The efforts of improving mathematical connection ability of senior high school student with 7e learning cycle model

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Abstract. Mathematical connection ability has important role in the success of students’ mathematics course. In fact, the mathematical connection ability of senior high school students is not quite good, thus a learning models is needed to improve mathematical connection ability. The purposes of the research are; (1) find out if 7e Learning Cycle Model could improving students mathematical connection ability; (2) determine whether the improvement of mathematical connection ability of student who obtain 7e Learning Cycle Model compare than student who obtain the conventional learning; (3) and find out how students attitude toward 7e Learning Cycle Model. The method applied in this research was a quasi-experimental design by using non-equivalent control group design. Result for this research are quantitative data and qualitative data. Quantitative data obtained from mathematical connection ability of student before and after the implementation of learning while qualitative data obtained from analysis of data from student questionnaires and observation sheets. The result of this research are: (1) 7e Learning Cycle Model could increasing mathematical connection ability, (2) increased mathematical connection ability student who obtain 7e Learning Cycle better than student who obtain the conventional learning, (3) and most students give positive attitude toward 7e Learning Cycle.

1. Introduction
The importance of understanding mathematics for student is unfortunately incompatible with the success of the student in learning mathematics. Based on a preliminary study conducted by the researchers found that the mathematical ability of students is still low. When researcher do observation in the classroom, student have difficulties when solving problems than have a conceptual link [1].

The difficulties experienced by students are suspected because students are less understanding of the prerequisite materials for the material being studied. Researcher suspect students see the concepts in mathematics separately. Though, the concept of mathematics are interconnected with each other [2], so that the students only memorize the concept that is being learned then forget it when learning other mathematical concepts. Researcher suspected it causes students having difficulty in learning new concept of mathematics that have relevance to the previous concept.

One of the abilities that must be possessed by students to successfully learn mathematics is the ability of connection. Such capability is necessary for high school students to understanding the mathematical concept. A mathematical curriculum characterized by a spiral in which all the concept in newly learned mathematics have to do with the previously learned concepts by adding complexity to them [3].
Therefore the mathematical concepts studied at the high school level have much relevance to the material at the previous educational level and concepts learned at the high school level itself.

In this research, students are considered to have mathematical connection ability if the student is able to understand and use the connection between mathematical concept or mathematical concept with other fields of science and application of mathematical concept in the real life [4,5].

Another cause of the lack of students in understanding the concept of mathematics is that teachers are less precise in planning the implementation of learning. The learning of mathematics in the classroom is still teacher-centered by using lecture methods and giving routine practice questions that are clear how to solve them [6]. As a result in the implementation of learning in the classroom students tend to be passive, not critical of mathematical concepts and problems.

The learning model that makes it easier for students to understand the concept of mathematics is a student-centered model and uses the knowledge that students already have to learn new knowledge [7]. One of the learning model that is expected to improve mathematical connection ability of high school students is Learning Cycle 7e model. Learning Cycle model is a student-centered learning model and based on constructivism [8]. Constructivism learning is a learning process whereby students construct their own learning concepts and teachers only as facilitators and mentors. It is in harmony with the mathematics learning base at the level of high school education [9].

In this study the researcher will use Learning Cycle 7e model to improve the connection ability of high school students. The learning model was chosen because it is the latest development of the Learning Cycle model, and has more complex stages than previous Learning Cycle models. There are seven stages in the implementation of Learning Cycle model is Elicit, Engage, Explore, Explain, Elaborate, Evaluate and Extend [10].

Previous research has proven that the Learning Cycle model [11] and 5e Learning Cycle [12] can improve students' mathematical connection ability. Therefore the researcher will find out whether the 7e Learning Cycle model is also able to improve students' mathematical connection ability, how to increase it compared to conventional learning and student response during learning process using 7e Learning Cycle.

2. Experimental method

The method applied in this research was a quasi-experimental design by using non-equivalent control group design. This study involves two groups, namely the experimental group and the control group. The experimental group is the group that will be given Learning Cycle 7e model. While the control group is a group given conventional learning.

This research was conducted on 10 to 20 May 2016 in one of Public Senior High School Bandung. Subjects in this study were high school students of class XI year 2015/2016. Class XI Science 2 (33 students) as experimental group and class XI MIA 3 (32 students) as control group.

The research instruments used in this study are test and non-test instruments. The test instrument in the form of a description. While the non-test instrument in this research is in the form of observation sheet and questionnaire.

The test instrument in this study will be divided into two similar tests, namely pre-test and post-test. Pre-test measures the initial ability of students' mathematical connections and post-test to measure students' mathematical connection abilities after treatment. Both tests will be applied to the control group as well as the experimental group. Pre-test is done at the first meeting of learning and post-test is given after treatment in both groups is complete. Before the instrument is used, the instrument is first tested on students who have studied the material submitted. It aims to determine the validity, reliability, distinguishing power, and difficulty index of the tests used in the study.

Non test instruments are given only in the experimental class. The observation sheet is used to determine whether the learning is done in accordance with the learning model used or not. The observation sheet filled by the observer during the learning takes place. Questionnaires are used to find out the students' responses to learning with the 7e Learning Cycle model. Questionnaires are given to student after treatment is complete.
Quantitative data is obtained from pre-test and post-test results, then the data is analyzed descriptively, statistical inferential and index gain to know the difference of influence of students' mathematical connection ability between who get 7e Learning Cycle Model treatment and conventional treatment. Descriptive analysis calculated the maximum and minimum values, mean, standard deviations and variance of pre-test and post-test data in experimental and control group. Inferential Statistics Analysis in the form of normality test, homogeneity test and test of difference of two mean. If the data is normally distributed and homogeneous then test the average difference using the t-test but if the data is not normally distributed then use Mann-Whitney. Gain index analysis is done to find out how the quality improvement of students' mathematical connection ability.

Qualitative data obtained from the questionnaire and observation. The questionnaire data will be presented in tabular form with data converted into quantitative data using Likert scale [13]. Assessment of observation results only seen from the fulfilled or not the things that must be done during the learning of mathematics using 7e Learning Cycle model. The data is then interpreted in the form of a sentence to find out how the learning process takes place.

3. Results and discussion
The quantitative data obtained is the result of the pre-test and post-test of mathematical connection ability of the experimental group and control group, the qualitative data obtained is the result of a questionnaire. Based on observations made by the observer, learning takes place in accordance with the plan.

3.1. Student mathematical connection ability after using learning cycle 7e model

| Data   | Mean | XMax | XMin |
|--------|------|------|------|
| Pre-test | 1.06 | 3    | 0    |
| Post-test | 5.61 | 13   | 1    |

Table 1 shows the improvement of students' mathematical connection ability who get 7e Learning Cycle model. Before the treatment, the average of pre-test student is 1.06 while after the treatment the average of post-test student is 5.61. It happens because almost every stage of the 7e Learning Cycle model encourages students to relate mathematical concept that students have previously learned with others concept in mathematics fields or others fields.

At Elicit, Engage and Explore stages, students were guided to use mathematical concepts that students have learned to discover new mathematical concepts that students were learning to solve the problems and questions that teacher given [14]. During Elicit, Engage and Explore stages, teacher and students gave each other information. At these stages teacher played a role to induced students’ curiosity and student learning motivation.

At Explain stage, students presented their work during previous stages [10]. At this stage, student would presenting their work using their own word. At the last, teacher and student would make conclusion based on previous problem and question, then teacher would help student to form the formal concept.

At the Elaborate and Extend stages, teacher provided others problem and questions to students. At these stages, students are led to use the newly acquired mathematical concept of student into mathematical problems and fields outside mathematics [10].

3.2. Improved student mathematical connection ability
The quantitative data obtained in this study is analyzed descriptively in advance to know the outline of the results of the initial ability and the end-ability of mathematical connections of students between experimental group and control group after getting different treatment.
Table 2. Recapitulation of Pre-test and Post-test data.

| Test   | Group  | N  | IMS | X<sub>Max</sub> | X<sub>Min</sub> | Mean | S<sup>2</sup> | S    |
|--------|--------|----|-----|-----------------|---------------|------|-----------|------|
| Pre-test| Experiment | 33 | 15  | 3               | 0             | 1.06 | 0.496     | 0.704|
|        | Control  | 32 | 15  | 5               | 0             | 1.41 | 1.733     | 1.316|
| Post-test | Experiment | 33 | 15  | 13              | 1             | 5.61 | 9.996     | 3.162|
|        | Control  | 32 | 15  | 10              | 0             | 3.41 | 8.351     | 2.889|

<sup>a</sup> Ideal Maximum Score

Table 2 shows the initial ability of mathematical connections of students between the experimental group and control group is not much different. While there is considerable differences of students’ end-ability mathematics connection between experimental group and control group. Researcher used test of difference of two mean to find out whether the differences are significant or not. But before doing the test the difference of two mean, first test the normality and homogeneity of the experimental class and control class.

Table 3. Inferential Statistics Analysis of Pre-test and Post-test data.

| Test   | Group | Normality Test | Difference of Two Mean Test |
|--------|-------|----------------|-----------------------------|
| Pre-test| Experiment | 0.000          | 0.352                       |
|        | Control  | 0.001          |                             |
| Post-test | Experiment | 0.160          | 0.014                       |
|        | Control  | 0.007          |                             |

Table 3 shows the pre-test results of both groups are not normally distributed and the post-test result of experimental group is normally distributed but the control group is not normally distributed, so the data tested the difference of two mean with Mann-Whitney test [15]. Based on the test result the difference of two pre-test mean concluded that there is no significant difference in the initial ability of students’ mathematical connections between experimental group and control group, however there is significant difference in the end-ability of students’ mathematics connection between the two groups.

In order to find out how is the difference of quality improvement of students’ mathematics connection ability between experimental group and control group, researcher use a gain index analysis [16].

Table 4. Interpretation of the gain index.

| Group | Interpretation | Number of Student | Percentage |
|-------|----------------|-------------------|------------|
| Experiment | High          | 3                 | 9%         |
|        | Moderate       | 15                | 45%        |
|        | Low            | 15                | 45%        |
| Control | High          | 0                 | 0%         |
|        | Moderate       | 8                 | 25%        |
|        | Low            | 24                | 75%        |

Table 4 shows the quality improvement of students' mathematical connection ability with Learning Cycle 7e model is better than conventional learning. The questions and problem that teacher conveyed on Learning Cycle 7e stages contain conceptual approach and story problem [10,14]. These questions encouraged students to actively seek out and understood the relevance of the subject matter that was being studied with the knowledge with knowledge possessed by students.

On conventional learning, students tended to be more passive [6]. On conventional learning, teacher conveyed the concept to be learned directly. Because of that, students’ effort to see and understand the relevance of subject matter that was being studied with other less learning.
3.3. Student response during learning process using 7e learning cycle model
Based on the analysis of questionnaires given to students, in general students showed a positive response to Learning Cycle 7e model. The result of the overall presentation of student responses to Learning Cycle 7e model on mathematical connection ability is 73%. Learning Cycle 7e Model makes student better understand the role of mathematics in other fields of study and daily life, and solve mathematics story problems related to other fields of study and daily life.

This model guiding students to be active during learning makes students not feel bored during the learning process takes place, improves students’ confidence to respond to each other during discussion process. The activity of exchanging opinions during group discussions and presenting their own work facilitates students in understanding the mathematical concepts that are being studied.

Based on the result of observation during the Learning Cycle 7e model took place, the factors that cause students' positive responses are; (1) teacher guide students in understanding the subject matter and solve the given problem; (2) teacher provide information that stimulates student to get to know the subject that is being studied with other fields of study; (3) students are encouraged to respond to information expressed by teacher and; (4) students are encouraged to comment on the opinions of others and set an example of the subject being studied during the discussion [17].

4. Conclusion
Learning Cycle 7e model has been proven to improve mathematical connection ability of high school students. Analysis result was the students’ mathematical connection ability average after learning by Learning Cycle 7e Model is higher than before studying. The improvement of students' mathematical connection ability using the Learning Cycle 7e learning model is significantly higher than students who learn conventional learning. The reasons are that students relate experience or information that students have with questions asked by teachers, students connect the concepts that students have previously learned to get new concepts, students use newly acquired concepts to solve story problems related to other mathematics fields or outside mathematics field and students are encouraged to provide examples or other applications of the concept being studied. Student responses to Learning Cycle 7e model is positive. This is indicated by the attitude shown by student during the lesson. Student group discussion run actively and students are more confident to express their opinion during the lesson. The role of teachers during the lesson only facilitate and guide students at every stages in the Learning Cycle 7e model.

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