

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

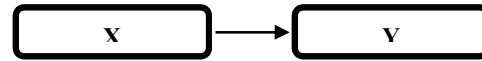
Definition of Terms

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 :



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.

Data Collection Method

1. Test

The test method will be used to measure the students' achievement after integrating the history of mathematics into discovery learning topic circle. The students' achievement will indicate by achievement on KKM (minimum completeness criteria).

2. Observation

The observation method will be used to observe the learning process then know the effectiveness of learning. This observation will be done by two observer. Observation will focus on observing the learning process which does by teacher and students.

3. Questionnaire

This questionnaire conducts to find out students' view toward their learning on the topic of circle. This method is away to collecting data using favorable questionnaire.

Data Analysis

Based on the definition of effectiveness of mathematics learning, there are five types that will be used in this research, as follows:

1. Interaction between teacher and students

Any activity that shows the presence of interaction between teacher and students are categorized in four types with score 1-4. Then the total score of teacher and students activity will categorized into some category. The category of the interaction between teacher and student are described in the following table:

Table 3.1 Category of Interaction Between Teacher and Students

Category	Total score of teacher and students activity
Poor	2-3
Fair	4-5
Good	6-7
Excellent	8

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 teacher and 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 teacher and students is said to be negative or poor interaction.

2. Interaction between and amongst students

Any activity that shows the presence of interaction between and amongst students are categorized in four types with score 1-4. Then total score of activity between and amongst students activity will categorized into some category. The category of the interaction between and amongst students are described in the following table:

Table 3.2 Category of Interaction Between and Amongst Students

Category	Total score of activity between and amongst students
Poor	2-3
Fair	4-5
Good	6-7
Excellent	8

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 categorized into some category. The category of the interaction between class and its environment are described in the following table:

Table 3.3 Category of Interaction Between Class and its Environment

Category	Total score of class situation and its environment
Poor	2-3
Fair	4-5
Good	6-7
Excellent	8

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 class situation and its environment 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 ≥ 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).

Table 3.4 Likert Scale of Students' Answer Category

Students' Answer Category	Score	
	Favourable (+)	Unfavourable (-)
SDA	1	4
DA	2	3
A	3	2
SA	4	1

Note:

SDA : strongly disagree

DA : disagree

A : agree

SA : strongly agree

b. Counting the number of students who chose each answer category of each item statement there.

1) Determine respondents who chose the answer with the score of the answer choices.

2) Determine the total score student responses each item statement.

$$\text{SRS Percentage} = \frac{\text{ESRS}}{\text{SRS Maximum}} \times 100\%$$

3) Determine percentage score of student responses to the statement of each item using a formula adapted from Sudjana (2011). The formula used is as follows.

Note:

SRS Percentage = percentage score of students' response on each item statement

ΣSRS = total score of students' response on each item statement

SRS maximum = $n \times$ best choice score

4) Interpret percentage score of students' responses to the statement of each item using

Table 3.5 Category of Students' Response Score

Percentage SRS	Category
$0\% \leq \text{SRS} < 25$	Poor
$25\% \leq \text{SRS} < 50$	Fair
$50\% \leq \text{SRS} < 75$	Good
$75\% \leq \text{SRS} \leq 100$	Very Good

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

Results

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 4.6 The Observation Results of the Interaction between Teachers and Students

No.	Teachers' Activity	Score	Students' Activity	Score	TS	Category
1	The teacher was giving good and clear motivation to students. This motivation was direct students to opening the learning by praying together.	3	Students were opening the learning by praying as teachers' expected	4	7	Good
2	The teacher has been very good in telling a story about Zu Chungzhi. Because the teacher told the Zu Chungzhi story detail and clearly.	4	The students give a very good response to the motivation given by the teacher. This was shown by students interested and motivated into learning	4	8	Excellent
3	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 in the introduction and the end of the lesson.	3	The students do not respond well the instruction. It was shown by some students were confused about what the teacher meant.	2	5	Fair
4	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.	4	Students respond well to such instruction. Students can remember and mention the elements of a circle	3	7	Good
5	The teacher explained the definition of central angle and peripheral angle clearly and well.	3	Students respond well to instruction teachers. This was 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	3	6	Good
6	The teacher has been good and clearly explain the goals of learning through learning slides. So students can focus observe, listen to and understand the learning objectives.	3	Students have been giving a good response. Students observe, listen to and understand the teacher's learning objectives are delivered.	4	7	Good
7	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.	3	The students respond very well. It was shown by the enthusiastic students gathered with his group.	4	7	Good
8	The teacher has distributed the group worksheet clearly and well. The teacher asked the representatives	3	Students are less well in responding to this instruction. This is shown when representatives of the group took worksheet	2	5	Fair

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No.	Teachers' Activity	Score	Students' Activity	Score	TS	Category
	of each groups taking group worksheet in order to save time.		then the other students buzzes uncontrollably			
9.	The teacher gave a good demonstration of the relationship of central angle and peripheral angle because the teacher has been giving examples and clear instructions during demonstrations.	3	Students give a good response on the demonstration conducted teacher indicated by the majority of students that looks understand and enthusiastic in the demonstration.	3	6	Good
10.	The teacher has been good directing students make hypotheses. The teacher directs students in making hypotheses by providing referrals, inquiries, and examples of the hypothesis.	3	The students have been giving an excellent response. Students make hypotheses and write it in their group worksheet. At this stage, the student also told the reason of their hypothesis.	4	7	Good
11.	The teacher clearly and good in instructs students to cooperate in solving group worksheet.	3	The students respond to the instruction very good. In accordance with the instructions of the teacher, the students do a discussion group.	3	6	Good
12.	Teacher has been good to guide the course of the discussion. Teacher also asked students to make conclusion from his invention	3	Students have respond well. it was shown from students writing the conclusion of his invention.	3	6	Good
13.	Teacher has been good and clearly choose a representative group to communicate the results of his discoveries.	3	Students have been very good presented the results of his discoveries. Because students are able to explain the reason for each step in finding the relationship of the center angle and peripheral angle.	4	7	Good
14.	The teacher has been very good provides clear instructions to students to pay attention and respond to the group who is the presentation.	4	The students give a very good response. It was shown when students give the question and response back about the results of another group presentation.	4	8	Excellent
15.	The teacher gives a very good feedback on students' presentations. Feedback is given in the form of questions and responses at each step of the invention of the students. This is done by the teacher to ensure students understanding at key points of study.	4	Students provide a good response to the teachers' feedback	3	7	Good
16.	The teacher gives clear and very good questions to the students in order to stimulate students in the exciting conclusion of the discovery.	4	The students give a very good response indicated from the answers provided such that students can be made the conclusion of discovery.	4	8	Excellent
17.	The teacher provided examples of reserved to students and explain the example solving clearly and well.	3	The students pay attention to the example given by the teacher.	3	6	Good
18.	The teacher gives worksheets to the students well and instructs clearly	3	Students respond well to teachers' instruction. it was shown by some students that look	3	6	Good

No.	Teachers' Activity	Score	Students' Activity	Score	TS	Category
	students to solve the worksheet.		enthusiastic in solving questions on the worksheet.			
19.	The teacher has been good in corrects the worksheet along with students because the teacher explains some of the points that are not yet understood clearly.	4	Students are less well in responding. Because it looks just a portion of students who pay attention at the teacher.	2	6	Good
20.	The teacher gives the questions clearly and well to the students in order to stimulate students in making conclusion.	3	The students respond very good indicated from the answers given by students. Then Students can make a conclusion.	4	7	Good
21.	The teacher closes the learning with either. The teacher asked the students to say <i>hamdallah</i> together	3	The students respond well. Students along with teachers say <i>hamdallah</i>	4	7	Good

2. Interaction between and amongst students

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

Tabel 4.7 The Observation Results of The Interaction Between and Amongst Students

No.	Students' Activity	Score	Other Students' Activity	Score	TS	Category
1	Student mentioned one of circle elements when teacher ask it. "radius"	4	Other students pay attention. Afterwards, Other students continued to mentioned circle elements.	4		Very Good
2	Student as a representatives of the group took worksheet orderly	3	The other student buzzes uncontrollably.	2	5	Fair
3	There is student in every group which managed the group gathering	4	The other students pay attention and gathered with respective groups immediately.	4	8	Very Good
4	Student give opinion about the hypothesis of their work.	4	The other students in the same group pay attention and give some suggestion. (discussion)	3	7	Good
5.	Student (as representative in every group) declare the hypothesis make by his group into the classroom. Student also give reason of their hypothesis.	3	The other students pay attention it and occasionally ask the detail of the hypothesis.	4	7	Good
6.	Student gives opinion in his group about their work.	4	The other students look like pay attention it and respond it well.	3	7	Good
7.	The student presented their	4	The students (member of	4	8	Excellent

No.	Students' Activity	Score	Other Students' Activity	Score	TS	Category
	group work in front of the class		other groups) paid attention and gave feedback (question). "Please, tell me more your opinion or reason in the stage....."			
8.	The student tell more about the result of group discussion clarity and brief	4	The other students give good responded and understood the feedback given by their friend.	3	7	Good
9.	Some of student actively do worksheet in front of class. Students look like holding competition to solve the problem in front of the class.	3	The other students are less well in responding. Because it looks just a portion of students who pay attention. Some of them looks not interest more because his friend can do it (in the same number of question) faster than him. Therefore he can not show up his work in front of class.	2	5	Fair

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 equals 50% interaction between the class situation and its environment in category of good or excellent. As for some of the details of the activities that show this aspect are as follow:

Table 4.8 The Observation Results of The Interaction Between Class and its Environment

No.	Class Situation	Score	Environment	Score	TS	Category
1	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.	3	The existence of the facilities that support learning-based technology. So teachers can use the PPT has been prepared in accordance with the RPP has been compiled	4	7	Good
2	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.	3	There are tools needed to support demonstration activity on the learning environment such as scissors and a ruler. The teacher's own have been prepare media circles made by paper for the demonstration activity.	4	7	Good

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

Explanation	Number of Students
Total of Students	34
Students who achieve the individual mastery	27
Percentage of class mastery	79.41%
Class mastery	The class mastery is achieved

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

No.	Statement	Frequency of Alternative Response				TS	Percentage (%)	Category
		SA	A	DA	SDA			
1	I felt happy with the instruction that integrates the history of mathematics	13	20	1	0	114	83.82	Very good
2	The instruction that integrates the history of mathematics increases my motivation to learn mathematics.	14	17	3	0	113	83.09	Very good
3	Finding the concept and formula in a mathematical topic on my own makes me understand how the concept and formula are developed.	19	14	1	0	120	88.24	Very good
4	The instruction this time is presented systematically, making it easy for me to understand the material delivered.	6	24	4	0	104	76.47	Very good
5	In this instruction, I found an exemplary attitude shown by the discoverer (an expert in mathematics).	12	21	1	0	113	83.09	Very good
6	With instruction that integrates the history of mathematics, I discovered the realistic application of a concept in the mathematical learning.	9	20	5	0	106	77.94	Very good
7	Solving questions becomes easy and fun because I understand how the concept and formula are developed.	15	15	3	1	112	82.35	Very good
8	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.	7	20	7	0	102	75	Very good

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