Improving Mathematics Learning Through Contextual Teaching and Learning Models Using the Math City Map App

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Abstract. This study aims to improve student learning results at SMP Negeri 3 Pule through the Contextual Teaching and Learning model using the Math City Map app. This research is Classroom Action Research. The data collected are the results of student tests and observations of student activities. Contextual Teaching and Learning models using Math City Map apps can improve student learning results of 9th grade SMP Negeri 3 Pule in the second semester of the academic year 2021/2022. The test results show that the class completeness is above 13%, with an average grade of 45 in the first cycle and 80% with an average grade of 75 in the second cycle.

Keywords: learning result · contextual teaching and learning model · mathcitymap app

1 Introduction

Each individual must master the ability to solve problems. This ability needs to be taught to and trained with students. Mathematics learning in schools provides students with skills to be able to solve daily problems. Students apply the knowledge or theory that has been obtained in a real situation. For this reason, learning mathematics should include problem-solving as a major part of all aspects of its activities. Problem-solving activities are an effective way to explore new mathematical ideas [1].

However, learning mathematics in schools is still focused on theory, formulas, and routine questions [2–5], including at SMPN 3 Pule. When students are given problems, they are confused about applying the formula that has been obtained. Eventhough all the information needed to solve the problem has been provided, the students are still unable to solve the problem, leading to low achievement in mathematics classroom. One of the possible reasons are students are not used to solve contextual problems and to look for data or information needed to solve the problem.

Learning is a change in an individual's behaviour due to their experience and practice [6, 7] and greatly depends on the environment where it happens [8]. Learning results are the abilities students have after certain learning experiences [9]. From the statements above it can be concluded, because the subject of learning is the student, the teacher

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must seek an environment that facilitates students to learn, as in an environment that provides activities for students to practice and gain experience.

One of the efforts to improve problem-solving skills is learning using the Contextual Teaching and Learning (CTL) models. The stages of the CTL model includes grouping, modeling, questioning, learning community, inquiry, constructivism, authentic assessment, and feflection [10]. Learning mathematics aims at students being able to understand mathematical concepts [11]. Students are able to make connections from one concept to another and are able to apply it accurately, effectively and efficiently in solving problems. CTL provides learning concepts that help teachers relate learning materials with real-world situations and encourages students to connect the knowledge they have with its application in life [12]. Through CTL, students work together to collect data, process data, and determine alternative problem-solving strategies [13], and can develop mathematical connection skills in the process [14]. Mathematical connection skills will make it easier for students to understand certain concepts because with connection skills they can look for the relevance or relationship of the concept being studied to the concept that has been studied. From these literature, it can be expected that CTL will facilitate students to gain understanding of concepts and apply them based on available data to solve problems.

As an advocate of the CTL models, researchers use the Math City Map (MCM) application as a learning media. The MCM application is a mathematics learning media in the form of web-based platform and smartphone application that utilize online maps and the surrounding environment to support the learning process [15]. The steps for using the Math City Map application consist of (1) opening the MCM app on their smartphones, then selecting Search Trail and enter the code provided by the teacher; (2) leaving the classroom to go to the location indicated by the map that appears on the application; (3) completing the assignments or problems at the location, with the help menu available on the app in cases where difficulty happens; (4) scores are generated automatically from the application according to the answers given; and (5) continuing the journey to the next task according to the instructions of the Math City Map application [15, 16] (Fig. 1).

2 Methodology

Classroom Action Research (CAR) is carried out in two cycles. Each cycle consists of four meetings. The stages of this research consist of planning, implementation, observation, and reflection [17]. The activities that researchers do at the planning stage are designing and compiling lesson plans, student worksheets, observation sheets, a test, and making a trail in MCM that contains tasks based on objects in SMP Negeri 3 Pule. The implementation stage is a learning process carried out by referring to the lesson plan. The main steps of learning activities carried out according to the CTL model consist of preliminary activities, core activities, and closure.

Observations are carried out by observing and recording the results of observations of all activities that appear during the learning process using observation sheets, that are based on predetermined criteria. The observer only needs to score on the observation sheet if the expected activities in the learning process occurred and record other things

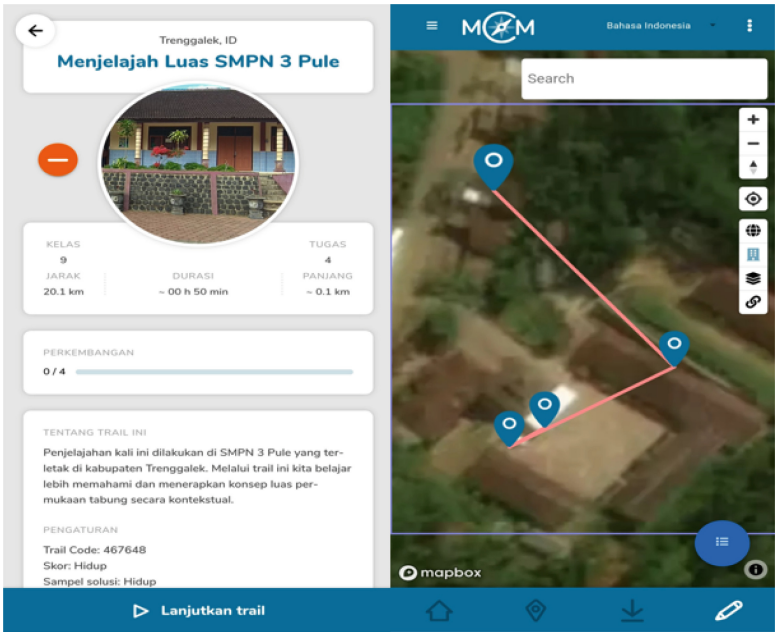

Fig. 1. Math Trail In SMPN 3 Pule

that are considered important in the space provided in the observation sheet. The reflection stage is an activity to evaluate and review the implementation of learning based on observational data and test results for improvement in learning. Reflection is done to view the whole process of implementing the actions and the results of student understanding. The steps in action reflection include: (a) recording problems that arise during direct learning actions, (b) analyzing and detailing the learning actions that have been carried out and learning activities based on the obstacles faced by the teacher, and (c) determining action repair.

The research was conducted at SMP Negeri 3 Pule. The subjects were grade 9 students of SMP Negeri 3 Pule in the second semester of the 2021/2022 academic year. There are two reasons the researchers chose the class. First, the learning result needed to be improved. Second, the meeting schedule is three times a week or more than other classes. The number of students in the class is 15 students.

The data collected are the results of student tests and the results of observations of student activities. The learning completeness criteria used in the study are based on the minimum completeness criteria that have been set by the school. The results of the end-of-the-cycle test are said to be complete if at least 80% of the number of students who take the test get a minimum score of 70.

3 Result and Discussion

The learning first cycle is divided into four meetings with the time allocation for each meeting being 40 min. The lesson is set in the topic of surface area of cylinders and cones. Trail or route for the MCM task used in the lesson entitled "Menjelajah Luas SMPN 3 Pule" (exploring the area of SMPN 3 Pule) (Fig. 2).

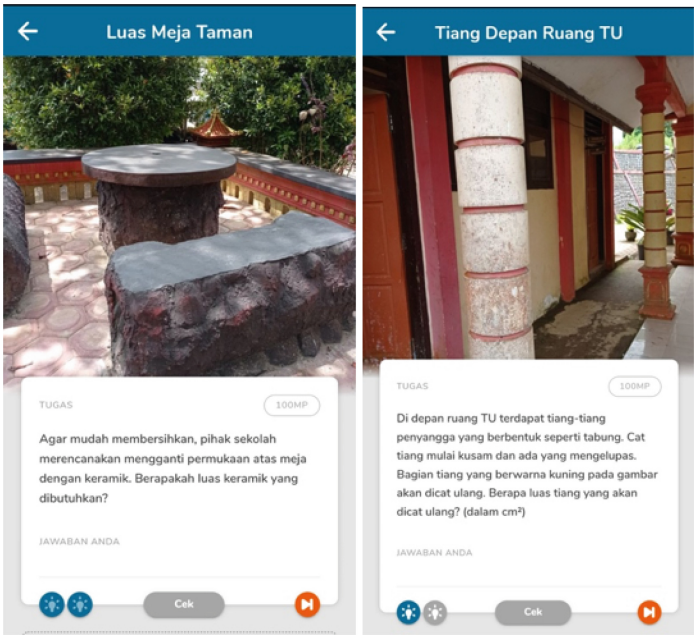

Fig. 2. *"Menjelajah Luas SMPN 3 Pule"* – exploring the area of SMPN 3 Pule - Task

The first meeting was used to facilitate students to gain an understanding of the concept of the surface area of cylinders and cones through exploration of real objects. MCM app was used in the second and third meetings. The fourth meeting is used for evaluating and reflecting on the learning from the previous meeting. The following are the learning sequence and the related CTL stages, when it applies.

3.1 First Meeting

Preliminary Activity

1. The teacher greets and asks students how they are, and checks student attendance and the readiness of the tools brought by students.
2. The teacher conveys the learning objectives and the assessment that will be carried out (Modelling).

3. The teacher conveys the CTL learning activities that will be carried out, namely students will be grouped and given real objects in the form of paint cans or biscuits tins. With the guidance of Student Worksheet I, students work together to find the elements of a cylinder and determine the surface area of a cylinder (Modelling).

Core Activities

4. Students are divided into several groups and get a worksheet and props in the form of paint cans or biscuits tins that have been prepared by the teacher (Group).
5. Students pay attention to the explanation of the topic by the teacher about the parts of the cylinder and the formula for the surface area of the cylinder (Questioning).
6. Students look at worksheet I and use the available materials. Students explore or collect data from the given props. Students fill in the data obtained on the worksheet I and complete it. (Learning Community)
7. The teacher asks students to prepare a report on the results of the discussion. Students submit a report on the results of the discussion.

Closing Activities

8. The teacher expresses appreciation of the learning activities that have been carried out by the students.
9. The teacher conveys the plan for the next meeting. Students are asked to bring a smartphone that can access the internet and has the Math City Map application installed, a rope, and a ruler or metre.
10. The teacher closes with greetings.

3.2 Second Meeting

Preliminary Activity

1. The teacher greets and asks students how they are, and checks student attendance and the readiness of the tools brought by students.
2. The teacher reminds the previous lesson by checking and reviewing the group discussion report.
3. The teacher conveys the learning activities that will be carried out. Students can complete at least two assignments on the Math City Map.

Core Activities

4. Students gather with their groups and prepare the tools to be brought. (Group)
5. The teacher asks each group to open the Math City Map application and enter the trail code given by the students. The teacher explains the activities that students will do outside the classroom (Modelling).

6. The teacher will choose a different starting point for each group to avoid crowds and then asks students to go to a predetermined location.
7. Students leave the class and go to the location indicated by the application.
8. At each location, students collect data by measuring the object that has been determined (Inquiry).
9. Students analyze the data obtained and the information available and relate it to existing concepts or formulas to complete the task (Constructivism).
10. Students discuss and do calculations to complete the task. The answers obtained are then typed into the application. When the answer is wrong, students correct or consult the teacher (Learning Community).
11. The teacher accompanies students at the location to provide guidance or provide instructions (Questioning).
12. Teachers can also provide an assessment of students' attitudes and abilities (Authentic Assessment).

Closing Activities

13. The teacher asks students to keep their notes because the activity using the Math City Map will be continued in the next meeting.
14. The teacher expresses appreciation of the learning activities that have been carried out by the students.
15. The teacher conveys the plan for the next meeting.
16. Teacher closes with greetings.

3.3 Third Meeting

The activities of the third meeting were almost the same as the second meeting.

Preliminary Activity

1. The teacher greets and asks students how they are, and checks student attendance and the readiness of the tools brought by students.
2. The teacher reminds the students of the previous lesson.
3. The teacher conveys the learning activities to be carried out to complete the remaining tasks or routes.

Core Activities

4. Students gather with their groups and prepare the tools needed (Group).
5. The teacher asks each group to open the Math City Map application and enter the trail code given by the students. The teacher explains the activities that students will do outside the classroom (Modelling).
6. Students go to a predetermined location that has not been done by the students.

7. At each location, students in groups collect data by measuring the objects that have been determined (Inquiry).
8. Students analyze the data obtained and the information is available and relate it to existing concepts or formulas to complete the task (Constructivism).
9. Students discuss and do calculations to complete the task. The answers obtained are then typed into the application. When the answer is wrong, the student corrects or changes it.
10. The teacher accompanies students at the location to provide guidance or provide instructions (Questioning).
11. Teachers can also provide an assessment of students' attitudes and abilities (Authentic Assessment)

Closing Activities

12. The teacher expresses appreciation of the learning activities that have been carried out by the students.
13. The teacher conveys the plan for the next meeting, namely doing reflection and testing.
14. The teacher closes with greetings.

3.4 Fourth Meeting

Preliminary Activity

1. The teacher greets and asks students how they are, and checks student attendance and student readiness
2. The teacher conveys the objectives and learning activities to be carried out.
3. The teacher also conveys the assessment that will be carried out.

Core Activities

4. The teacher asks group representatives to submit evaluations and reflections on the lessons that have been implemented. Other students can respond. The teacher facilitates the compilation of joint conclusions (Reflection).
5. Students prepare themselves to do the test.
6. The teacher distributes the test sheet. Students answer the test. Then students collect test answer sheets.

Closing Activities

7. The teacher expresses appreciation of the learning activities that have been carried out by the students.

Table 1. Test Result in First Cycle (n = 15)

No	Description	Result
1	Average test scores	45,33
2	Number of students who finished the test	2
3	Percentage of learning completeness	13

8. The teacher conveys the plan for the next meeting.
9. The teacher closes with greetings.

After grading the students' answers, the test results are as follows:

Table 1 shows that the average test score is 45 and the percentage of learning completeness is still 13% so it does not meet the criteria for the success of this study. The results of observations during learning and the student test results are used as material for reflection. The results of the reflection are as follows:

- Some groups did not bring the tools that were needed, namely ropes and folding rulers so it took a long time to measure.
- Students' lack of understanding regarding the parts of cylinder. Students assume the circumference of the cylinder is a blanket, when they have found the diameter they used the area of the circle or others.
- Some students were not able to read the measurement results using the folding ruler.
- Students are not used to dealing with contextual or real problems in mathematics so it is difficult and confusing where to start working.
- Student notes regarding the results of completing the Math City Map task are not neat, resulting in students lacking references in learning.

From the results of the reflection of the first cycle, the improvements needed were:

- The teacher reiterates the tools that needed to be brought at the end of the first cycle and at the meeting that will be held.
- The teacher also asks students to be creative in replacing tools that are not brought with them with other tools around them.
- The teacher needs to give instructions regarding the use of the folding meter.
- Teachers need to supervise and emphasize that students fill in the worksheets given with the data and answers obtained.

For the second cycle, the learning steps are generally the same as those in the first cycle. The difference is in the learning materials. The second cycle material is the volume of cylinder. Trail or route for the Math City Map task used in the lesson entitled "Menjelajah Volume SMPN 3 Pule" (exploring SMPN 3 Pule).

The use of the CTL model using the MCM in the second cycle has been carried out better. This can be seen by observing that in general students are better in their learning activities. Student learning results have also improved. This is evidenced by the test results at the end of the second cycle which have improved when compared to the first cycle test results (Table 2).

Table 2. Improvement of Test Results (n = 15)

No	Description	First Cycle	Second Cycle
1	Average test scores	45,33	75,00
2	Number of students who finished the test	2	12
3	Percentage of learning completeness	13	80

Learning before the research was conducted was different compared to learning in cycles I and II. Learning before research places students as passive recipients of knowledge, while the student is an active participant in the learning process, as a result of using the CTL model which makes students active while the teacher acts as a facilitator. Because the subjects in the learning process are students, the most important thing in learning is how students learn.

As mentioned earlier, the process of creating a learning environment is needed, and the teacher has an important role in creating this environment and arranging its elements so that it can change the student behavior [8]. The CTL model provides significant changes to understanding concepts from direct conventional learning [18]. Through the CTL model, situations are placed in real outdoor learning situations following the route in the MCM application. Students work together to solve problems by gathering information, obtaining new concepts, strengthening existing concepts and connecting these concepts and the information obtained to find solutions.

From the results of student tests, there was an improvement in the percentage of completeness and the average grade of the class. This shows that students improved with experience after initially struggling with the new challenges. Through the CTL model student learning outcomes can be improved [19, 20]. This is in accordance with [9], where learning results are reflecting the abilities possessed by students after receiving learning experiences. The use of the MCM application also supports the improvement of student learning outcomes by providing experience and practice in real situations outside the classroom resulting in better problem-solving skills. This statement is in accordance with the results of other studies [21, 22].

4 Conclusion

Contextual Teaching and Learning (CTL) assisted by Math City Map on students can improve student learning outcomes. The test results showed that class completeness rose from 13% with an average score of 45 in the first cycle, to 80% with an average score of 75 in the second cycle.

This research was conducted when face-to-face learning was limited due to the Covid-19 pandemic so that the research subjects were only half of the number of students in one class. Therefore the results of this study will not necessarily produce the same results if it is carried out in normal classes, especially with more than 30 students, as CTL model is more effectively applied to a research sample of no more than 30 students [23].

Further researchers are advised to be able to apply this research with a larger number of research samples. This research can also be developed by paying attention to the influence of student learning styles on learning success.

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