Development of learning innovations and MiC (mathematics in context) teaching materials to strengthen character friends of the earth

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Abstract. The purpose of this study is to find a model for developing learning innovations and MiC teaching materials to strengthen the character of Sahabat Bumi. This study uses a quasi-experimental design. This research was conducted at MAN 1 Kudus Regency, Central Java Province. The study population was students of class X MAN 1 Kudus Regency. The research sample of 2 classes, taken by cluster-random-sampling technique. Experimental class students were taught using a PBL model with a MiC nuance, while control class students were taught using an expository model. Data were collected using tests, then analyzed descriptively and inferential statistics, using t-tests (independent samples t-test). The results showed (1) learning PBL nuanced MiC in the culture of the Holy community which can improve the ability of the amtematic representation and character of earth friends and (2) various forms of MiC in community culture related to mathematical concepts, so that it can be integrated in mathematics learning at the MA level

1. Introduction

Social reality shows the increasingly damaged environment due to the behavior of a group of people who are not responsible. Forest fires in Riau Province, for example, have had a widespread impact on all walks of life. Likewise, the flood disaster that struck in most of the region, as a result of environmental damage in the upstream area (catchment area). On the other hand, there are still some communities in this country that have the wisdom to preserve the environment. Farmers in Central Java have the local wisdom of "Nyabuk gunung", while Sundanese farmers have "mountain ngais" to control erosion. The people of Kampung Naga Tasikmalaya have a tradition of "Taruban" to maintain forest conservation. The essence of this tradition can be systematically stated in the sentence: "people are prohibited from cutting down trees in the Biuk Forest; if forced to cut, he must put his left foot in the Biuk Forest, while his right foot in the river ".

Various forms / values of local wisdom that grow and develop in the community must be preserved and bequeathed to future generations. The form / value of local wisdom can effectively be integrated in innovative learning in harmony with the implementation of the 2013 Curriculum in elementary schools. With thematic learning made from teaching containing local wisdom, the habit of loving behavior around the environment of students can be realized. Continual habituation will encourage students to have the character of the earth friends. This research is focused on issues related to the development of learning innovations and MiC teaching materials to strengthen the character of earth friends.

MiC was developed by Madison-Wisconsin University, which is funded by the National Science Foundation. Medically speaking, the contents of the MiC are consistent with the Curriculum and Evaluation Standards for School Mathematics, Professional Standards for Teaching Mathematics, and Assessment Standards for Teaching Mathematics. MiC will shed some light on these connections [1].

MiC is actually closer to a realistic learning approach, because teachers can give assignments to students in accordance with the conditions of the surrounding environment to expand the world of their lives. This is in line with the view of [2], the use contextual problems offers some potentials to engage and motivate students in learning mathematics but it also presents some challenges for students in classrooms. This context-connected approach to mathematics education emerged from studies of mathematics in out-of-school [3]. This phenomena namely "Mathematics is human activity". Mathematics must be connected with reality, be close to students and relevant to people's lives in order to have human values. Mathematical material must be transmitted as human activity. Education should provide students the opportunity to reinvent (discover / create) mathematics through practice (doing it). Thus in mathematics education, mathematics should not be a closed system but as an activity in the process of mathematics. According to [4-6], students are more motivated by authentic questions than by authentic contexts.

The use of real problems (context problems) is very significant in MiC. Real problems are intended to support the reinvention process that allows students to work on real problems related to mathematics using formal mathematics. With MiC students are expected to be able to solve mathematical problems they face. Learning mathematics is a problem solving process. Students construct their knowledge through asking questions, and communicating their ideas with other students [7]. Based on [8], students explained their ideas, asked questions with other students, and compared ideas and solutions to problems given by the teacher. On other hand [9-10] argues, teaching reasoning skills can help develop students' mathematical abilities

In solving real problems, students are expected to step in the direction of horizontal and vertical mathematization. In horizontal mathematical, students start from contextual questions, try to decipher with language and symbols that are made themselves, then solve the problem. In this process, each student can use their own methods that may be different from other students. In vertical mathematical, it starts with contextual questions, but in the long run can arrange certain procedures that can be used to solve similar problems directly, without the help of context. According to[11-13] concluded that the context in learning mathematics is very important. learning approaches that connect mathematical material taught with local culture are known as ethnomatematics.

In MiC, mathematics must be connected with reality, be close to students and relevant to people's lives in order to have human values. In other words, MiC is based on local culture. The mathematics teacher must implement the principle of cultural suitability; they must have knowledge and respect for the various cultural traditions and languages of the students in their class. The character of the friend of the earth is the attitude and actions that always try to prevent damage to the earth and the surrounding natural environment, and develop efforts to repair the damage to nature that has already occurred.

2. Research Methods

2.1. Research design

This study uses a quasi-experimental design. This research was conducted at MAN 1 Kudus Regency, Central Java Province. The study population was students of class X MAN 1 Kudus Regency. The research sample of 2 classes, taken by cluster-random-sampling technique. Experimental class students were taught using a PBL model with a MiC nuance, while control class students were taught using an expository model.

2.2. Data Collection and Analysis Techniques

Data collection in this study was carried out using tests. The instrument for testing the ability of mathematical representation is in the form of a description of the problem, by taking the context of the Kudus Tower and the Kretek Museum. The study was conducted on BC: 4.9. Resolve problems related to sine and cosine rules. Learning Objectives: Students can solve problems related to cosine rules. Beside test, data collection uses observation, documentation, and literature review. Data were analyzed descriptively qualitatively.

The instrument was tested before being used. The collected data were analyzed descriptively and inferential statistics, using the t-test (independent samples t-test). Previous data were tested for normality and homogeneity.

3. Result and Discussion

The results of the mathematical representation abilities of the experimental and control groups are presented in Table 1.

Table 1. Mathematical Representation Ability

No	Experiment Group	Score	Control Group	Score
1	E-1	80	K-1	70
2	E-2	73	K-2	75
3	E-3	86	K-3	86
4	E-4	75	K-4	75
5	E-5	89	K-5	89
6	E-6	82	K-6	82
7	E-7	77	K-7	77
8	E-8	84	K-8	82
9	E-9	77	K-9	77
10	E-10	70	K-10	70
11	E-11	73	K-11	73
12	E-12	80	K-12	80
13	E-13	80	K-13	80
14	E-14	95	K-14	77
15	E-15	95	K-15	80
16	E-16	91	K-16	80
17	E-17	86	K-17	86
18	E-18	84	K-18	73
19	E-19	70	K-19	70
20	E-20	73	K-20	73
21	E-21	68	K-21	68
22	E-22	98	K-22	77
23	E-23	82	K-23	82
24	E-24	82	K-24	80
25	E-25	95	K-25	70
26	E-26	77	K-26	77
27	E-27	75	K-27	75
28	E-28	75	K-28	75
29	E-29	95	K-29	75
30	E-30	89	K-30	86
31	E-31	93	K-31	77
32	E-32	95	K-32	68
33	E-33	93	K-33	84
34	E-34	86	K-34	86
35	E-35	98	K-35	73
36	E-36	86	K-36	77

Data Table 1 is processed using SPSS, both descriptively (Table 2) and inferential (Table 3).

Table 2. Descriptive Analysis

	Group	N	Mean	Std. Deviation	Std. Error Mean
Sample	Eksperimen	36	83.5278	8.82686	1.47114
	Kontrol	36	77.3611	5.54026	.92338

Table 3. Inferential Analysis

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Sample	Equal variances assumed	10.706	.002	3.550	70	.001	6.16667	1.73692	2.70249	9.63084
	Equal variances not assumed			3.550	58.872	.001	6.16667	1.73692	2.69094	9.64239

From Table 2 it can be stated that the average mathematical representation ability of the experimental group students reached 83.53 while the control group students amounted to 77.36. In absolute terms there is a gap of 6.17. Relatively this average difference is very significant, and according to the analysis results (Table 3), in the equal variance assumed line, the sig (2-tailed) value of 0.001 is less than 5%. Thus the null hypothesis is rejected, meaning that the average of the two groups is significantly different. The average mathematical representation ability of the experimental group is greater than the control group. In other words, the mathematical representation ability of students who are taught using teaching materials that are nuanced MiC is better than students who are taught conventionally.

The mathematical representation ability of experimental class students cannot be separated from the learning process that is taking place. In the experimental class, the teacher presents trigonometry material by linking the context that is around students, so students more easily understand. Students also find it easier to associate mathematical concepts learned with everyday life. The following presents the problems students must solve (Figure 1).

Problem

Logung Lake in Kudus will be measured in width. For this purpose, several points were set in the area around the dam, including point C and point D as a reference point to measure the dam.

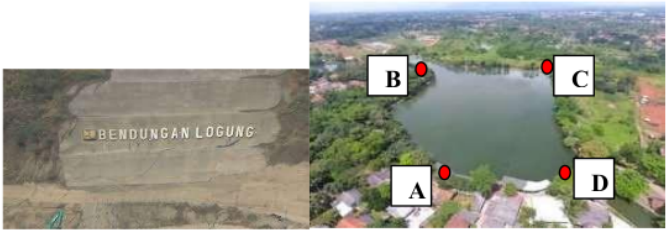

Figure 1. Logung Lake

Distance of point B to the edge of the lake (say point A) 8.4 m. The other lake point is named point C. At reference point B and one of the C edge points of the lake forms an angle of 74 ° and 53 °, while at reference point D and edge A form an angle Estimate the width of the lake if measured from the reference point B and D! (sin 74 = 0.96; sin 52 = 0.79; sin 64 = 0.89; sin 65 = 0.91; sin 87 = 0.99)

Lake is a form of landscape, besides rivers and seas. Geohydrologically, lakes accommodate water flow (inflow) from upstream areas to then flow through small rivers (outflows) to downstream. Heavy rainfall that occurs in the River Basin (DAS) is accommodated in lakes, so that the lake has a function as well as flood control. Surface run-off collected in a lake can minimize erosion. Falling rainwater can infiltrate and percolate and become a source of shallow ground water and deep ground water. When the dry season arrives, the lake functions as a water provider, which can be used to irrigate rice fields, so that the harvest of rice and crops can be maintained.

Lake as a learning context has links with many subjects. Physically, lakes have parameters related to water quality, water depth, water volume, as well as other abiotic and biotic characteristics. People who live around the lake have their own norms, which can be used as a context for social science subjects.

In mathematics, lakes can be used as contexts for learning trigonometry, specifically the rules of sines and cosines. This material was developed from problems that occur in a triangle, which has 3 sides and 3 angles. Its application is very diverse and broad and has links with everyday life. From Figure 5.4, cases can be solved using the cosine rule, which is:

$$a^2 = b^2 + c^2 - 2bc\cos A$$

$$b^2 = a^2 + c^2 - 2ac\cos B$$

$$c^2 = a^2 + b^2 - 2ab\cos C$$

assisted with sine rules

$$\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$$

Notes:
A, B, C is the angle of triangle ABC
a, b, c are sides of triangle ABC

Students can use the Logung Reservoir as a MiC object to estimate reservoir width using trigonometric formulas. By applying trigonometric formulas in problem based learning with Polya's steps making mathematics learning very interesting and challenging. The students increasingly understand that mathematics has a relationship with everyday life. They will gradually become Friends of the Earth.

Earth with all its contents is a giant laboratory, which can be used as a source of learning mathematics and other sciences. Mathematical learning outside the classroom (outdoor mathematics) will accelerate the Ministry of Education and Culture policies related to Student Learners and will accelerate Independent Students. Teachers and students will be more friendly with nature, becoming Friends of the Earth. [14-15] stressed, local culture can be a fun learning material.

4. Conclusion

Based on the description presented in the results and discussion section, the following conclusions can be drawn Logung Reservoir is a form of MiC in the culture of the Holy community that can be used to improve the character of the earth's friends and 2. Logung Reservoir as a form of MiC in community culture is related to mathematical concepts (trigonometry), so that it can be integrated in mathematics learning at the MA level

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PAGE 1

PAGE 2

PAGE 3

PAGE 4

PAGE 5

PAGE 6

PAGE 7