INTEGRATING THE HISTORY OF MATHEMATICS IN DISCOVERY LEARNING ON THE TOPIC OF CIRCLE

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Abstract
In fact, students see circle as the material which is not important. Circle contains abstract concept (far away from daily life), and contains complicated equations and formulas. This indicates students still do not understand the concepts and the formulas that are used. The implementation of integrating the history of mathematics in learning can help students to improve the response of students toward mathematics itself, and increase understanding of students. Understanding of students toward mathematics is very important because the mathematics is the Queen of the sciences that will support the understanding of other science which relies depend upon it. The objective of this research is describing the effectiveness of circle learning that integrates the history of mathematics. Method of collecting data is test, observation and questionnaire. The data collected were analyzed with descriptive statistics analysis techniques. This research revealed that the mathematics learning that integrates the history of mathematics; specially in circle learning is effective. Because the interaction between teacher and students, between and amongst students, between class situation with its environment are positive or rich interaction. Its also following by students’ achievement in learning and positive response from students towards their learning. Therefore, teachers are advised to apply the history of mathematics in mathematics learning specially on the topic of circle.

Keywords: history of mathematics, effective learning, interaction, students’ achievement, students’ response, circle, teaching and learning

INTRODUCTION
Understanding of students toward mathematics is very important because the mathematics is the Queen of the sciences that will support the understanding of other science which relies depend upon it (NGO,2015). In fact based on interview, students see circle as the material which is not important. Circle contains abstract concept (far away from daily life), and contains complicated equations and formulas. This indicates students still do not understand the concepts and the formulas that are used.

One strategy that can be alternative solution in learning on the topic of circle is integrating the history of mathematics. According to Katz (1997), history is one valid approach for teachers to assist students in grappling and understanding ideas. The implementation history of mathematics in learning can help, improve the response of students toward mathematics itself, and increase understanding of students (Fauvel, 1991).

The procedure to integrate the history of mathematics depends on the approaches used. Tzanakis and Arcavi (in Jankvist, 2009) mentioned three different main approaches to integrate the history mathematics in learning; learning history approach, learning mathematical topics approach, and developing deeper awareness. On the topic of circle, we can use “Learning Mathematical Topics” approach. This approach will be used by following the history of how the formula was found. The learning is begun with a motivation which contains the discoverer of circle. Hopefully, students will imitate and be inspired by the discoverer. Then students were stimulated to do discovery activity. Discovery activity will find the relation of peripheral angle with the central angle. In the history, the discoverer made a hypothesis before discovering something. Adapted from the history, the teacher must guide the students to make a hypothesis like a real discoverer. Then in the last section of learning, students will make conclusion about the validity of their hypothesis.

Therefore, discovery learning methods will be an appropriate way to realize mathematics learning on the circle topic. This learning will give a chance for students to construct how the formulas were developed that inspired by the history of mathematics.

Hopefully, after the learning students will see the concrete side of mathematics and enjoy the equations or formulas. Seyitoglu et al. (2011) stated as an impact of implementation of history of mathematics, students’ attendance to lesson in the more active way and thereby
the instruction of mathematical subjects and concepts can become more meaningful and permanent for students. The conclusion is that he suggested for teachers to use history of mathematics.

Based on the background above, the researcher wants to conduct a research entitled “Integrating the History of Mathematics in Discovery Learning on the Topic of Circle”.

The problem in this research is “how is the effectiveness of circle learning using discovery learning model that integrates history of mathematics?” While the goals of this research are to describe the effectiveness of circle learning using discovery learning model by integrating the learning with the history of mathematics

Definition of Terms
1. The discovery learning can be defined as a learning situation, in which the teacher does not give directly the main content of the materials, but it should be found independently by students. So, this learning will make students active in their learning. There are six steps in Discovery Learning as follow as:
   a. Stimulation, in this step teacher gives initial question or initial activity to the students which is suitable to stimulate students to follow the lesson.
   b. Problem Statement, in this step teacher gives a problem then students will identify the problem. Afterwards, students can formulate a hypothesis from the problem given.
   c. Data Collection (collecting data), the teacher gives chance to the students to collect data and information which relevant to the problem.
   d. Data Processing (preparing data), teacher and students will classify data and information that they get to test the truth of students’ hypothesis.
   e. Verification, based on the result or information, students will check the truth of their hypothesis.
   f. Generalization, students and teacher are making conclusion together.
2. Learning mathematical topics is teaching and learning approach inspired by history. In this approach, the teacher should use activities that call collaborative work and student investigation. Teachers can including the elements of the history of mathematics in teaching and learning activities like including the biography of mathematicians and the way of discoverer find formula of something.
3. The effectiveness of mathematics learning is the function of interaction between teacher and students, interaction between and amongst students, and the interaction between the classroom and its environment followed by positive impact on student achievement and positive response from students.
4. Students’ achievement is students’ understanding on circle that described by students’ test score
5. Students’ response in this research is students’ opinion about their circle learning that integrates the history of mathematics in discovery learning.

METHODS
The type of this research is quantitative research. The research design is one-shot case study. The scheme of this research look like:

\[
\begin{array}{c}
X \\
Y
\end{array}
\]

Source:Siswono (2010)

Note :
X = the implementation of discovery learning on the topic of circle by integrating the learning with the history of mathematics
Y = The learning process, students’ achievement, and students view toward discovery learning on the topic of circle by integrating the history of mathematics

Data obtained in this research are the effectiveness of circle learning that integrates the history of mathematics in discovery learning which getting from observation, the students’ achievement on the topic of circle after integrating history of mathematics in discovery learning which getting from test and the students’ response toward their circle learning that integrates the history of mathematics in discovery learning that getting from questionnaire.

This research will be conducted at the VIII grade in even semester academic year 2016/2017 at Kediri. The reason for choosing students as the subject of the research is based on the observations of the researcher that the students have curiosity. It shown in the learning process during the instruction in the previous semester.

Research Instruments
Sugiyono (2008) stated a research instrument is a tool that used to measure the science phenomenon or social phenomenon that observe. The instrument that used in this study are:
1. Paper Test
   In paper test, researcher will use some question to assess the students’ achievement using assessment instrument.
2. Observation Sheet
   In the observation sheet, the researcher will use list some activities of teacher and students, then it will be observe by observer.
3. Questionnaire
   Questionnaire will use by the researcher as a instrument to know students’ view toward their learning on the topic of circle using the history of mathematics.
Choose the category for the entire interaction, i.e. when the percentage of categories of the entire interaction in category of good or excellent is more than or equals 50%, then interaction between and amongst students said to be a positive or rich interaction. Conversely, if the number of categories of the interaction in category good or excellent is less than 50%, then the interaction between and amongst students is said to be negative or poor interaction.

3. Interaction between the class situation and its environment

Any activity that shows the interaction the class situation and its environment are categorized in four types with score 1-4. Then the total score of class situation and its environment will be categorized into some category. The category of the interaction between class and its environment are described in the following table:

<table>
<thead>
<tr>
<th>Category</th>
<th>Total score of class situation and its environment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Poor</td>
<td>2.5</td>
</tr>
<tr>
<td>Fair</td>
<td>4.5</td>
</tr>
<tr>
<td>Good</td>
<td>6.7</td>
</tr>
<tr>
<td>Excellent</td>
<td>8</td>
</tr>
</tbody>
</table>

Choose the category for the entire interaction, i.e. when the percentage of categories of the entire interaction in category of good or excellent is more than or equals 50%, then interaction between and amongst students said to be a positive or rich interaction. Conversely, if the number of categories of the interaction in category good or excellent is less than 50%, then the interaction between class situation and its environment is said to be negative or poor interaction.

4. Analyzing students’ achievement

a. Individual Mastery

Student is said passing the standard of teaching and learning circle if student get score $\geq 75$, as the minimum completeness criteria.

b. Classical Mastery

The classical mastery was counted use following formula:

$$\text{Classical Mastery Percentage} = \frac{\sum \text{Students' Mastery}}{\sum \text{Students}} \times 100\%$$

Classical mastery was achieved if minimum 75% of students have passed the minimum completeness criteria.

5. Analyzing Questionnaire

Students’ view toward their learning on the topic of circle are obtained from the questionnaire were distributed after teaching and learning about circle. Analysis stage of data of students’ view adapted from Masriyah (2006) described as follows:

a. Determine the score of each answer choice using Likert scale that has been modified by Masriyah (2006).
Choose the category for the entire item statements, i.e. when the percentage of categories of the entire item statement is more than or equal to 50% or in category of good or very good, then students’ response said to be a positive. Conversely, if the number of categories of the entire item statement is less than 50% or in category less good or bad, then students’ response is said to be negative. The final analysis will explain well in narrative text.

RESULTS AND DISCUSSIONS

1. Interaction between teacher and students

The interaction between teacher and students in mathematics learning that integrates the history of mathematics is categorized into positive or rich interaction because more than or equal to 50% interaction between teacher and students in category of good or excellent. As for some of the details of the activities that show this aspect are as follow:

<table>
<thead>
<tr>
<th>Students’ Answer Category</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>SDA</td>
<td>1</td>
</tr>
<tr>
<td>DA</td>
<td>2</td>
</tr>
<tr>
<td>A</td>
<td>3</td>
</tr>
<tr>
<td>SA</td>
<td>4</td>
</tr>
</tbody>
</table>

### Table 3.4 Likert Scale of Students’ Answer Category

<table>
<thead>
<tr>
<th>Score</th>
<th>Favourable (%)</th>
<th>Unfavourable (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Table 3.5 Category of Students’ Response Score

<table>
<thead>
<tr>
<th>Percentage SRS</th>
<th>Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>≥75</td>
<td>Excellent</td>
</tr>
<tr>
<td>50 ≤ Percentage SRS &lt; 75</td>
<td>Good</td>
</tr>
<tr>
<td>25 ≤ Percentage SRS &lt; 50</td>
<td>Fair</td>
</tr>
<tr>
<td>≤25</td>
<td>Poor</td>
</tr>
</tbody>
</table>

### Table 3.6 The Observation Results of the Interaction between Teachers and Students

<table>
<thead>
<tr>
<th>No.</th>
<th>Teachers’ Activity</th>
<th>Score</th>
<th>Students’ Activity</th>
<th>Score</th>
<th>FS</th>
<th>Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>The teacher was giving good and clear motivation to students. This motivation was directed students to opening the learning by praying together.</td>
<td></td>
<td>Students were opening the learning by praying as teachers’ expected</td>
<td>4</td>
<td>7</td>
<td>Good</td>
</tr>
<tr>
<td>2</td>
<td>The teacher has been very good in telling a story about Zu Chungzhi. Because the teacher told the Zu Chungzhi story detail and clearly.</td>
<td>4</td>
<td>The students give a very good response to the motivation given by the teacher. This was shown by students interested and motivated into learning</td>
<td>4</td>
<td>8</td>
<td>Excellent</td>
</tr>
<tr>
<td>3</td>
<td>The teacher has been good in telling the students about the close relationship between the circle material and the daily life. Because teacher tells it detail and clearly. The teacher tells it as the introduction and the end of the lesson.</td>
<td>6</td>
<td>The students do not respond well to the instruction. It was shown by some students were confused about what the teacher meant.</td>
<td>2</td>
<td>5</td>
<td>Fair</td>
</tr>
<tr>
<td>4</td>
<td>The teacher has been good reminded students about the elements of a circle. It was shown when initially teacher gave some questions to stimulate students considering elements of a circle. But the students have yet to give a response. So to address the gaps in learning, teachers gave little explanation for stimulating their prior knowledge.</td>
<td>4</td>
<td>Students respond well to such instruction. Students can remember and mention the elements of a circle</td>
<td>3</td>
<td>7</td>
<td>Good</td>
</tr>
<tr>
<td>5</td>
<td>The teacher explained the definition of central angle and peripheral angle clearly and well.</td>
<td>4</td>
<td>Students respond well to instruction teachers. This is shown by the majority of students were listen and understand to the teacher’s explanation which is evidenced by question and answer between teachers and students.</td>
<td>3</td>
<td>6</td>
<td>Good</td>
</tr>
<tr>
<td>6</td>
<td>The teacher has been good and clearly explain the graph of learning through teaching slide. In students can focus observe, listen to and understand the learning objectives.</td>
<td>4</td>
<td>Students have been giving a good response. Students observe, listen to and understand the teacher’s learning objectives are delivered</td>
<td>4</td>
<td>7</td>
<td>Good</td>
</tr>
<tr>
<td>7</td>
<td>The teacher divides the students into heterogeneous groups with either. Because the teacher uses counting techniques to divide the students. Such that group was formed in a heterogeneous group.</td>
<td>4</td>
<td>The students respond very well. It was shown by the enthusiastic students gathered with his group.</td>
<td>4</td>
<td>7</td>
<td>Good</td>
</tr>
<tr>
<td>8</td>
<td>The teacher distributed the group worksheet clearly and well. The teacher asked the representatives</td>
<td>5</td>
<td>Students are less well in responding to this instruction. This is shown when representatives of the group took worksheet</td>
<td>2</td>
<td>5</td>
<td>Fair</td>
</tr>
</tbody>
</table>
INTEGRATING THE HISTORY OF MATHEMATICS...
3. Between the class situation and its environment

The interaction the class situation and its environment is categorized into positive or rich interaction because more than or equal 50% interaction between the class situation and its environment in category of good or excellent. As for some of the activities that show this aspect are as follow:

Table 4.8 The Observation Results Of The Interaction Between Class and Its Environment

<table>
<thead>
<tr>
<th>No</th>
<th>Class Situation</th>
<th>Score</th>
<th>Environment</th>
<th>Score</th>
<th>TS</th>
<th>Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>The situation in the class is under control and fun. Students look enthusiastic and can focus on the presentation delivered by teachers through the PPT.</td>
<td>3</td>
<td>5</td>
<td>4</td>
<td>7</td>
<td>Good</td>
</tr>
<tr>
<td>2</td>
<td>Classroom situation well conditioned. This is shown by the competitive atmosphere among groups and the enthusiasm of the students in following the stages of demonstration.</td>
<td>3</td>
<td>5</td>
<td>4</td>
<td>7</td>
<td>Good</td>
</tr>
</tbody>
</table>

4. Students’ Learning Achievement

In this research, the researcher using test to assess students’ learning achievement. The test was done at the last meeting of the class. The maximum score of the test is 100. A student is said pass if his/her test score is at least 75. Class mastery is achieved if 75% or three-fourth of the number of students in the class has passed the minimum completeness criteria in MTsN II Kediri.

Table 4.9 Students’ Learning Achievement

<table>
<thead>
<tr>
<th>Explanation</th>
<th>Number of Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total of Students</td>
<td>34</td>
</tr>
<tr>
<td>Students who achieve the individual mastery</td>
<td>27</td>
</tr>
<tr>
<td>Percentage of class mastery</td>
<td>79.41%</td>
</tr>
<tr>
<td>Class mastery</td>
<td>The class mastery is achieved</td>
</tr>
</tbody>
</table>

Based on table 4.7, there are 27 out of 34 students in the class get score at least 75 as minimum completeness criteria. It means 27 students achieve the individual mastery. Such that class mastery is also achieved since 79.41% of students in the class have passed the minimum completeness criteria of mathematics in the school.

5. Students’ Response Towards Learning

Students’ response is students’ response on the circle learning using discovery learning model by integrating the learning with the history of mathematics. Students’ questionnaires response was filled by students on first meeting after they did learning.

Table 4.10 Data of students’ view toward teaching and learning circle using discovery learning that integrates the history of mathematics

<table>
<thead>
<tr>
<th>No</th>
<th>Statement</th>
<th>Frequency of Alternative Response A</th>
<th>TS</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>I feel happy with the instruction that integrates the history of mathematics.</td>
<td>13</td>
<td>10</td>
<td>20</td>
</tr>
<tr>
<td>2</td>
<td>The instruction that integrates the history of mathematics increases my motivation to learn mathematics.</td>
<td>14</td>
<td>17</td>
<td>3</td>
</tr>
<tr>
<td>3</td>
<td>Finding the concept and formula in a mathematical topic is done by my own makes me understand how the concept and formula are developed.</td>
<td>19</td>
<td>14</td>
<td>1</td>
</tr>
<tr>
<td>4</td>
<td>The instruction this time is presented systematically, making it easy for me to understand the material delivered.</td>
<td>6</td>
<td>24</td>
<td>4</td>
</tr>
<tr>
<td>5</td>
<td>In this instruction, friendliness, enthusiastic, and happy attitude shown by the discoverer (an expert in mathematics).</td>
<td>12</td>
<td>21</td>
<td>1</td>
</tr>
<tr>
<td>6</td>
<td>With instruction that integrates the history of mathematics, I discovered the realistic application of a concept in the mathematical learning.</td>
<td>9</td>
<td>20</td>
<td>5</td>
</tr>
<tr>
<td>7</td>
<td>Setting questions becomes easy and fun because I understand how the concept and formula are developed.</td>
<td>15</td>
<td>15</td>
<td>3</td>
</tr>
<tr>
<td>8</td>
<td>After being involved in the mathematical instruction that integrates the history of mathematics, I am more curious about this material, especially with regard to the history.</td>
<td>7</td>
<td>20</td>
<td>7</td>
</tr>
</tbody>
</table>
According to table 4.7, the number of statements getting good or very good categories is 100%. This percentage is greater than or equal 50%, then students’ response toward their learning on the topic of circle using discovery learning model that integrates the history of mathematics is positive.

Discussion

1. The integrating of history of mathematics in discovery learning can be said an effective learning, specially in circle topic. Because the interaction between teacher and students, between and amongst students, between class situation and its environment are positive or rich interaction. Its also following by students’ achievement in learning and positive response from students towards their learning.

2. Some of students still do not like mathematics while they have been done learning mathematics using history of mathematics. This phenomenon is contrast with Fauvel (1991) theory.

CONCLUSIONS AND SUGGESTIONS

Conclusions

The mathematics learning that integrates the history of mathematics, specially in circle learning is effective. Because the interaction between teacher and students, between and amongst students, between class situation and its environment are positive or rich interaction. Its also following by students’ achievement in learning and positive response from students towards their learning.

Suggestions

1. Mathematics teachers are recommended to teach circle topic specially the relationship between central and inscribed angles with integrate the history of mathematics to increase students’ mathematics understanding.

2. Researchers who will conduct similar research are suggested to reduce weaknesses of this research.

REFERENCES


Castronova, Joyce A. Discovery Learning for the 21st Century? What is it and how does it compare to traditional learning in effectiveness in the 21st Century? (http://teach.valdosta.edu/are/litreviews/vol1no1/castronova_litr.pdf accessed on 22 December 2016 at 19:00)


Miles, MB dan AM Huberman. Qualitative Data Analysis: A Sourcebook of New Methods. SAGE. Beverly Hills.

Moleong, J Lexy, Prof. Dr. 2009. Metode Penelitian Kualitatif. Bandung : PT. Remaja Rosdakaya


Siu, Mang-Keung. “No, I don’t use history of mathematics in my class. Why?”. Hong Kong: University of Hong Kong.


