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Learning Circles to Accelerate 4CS

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Abstract: 4CS acceleration is not fully supported by educators. As reported by several researchers, including; Not a few teachers in the practice of learning only present the material, and provide examples to students (as a result, the process of building knowledge is less successful, and there is a tendency for students to always be guided or given instructions, especially in solving problems. The main focus of this research is learning activities and efforts to improve learning. During the learning activities, the researcher was directly involved from the beginning to the end. In this case, the researcher acts as a planner, designer, implementer, data collector, data analyzer, and research reporter. By looking at the characteristics of this research, namely research starting from practical problems in the classroom, research through self-reflection, the focus of research is learning activities and aims to improve learning, then based on Lambas' statement above, the type of research that is by this research is classroom action research. Problem-solving process to accelerate 4CS can improve student learning outcomes. The stages of accelerating 4CS which involve mathematical processes include identifying and justifying concepts, solving problems, generalizing and analyzing algorithms.

INTRODUCTION

The framework for 21st-century learning is a learning and innovation framework in developing several abilities, including critical thinking skills, communicative skills, collaboration skills, and creative thinking skills, abbreviated as 4CS. This framework is supported by several researchers, including; Student Acquisition of high-order thinking (critical thinking, communicative, and creative thinking) is now a nation goal (Thinking, 2015)(Traut-Mattausch et al., 2015)(Collaborative, 2016)(Hanks, 2018). Critical and creative thinking skills and communicative abilities are abilities that are currently needed by students to improve the quality of original thinking and intellectual thinking (Andrews, 2016).

4CS acceleration is not fully supported by educators. As reported by several researchers, including; Not a few teachers in the practice of learning only present the material, and provide examples to students (Strauss, 2016) (as a result, the process of building knowledge is less successful, and there is a tendency for students to always be guided or given instructions, especially in solving problems.

The first component of 4CS is critical thinking. Critical thinking is a mental activity to assess the truth of arguments, ask questions, and evaluate(Braun & Barnhardt, 2014)(Maynes, 2013). Thus critical thinking is an intellectual process in interpreting, evaluating observations, communicating, and arguing.

The second component of 4CS is communicative. Communicative is one of the goals to be achieved in learning, through providing the widest opportunity for students to develop and integrate communicative skills through oral and written, patterning, speaking, writing, talking, drawing, and presenting what has been learned(Andrews, 2016). Communicating both orally and written can bring students to a deep understanding of and can solve problems well (Pateşan et al., 2015).

The third component is collaborative. The collaborative is a philosophy of interaction and personal lifestyle in which individuals are responsible for their actions, including actions in learning, and respect the abilities and contributions of their peers (Collaborative, 2016). Collaborative learning is an umbrella term for several educational approaches that involve efforts to combine the intellectuals of students with students or students with teachers (GlobalSurg Collaborative, 2016b). Collaborative learning uses social interaction as a means to build knowledge (Starsurg Collaborative, 2014).

Creativity is a cognitive activity that produces a new perspective on a problem or situation (GlobalSurg Collaborative, 2016a). Creativity is a person's ability to produce compositions, products, or ideas that are new, and previously unknown to the maker (Group, 2011). This creativity can be in the form of imaginative activity or synthesis of thought the results of which are not only summaries, may include the formation of new patterns and the combination of information obtained from previous experiences, grafting of old relationships into new situations, and may include the formation of new correlations.

The four 4CS components are related to each other in compiling and making arguments. Familiarize students to identify and justify information by making logical and systematic reasons. So that the doubts that sometimes prevent a person from rising to a higher level of thinking are easily overcome.

The importance of 4CS acceleration through mathematical processes so that students are actively involved in discussion activities, reviewing information from various sources, questioning the value of truth, and proposing solutions. Become a guide for teachers in organizing and giving orders to students to communicate evidence, and supporting data, as well as an explanation of how to obtain it. Thus, it is interesting to study more deeply theoretically or empirically 4CS acceleration (critical thinking skills, communicative skills, collaborative skills, and creative skills) through mathematical processes for students.

RESEARCH METHOD

This research departs from practical problems that exist in the classroom, then is reflected (rethinking the learning process that has been carried out so far), and analyzed based on supporting theories. The main focus of this research is learning activities and efforts to improve learning. During the learning activities, the researcher was directly involved from the beginning to the end. In this case, the researcher acts as a planner, designer, implementer, data collector, data analyzer, and research reporter. By looking at the characteristics of this research, namely research starting from practical problems in the classroom, research through self-reflection, the focus of research is learning activities and aims to improve learning, then based on Lambas' statement above, the type of research that is by this research is classroom action research.

The procedure for implementing the action in this study refers to the model developed by Kemmis and McTaggart. These steps are in the form of a cycle consisting of four stages, namely planning (plan), implementation of action (action), observation (observation), and reflection (reflection). More details can be seen in the following picture

Research Instruments

The research instruments include learning outcomes tests, student activity observation sheets, interview guidelines, and instrument validation sheets. More details are described as follows.

Study result test

The test given in the form of a final test. The test kit consists of a test sheet containing description questions and scoring guidelines. The test serves to measure students' ability to build understanding on the material tangent to a circle after students carry out the problem-solving process for 4C acceleration. The things that need to be considered in the preparation of the test sheet are the suitability of the items with the aspects being measured, the items can show students' ability to build understanding on the material tangent to the circle, and the items are communicative.

Student activity observation sheet

The student activity observation sheet was made by the researcher based on the observed aspects related to student activity which refers to the lesson plan that has been prepared. This observation sheet was made to observe student activities during the learning process. The contents of the student activity observation sheet include filling instructions, scoring criteria, scoring tables, and notes.

Interview guide

The interview guide was made by researchers aiming to obtain information on student responses and understanding after the implementation of the problem-solving process through 4C on the tangent to a circle material. Interviews were conducted after the final test. The interview guide is deliberately designed in such a way that it is hoped that the results obtained from the interviews are objective and useful for improving learning activities. The questions in this interview are structured and revolve around various matters relating to student responses and understanding after carrying out the problem-solving process through the 4Cs.

Validation sheet for research instruments and learning tools

The validation sheet for research instruments and learning tools consists of a learning implementation plan validation sheet, a student worksheet validation sheet, a learning outcome test validation sheet, a student activity observation validation sheet, and an interview guide validation sheet. The validation sheet was made by the researcher so that the research instruments and learning tools were designed by the research objectives.

RESULT AND DISCUSSION

This chapter discusses the problem-solving process to accelerate the 4CS, the activities and student learning outcomes with the problem-solving process to accelerate the 4CS and the constraints in research and their solutions. It is described in detail as follows.

Troubleshooting Process to accelerate 4CS

The problem-solving process for accelerating 4CS on the tangent line material in this study was carried out in three meetings. At the first meeting, the students determine the length of the tangent that passes through a point outside the circle. In the second meeting, the students determine the length of the common tangent line in two circles, and in the third meeting, the students determine the length of the external common tangent line to the two circles.

The purpose of this study is to describe the problem-solving process to accelerate 4CS. The stages in 4CS include identifying and justifying concepts, problem-solving, problem solving, generalizing, and analyzing algorithms. While the problem-solving process is carried out at the problem-solving stage, were at this stage students are expected to be able to determine the length of the tangent to the circle. (Prayitno, 2018) The steps for solving the problem according to Polya are understanding the problem, making a plan, implementing the plan, and checking back.

Overall mathematical problem-solving activities can be used as a reference to be able to maximize the acceleration of 4CS and motivate students more. This is very reasonable because learning by applying to learn presents mathematical problems that can train metacognition, teacher intervention, and classroom interaction. Learning is centered on students with the teacher as a facilitator, shy students can also actively ask and answer questions through notes on paper.

The learning of tangents to circles in this study is generally divided into three activities, namely initial activities, core activities, and final activities. The learning activities contain the 4CS stages which include the stage of identifying and justifying the concept, the problem-solving stage, the problem-solving stage, the generalization stage, and the algorithm analysis stage.
The discussion of each of these stages is as follows.

Initial activity

This initial activity is the stage of identifying and justifying the concept, which takes approximately 15 minutes of the total lesson hours in one meeting, which is 2 x 40 minutes. The stage of identifying and justifying concepts is a preliminary stage to prepare students to be truly ready to learn. This is supported by Endra's opinion that students who are ready to learn will learn more than students who are not ready (Priawasana et al., 2020). Activities to prepare students include conveying learning objectives, motivating student learning by conveying the importance of tangent to circle material, and generating prerequisite knowledge.
Submission of learning objectives in this study can make students' attention focused on the topic to be discussed. This is supported by Eugenia's opinion that the delivery of learning objectives to students can focus students' attention on relevant aspects of learning (Boa et al., 2018).

The learning objectives presented are that students are expected to be able to:

1. Find the formula and calculate the length of the tangent that passes through a point outside the circle.
2. find the formula and calculate the length of the common tangent in two circles
3. find the formula and calculate the length of the external common tangent to two circles

In addition to conveying the learning objectives, the researcher also conveyed the importance of the tangent line material in everyday life and in mathematics itself. It is intended that students are motivated to learn. Motivated students will be better prepared to learn and will achieve better learning outcomes. This is in line with Dagmar's opinion that students who are motivated will be more ready to learn than students who are not motivated (El-Hmoudova, 2015).

Core activities

The core activity takes approximately 50 minutes of the total lesson hours in one meeting, which is 2 x 40 minutes. This activity begins with students occupying seats according to study groups consisting of 4-5 students. The selection of groups consisting of 4-5 people is based on reasons, if one group only consists of 2 students then the interaction between group members will be very limited and the group will be stopped if one of the members is absent. On the other hand, if the group members are too large, it will be very difficult for the group to function effectively. This is because vocal students will tend to dominate and quiet students will tend to just follow.

In forming groups, the researchers paid attention to the level of students' abilities. Each group consists of high-ability students, medium-ability students, and low-ability students. This is intended so that there is good cooperation in a group, where students with high abilities can help students with low abilities and no vocal student is tending to dominate the group. This is in Jing Zhou's opinion that in group work students will learn from each other through the process of mutual acceptance and giving that occurs in groups (Zhou, 2018).

The core activities include the problem-solving stage. At the problem-solving stage, students join their groups to determine the length of the tangent to the circle by applying the problem-solving process based on the worksheet given. Meanwhile, at the problem-solving stage, students display the results of their work and clarify through class discussion. Details of the activities at the problem-solving stage are given in the following section.

At the problem-solving stage, students determine the length of the tangent to the circle using the worksheet in groups. The use of worksheets is proven to be able to help the direction of student work. The steps are given in the Student Worksheet (SW) are a form of assistance for students. However, SW does not guide students. SW only outlines the steps, so that students are still given the freedom to express their ideas and creativity. Thus, students form their knowledge together with friends in their groups actively with the help of SW.

At this stage, learning mathematics must facilitate the involvement of students to carry out the mathematical process to understand mathematical concepts correctly. 4CS involves the process of analyzing or evaluating the information on a problem based on logical thinking to determine decisions (Widana, 2018). One's 4CS can be done by using the right learning model.

Learning oriented to the theoretical framework of constructivism. Mathematics learning focuses on the chosen problem so that students do not only learn the concepts related to the problem, but also their relevance to the real world (Khoiriyah & Husamah, 2018). Learning that presents a problem to be solved with high thinking skills (Surya & Syahputra, 2017). Based on this description, it can be concluded that to accelerate 4CS in mathematics learning through problem posing and the rest are directly involved in solving problems.

Completing the task using the worksheet, students apply the problem-solving process. The problem-solving process carried out contains four steps, namely understanding the problem, formulating a plan, implementing the plan, and checking again. In the first step, students understand the given problem by looking at the picture and determining which line is a tangent to the circle. Then students make a plan by identifying the existence of a right triangle that is formed.

The next step is to carry out the plan, namely by determining one of the sides of the triangle using the Pythagorean theorem, can be determined the length of the tangent to the circle. The last step is to check the results, which is to determine the length of the tangent to the circle using a picture and compare it with the calculation results if you use the formula that has been obtained. Through these four steps, students are expected to be able to conclude the formula for determining the length of a tangent to a circle.

The next stage is the problem-solving stage. At this stage, each group takes turns showing the results of their work on the blackboard. After all the questions in the SW are displayed, students with the direction of the teacher clarify the results obtained through class discussions. In discussing the results of group work, there was a discussion between groups. Discussions between groups allow for the correction of mistakes made by the presenting group. Discussions between groups also train students to communicate their group's ideas to other groups.

End activities

This final activity contains the stages of generalizing and analyzing the algorithm, which takes approximately 15 minutes of the total lesson hours in one meeting, which is 2 x 40 minutes. This activity begins with making conclusions about the learning that has been carried out under the direction of the teacher. This is intended to strengthen the concepts that have just been learned so that they are truly embedded in the minds of students and that they are not easily forgotten.

Next, students work on individual exercises related to the material learned at the meeting. The questions given are as a review of whether students have been able to apply the material learned in various situations. This is intended as an evaluation of student learning activities as well as to further strengthen understanding of the material that has been studied.

Student Activities and Learning Outcomes with Problem Solving Process to accelerate 4CS

Student learning activities with the problem-solving process to accelerate 4CS are shown by the results of observing student activities. The results of observing student activities at the first meeting showed that the percentage based on observer P1 was 86.1% so that which was in good criterion, while the percentage according to observer P2 was 97.2% so that the criteria were very good. From these results, there are differences in

observations between observers P1 and P2. At this first meeting, students were still making adjustments to the implementation of learning. This resulted in the less effective use of time, especially during the initial activities, namely the delivery of prerequisite knowledge and organizing students in groups. However, from the average percentage of the two observers, it can be concluded that the student activity in the first meeting was in very good criteria.

Furthermore, the results of observing student activities at the second meeting showed that the percentage according to observer P1 was 91.7% so that the criteria were very good, while the percentage based on observer P2 was 83.3% so that it was in good criteria. At the second meeting, there were still differences in the observations between observers P1 and P2. This is because the material discussed is more difficult than in the previous meeting. So that the time used for group discussion is more.

As a result, the implementation of class discussions and individual exercises is less than optimal. Based on the average percentage of the two observers, it can be concluded that the student activities at the second meeting were in good criteria.

The results of observing student activities at the third meeting showed that the percentage according to observer P1 was 91.7% so that the criteria were very good, while according to observer P2 it was 94.4% so that the criteria were very good. The difference in observations between observers P1 and P2 is not too big. This is because at the third meeting the students were familiar with the learning activities carried out and the material discussed was not much different from the previous meeting. Thus, based on the average percentage of the two observers, it can be concluded that the student activities at the third meeting were in very good criteria.

In this study, students actively completed tasks given by the teacher in the form of worksheets. In working on the SW, students and their groups complete the given task. This means that students in groups complete their assignments and the teacher gives directions but does not directly provide solutions. Activities like this cause the knowledge gained by students to be truly meaningful. This is supported by Bruner who states that trying alone to complete a task will produce meaningful knowledge (Warner & Kaur, 2017).

The organization of students in groups in learning is intended to provide more opportunities for students to explore the problems they face to construct new knowledge. When students learn in groups, students will do more debate and complement each other. Students are more flexible in completing the learning tasks presented in the SW.

The use of worksheets in learning is also expected to encourage students to work and study independently. Meanwhile, the teacher plays a more role as a supervisor who provides direction to students who have difficulty in the learning process. With SW, teachers provide opportunities for students to explore the problems they face, so that students can construct new knowledge that is expected to be possessed after doing learning activities.

After students can complete learning tasks with SW, clarification activities as a form of explanation of student work are carried out classically. In turn, each group shows the results of their work and the other groups compare the results of their work and provide comments. This is intended to correct mistakes made by the presenter group and train students to communicate their group's ideas to other groups.

Meanwhile, student learning outcomes with the problem-solving process to accelerate 4CS have increased at each meeting. At the first meeting, from 41 students who took part in the evaluation, 80.5% or 33 students had completed their studies. At the second meeting, there were 82.5% or 33 students who had completed learning from the 40 students who took part in the evaluation. Furthermore, at the third meeting, of the 39 students who took part in the evaluation, 89.7% or 35 students who finished studying were obtained. Likewise, at the time of the final test, there were 97.5% or 40 students who had completed learning from 41 students who took the evaluation.

The increase in learning outcomes at each meeting is due to the problem-solving process to accelerate 4CS has made learning more meaningful. Learning becomes meaningful because the learning process has been able to activate students so that learning is no longer teacher-centered but more student-centered. This is because the problem-solving process to accelerate 4CS helps teachers in carrying out learning activities so that students are actively involved in exploring the problems they face to construct new knowledge.

The problem-solving process to accelerate 4CS makes students able to remember and understand the subject matter more easily. This is because students can construct and understand the subject matter by exploring the problems they face independently. In addition, by applying the problem-solving process to accelerate the 4CS, students can construct the expected knowledge step by step with the help of the teacher.

Therefore, so that students can explore optimally in learning, the teacher conditions a learning environment that can encourage students to actively learn. The management of a learning environment that encourages a learning atmosphere is important for teachers. This is supported by Mulenga that the student's learning experience is also influenced by the given learning environment (Mulenga & Marbán, 2020).

Moreover, the stages that have been compiled starting from the stage of identifying and justifying concepts (introduction), problem-solving (exploration), problem-solving (explanation), generalizing (implementation of concepts), and analyzing algorithms (evaluation) in 4CS are expected to make learning more meaningful. Elinor stated that 4CS is a constructivist learning model developed to improve students' understanding (Elicor, 2017).

Because the series of activity stages in 4CS is organized in such a way that students can master the competencies that must be achieved in learning by playing an active role. It is also in Magnussen's opinion that the learning process will be more meaningful if students work on their own and build their understanding (Magnussen et al., 2018).

CONCLUSION

Based on data exposure and discussion, it can be concluded that the problem-solving process to accelerate 4CS can improve student learning outcomes. The stages of accelerating 4CS which involve mathematical processes include identifying and justifying concepts, solving problems, generalizing and analyzing algorithms.

Based on the research results and research findings, some suggestions can be made as follows. The problem-solving process for accelerating 4CS is worth considering as alternative learning that can improve student learning outcomes on the tangent to circle material. In applying the problem-solving process to accelerate 4CS on the tangent to a circle, the use of time must be used as effectively as possible. According to this study, the problem-solving process to accelerate the 4CS on the tangent line material requires a lot of time, especially when conducting group discussions and class discussions on core activities. One way to overcome this is to manage time as effectively as possible, for example in discussing material between students who are guided by the teacher, the discussion is only directed to things that are important and do not need all of them. Before implementing the problem-solving process to accelerate 4CS on the tangent to a circle material, the teacher must pay attention to the students' prerequisite material abilities, because not all students have the required prerequisite skills. For researchers who are interested in the problem-solving process to accelerate 4CS, they should be able to develop this learning in other mathematics materials.

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