying attention to some aspects that exist then recognizing a significant problem situation, and then the result of observing will be determined. To recognize a problem is the first step in solving problems that occur with a missing or invisible situation that must be a concern. If a problem is identified, then student can achieve or get a solution. Accuration in observational information can be obtained from in interactive media. Otherwise, students can ask about the observational information to teacher whether there is a mistake or not.

The second stage, asking [17] is one of the entry point in gaining knowledge. Some of the benefits of asking are to improve students' curiosity, interest and attention to the learning topic. Questions that
students have asked are question about yes or no answer and concepts. Questions in the form of concepts that have been submitted either in the experimental class or in the control class are 1) in the first meeting pointing to "how to determine a point based on a certain point (a, b)?", 2) the second meeting leads to "what is the reason the line is parallel to the x-axis and y-axis?" and 3) the third meeting leads to "what is the reason the line is parallel to the other line?".

The third stage, collecting information [17] refers to further action from asking. This stage is carried out by exploring and collecting information from various sources. At this stage, students will be given scaffolding because can lead students to new knowledge deeply about the material. The scaffolding strategy used is a bridge, carried out with a scaffolding strategy to recall the previous knowledge which is provided as structured scaffolding in interactive media. In learning, the alignment of lines drawn from two coordinate points on the x-axis and y-axis, students will be reminded again by looking at the pattern as a bridge to understand alignment. For example: "note the points on the x-axis, how is the absciss value? What is the ordinate value?". This also applies to scaffolding through teachers, only the teacher will give prior knowledge randomly according to what students need.

The fourth stage, reasoning [17] is to connect one fact or several facts that conclude a relationship of concepts. Furthermore, reasoning leads to problem solving as additional information. In reasoning for problem solving, students will be assisted with scaffolding related to problem solving. Because scaffolding in reasoning using scheme building that relates to the Polya model, such as questions regarding what is known, what is asked, and the connection between the two to get answers. Examples of scaffolding that have been provided such as: 1) what is known about the coordinates on the problem?; 2) what is asked about the problem?; 3) what is the relations between what is known and what is being asked?; 4) Can you complete the answer?. In this case, students who learn with scaffolding through interactive media can be checked the right answer directly after discussion with the group, so students can find out the expected answers. In reasoning with scaffolding through teacher can also be given directly by the teacher when students are confused about the answers or corrected answers, but scaffolding with interactive media can encourage students into the scientific approach principle such as student-centered, avoiding more verbalism, and providing opportunities for students to practice the ability to discuss in groups to get the expected answers.

The fifth stage is communicating, students do presentation about result of discussion in their group. In communicating [17], teacher can provide an explanation or clarification about answers that must be corrected or already correct for students who learn with scaffolding through teacher and provide opportunities for presentation on the correct answers for students who learn with scaffolding through interactive media.

5. Conclusion
Based on the result of research, scaffolding with interactive media developed using three strategy called modeling, bridges, and schemes building is effective according to students’ mathematics achievement. Of the three strategies can form a planned scaffolding according to knowledge related to concepts and problem solving. Scaffolding according to the modeling strategy can be given at the observation stage, scaffolding according to the bridge strategy can be given at the questioning stage and collecting information to help students make a conclusion on the concept or deep information, and scaffolding according to the scheme building can be given at the reasoning stage with the pattern problem solving, so that the learning process guides students to construct knowledge while maintaining students’ self-regulated.

Scaffolding through teachers is assistance or support in verbal questions that relate to teacher’s knowledge to build knowledge and solve an problemis effective according to students’ mathematics achievement. In this case, scaffolding through interactive media has the advantage that scaffolding through teacher because the scaffolding is written questions that have been provided and arranged so that students can discuss about concepts and problem solving with the group. Although there is no difference in effectiveness between the two, but scaffolding with interactive media can be more efficient because each student can access scaffolding directly but scaffolding through teacher cannot
do the same, avoid more verbalism, and provide opportunities for students to practice the ability to discuss in the groups to get answers which are expected.

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7. References
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