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Ethnomathematics CMP learning-teaching model for improving capabilities in problem solving

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Abstract. This research was intended to analyze the effectiveness of ethnomathematic CMP learning-teaching model in improving students' abilities in problem solving. The population for this research consisted of grade VII students of 2017-2018 period of SMP N 12 Semarang. The samples for this research were taken by means of cluster random sampling. By this technique we could get two different classes of samples; (1) experimental class taught using ethnomathematic CMP learning-teaching model and (2) control class taught using PBL (Learning-Teaching Model based purely only on classroom mathematical problems). The data for this research were collected using the ordinary tests and questionnaires. The data were then analyzed using t-tests; *one-sample* tests (for independent or individual samples) and *paired-sample* tests. From the analyses, we could draw the following conclusions: (1) the average capabilities of students taught with ethnomathematic CMP learning-teaching model were higher than those taught using PBL, (2) there were significant increases in the appreciation and love toward the local cultures in students taught with ethnomatic CMP.

1. Introduction

Problem solving constitutes one of many skills which should be mastered by students in learning mathematics. The other skills which should also be mastered are reasoning & proving, connecting, communicating and representing. NCTM in [1-2] pointed out that problem solving constitutes the heart of mathematics, that in mathematical learning activities the capabilities in problem solving should be continuously improved by earnestly trying to find solutions for daily-life problems

A problem constitutes a situation when a student is faced with an assignment and there is no complete algorithm for finding the solution. The problems given in mathematical learning-teaching processes should be oriented to daily-life situations in order that the learners could more easily understand the connections between mathematical concepts and the phenemona within the nearby surroundings. This is what we call ethnomatematics, which is the mathematical product of cultures [3-5].

Capabilities in problem solving could be exercised using Polya [6-7] procedures, namely: (1) *understanding the problems*, (2) *devising a solution plan*, (3) *carrying out the plan* and (4) *looking back (self-evaluations)*. Polya procedures could be more effective if they are presented by using CMP (*Connected Mathematical Project*) Model. By means of this, the problem of this research was focused on the effectiveness of the implemented ethnomathematic CMP

Gagne [1] pointed out that problem solving constitutes a thinking step of the highest level among eight learning processes. These eight learning processes are learning the existing signs, learning to respond to the incoming stimuli, learning the series, learning in verbal associations, learning in

discriminating, learning the existing concepts, learning the given rules and learning to solve the problems.

CMP constitutes a learning-teaching model which provides the learners with the broadest opportunities to build their own mathematical skills and understanding [8]. Through the activities covered in the CMP learning-teaching Model (1. problem launching, 2. *exploring*, and 3. *summarizing*), the students could be stimulated to improve their capabilities in solving the given problems.

Researches that focused on CMP had been conducted by [8-10]. Research [8] showed that by using CMP based on presentation media, the learners' capabilities in *mathematical connections* were higher than the same capabilities of other learners taught with conventional learning-teaching model. In addition, the learners taught with CMP based on presentation media became so positively activated.

Research [9] showed that literate capabilities in mathematics in classes taught with CMP model were higher than those taught using only conventional learning-teaching model. In the CMP classes, there was also improvement in meta-cognition. Research [10] found that by using CMP learning-teaching model, reasoning and activity powers of the students could be developed

2. Methods

The population for this research consisted of grade VII students of SMP N 12 Semarang, for 2017-2018 period. The samples were taken using the technique of cluster random sampling. By this technique, two different classes of samples could be obtained. They were (1) experimental class taught using ethnomatematic CMP learning-teaching model and (2) control class taught using PBL.

In this research, the instruments used were documentation, questionnaires on local culture appreciation and tests on capabilities in solving mathematical problems. Before being used, these instruments were confirmed for their validities and put into trials by the experts (validators)

The documentations were used for documenting the whole activities of the research. This instrument was used for collecting the needed data. The data consisted the name of the students who would become the samples for this research, photographs and life videos taken during the learning-teaching activities, sillabus and RPP. The questionnaires were composed based on five indicators; spiritual lives, literature & linguistic, art, historic and scientific skills of the samples. For collecting the needed data, the questionnaires were given both before and after the CMP learning-teaching model were exercised.

The points of problems for the tests on the capabilities in problem solving were written in the following steps: (1) strictly defining the test materials which focused on geometry, (2) determining the problems, which were wording problems, (3) determining the allocated time periods, (4) determining the numbers of problems, (5) composing the problems for the trial tests based on the indicators on the students' capabilities, (6) composing the problems for the real tests, (7) providing answer keys and bases for scoring, (8) determing the validities of the tests' constructs and contents; in this context, related experts were asked for determining the suitable connectiveness between research goals and the existing indicators on the students' capabilities in problem solving; mathematical lecturers of UNNES stated that the problems composed for the real tests (point 6 above) were valid, (9) conducting try outs on the capabilities in problem solving, (10) analysing and then re-processing the validities, reliabilities, levels of difficulties and specificity powers of each problem writen for the try outs (these variables obtained from the results of the try outs); the try outs showed that our instruments were valid and reliable, (11) writing the problems, for the real tests, that fulfilled the criteria determined from the analyses. The data were then analyzed using one-sample (individual sample) and paired-sample t-tests

3. Results and Discussion

Qualitatively, this research was conducted for analyzing the effectiveness of the ethnomathematic CMP learning-teaching model. Initial data collected from the pre-tests on the skills in problem solving of the two classes of samples showed that the needed data came from homogen population with normal distribution.

The CMP learning-teaching model was exercised four times and observed by two observers. The results were prsented in Table 1

Table 1. Results from the exercised CMP Model

Observers	Average Scores			
	Session 1	Session 2	Session 3	Session 4
O_1	3,23	3,30	3,54	3,85
O_2	3,38	3,46	3,62	3,77
Means		3,52		

Based on Table 1, it can be stated that the average score was very good (3.52). The implementation of the CMP model effected high achievements in the participating students. The averages capabilities in problem solving of the experimental and the control groups were, respectively, 83.50 and 75.80. Based on the *one-sample* (individual samples) t-tests, it can be concluded that, by exercising CMP model, the average capability of the students in solving mathematical problems is higher than that of the other students provided only with PBL learning-teaching model.

Further analyses on the results from the questionnaires showed that the students' appreciations on the local cultures before and after the implementation of the ethnomathematic CMP model scored 80.28 and 85.75, respectively,

Effectiveness of a learning-teaching model becomes an indicator on the successfulness of the learning-teaching activities. The high average scores on problem solving after the implementation of ethnomathematic CMP model constituted a supporting fact that the CMP learning-teaching model was very effective.

The ethnomathematic CMP constitutes a learning-teaching model which supports the mathematical problem solving based on direct and real objects. In this context, the participating students were given assignments which have close relations to local tourim objects. This suites conveniently with Gagne theory stating the harmonious integration between direct objects (facts, skills, concepts and rules intergrated into one activity), on the one hand, and indirect objects (capabilities in investigating and solving the problems), on the other hand.

In the first session, the students, in group, were asked to work out an assignment. The assigment display a relatively well known restaurant building located in the Old City Area of Semarang. The problem for this assignment were worded as follow:

Case 1.

All of you must have been familiar with the Old City Area of Semarang. In this Area, there was an old restaurant. It is located across Blendhuk Church. The doors and windows of the restaurant are of ancient fashion indicating the specificity of many other buildings built in colonial era in this country. Various accessories within the restaurant also support the impression of classical nature of the building. The front door of the restaurant was decorated by small cut of glasses in the forms of perfect squares. The lenght of each of these squared glasses is about 40 cm, Now, calculate the total circumference of the glasses decorating the door. In group, the students worked out the problem in Case 1 (as well as in Case 2 below) using 4 steps of Polya. In the second session, the problem was worded as follow:

Case 2:

Diponegoro Park was built by Thomas Karsten. It is located in the intersection between Jalan Sultan Agung, Jalan S. Parman, Jalan Kawi, Jalan Telomoyo, dan Jalan Argopuro. The location of the Park is higher than the surrounding roads. The Park is in the form of a 50 x 15 meters rectangle. In the western part of the Park there was a big Kesambi tree. Within the Park, in the southern part, there is a semi-circle plane yard that can be used for sitting relaxly. Dino wants to run around along the sides of the Park for 5 circlings. For Dino, each circling takes about 55 seconds. If Dino starts to run at 07,15, what time does Dino finish his 5-circling run? How long is the total meters covered by Dino for his 5-circling run?

For the third and fourth sessions, we presented Case 3 and Case 4, in which the problems were worked out by the students also as groups. This method produced an average high score for the capability in problem solving. The students were very active in digging out the information necessary for deepening their understanding on the problem. The information could be constructed into a solid understanding. This suited very well with Piaget theory. The students were also highly enthusiastic in every syntax of the CMP.

The ethnomathematic CMP learning-teaching model requires the students to learn to work out every assignment accorded to the local cultures. This was in accord with Brunner opinion that during the learning-teaching activities, the students should be provided with problems having close relationships with the local cultures. Learning materials with an ethnomathematic character should be prepared as a mean for guiding the students in understanding the materials. Below is another example of problem which was related to the local culture in Semarang.

Example 1

Masjid Agung of Central Java is located in Semarang. Not only as a place for praying, this Mosque is also prepared as a religious tourism object. In the front yard of the Mosque, there is a replica of a giant **beduk** designed by the students of Alfalah Moslem School of Mangunsari, Jatilawang, Banyumas. The roof of the Mosque is in the form of a trapezoid with the paralel lenghts of 5 and 3 meters. The height of this trapezoidal roof is 1.75 meters. If each of the roof tiles is 33 cm x 25 cm in size (and it is assumed that the tiles are arranged in such a way that they covered the roof perfectly), how many tiles are there covering the roof?

Example 2

The Buddhagaya Vihara is located in Watugong, Semarang. After the fall of Majapahit Kingdom, this is the first Vihara spreading Budha Religion in Java Island. Avalokitesvara Pagoda constitutes the highest pagoda in the Vihara. The first part of this octagonal Pagoda has its side of 15 meters in length. In the central part of this space, there is a statue of Dewi Kwan Im, 5.1 meter in height.

Figure 1. Masjid Agung Jateng

Figure 2. The Buddhagaya Vihara

Masjid Agung of Central Java and Buddhagaya Vihara as shown in Figure 1 and Figure 2, constitute 2 buildings full with ethnomathematic characters. Mathematical learning-teaching activities which introduce the two buildings (as well as other similar buildings) would encourage the students to have higher apreciation on cultural buildings. This, in turn, would lead the students to love more deeply the existing local cultures. The deeper feeling of love of students toward the local cultures could be seen in the intensities of attraction, loyality, cares and appreciation of the students toward the existing local cultures.

4. Conclusion

From the research results and discussions above, we could forward the following conclusions: the average capabilities of students taught with ethnomatematic CMP learning-teaching model were higher than those taught using PBL. There were significant increases in the appreciation and feeling of love toward the local cultures in students taught with ethnomatic CMP

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