Application of information technology and communication-based lesson study on mathematics problem-solving ability

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Abstract. The purpose of this research is (1) to test whether there was a difference in the average students' mathematical problem-solving abilities before and after implementing information and communication technology-based lesson studies and (2) to test whether students' mathematical problem-solving abilities after learning through the application of technology information and communication-based lesson study to achieve learning completeness. This research was an experimental type using a quasi-experimental design and refers to the one group's pretest-posttest design. The population in this research were students of the Mathematics Education study program Universitas Muria Kudus. The sample of this research is the first semester students. The test technique is used as a research data collection technique. Technique tests are carried out to measure students' mathematical problem-solving abilities. The data analysis in this research includes the sample group average difference test and learning mastery test. Based on the data analysis, the results of the mathematical problem-solving ability after implementing lesson study based on information and communication technology are better than before applying and the mathematics problem-solving ability of students after learning through application after implementing lesson study based on information and communication technology reaches learning completeness.

1. Introduction

In Indonesia, learning mathematics at various levels of education from basic education to higher education is a strategic tool for building competitive human resources in the global era because mathematics as one of the basic sciences, both its reasoning and applied aspects, has an important role in mastery of science and technology. This implies that mathematical ability is a must for all levels of Indonesian society to master. Therefore, the Indonesian government through the ministry of education and culture makes mathematics a compulsory subject at the educational unit level.

So far, mathematics learning is still taught in an abstract manner. As a result, the problem-solving ability of children is hampered. Students' problem-solving in mathematics is often problematic for both students and teachers and this needs to be addressed by applying relevant skills and strategies in mathematics teaching and learning [1]. The teacher's role in managing the student's problem-solving process is very important [2].

For that, we need a strategy to teach mathematics so that it is easily understood by children. One strategy is to link mathematics learning with everyday life and be supported by information technology. The goal is that children feel happy and easy in learning mathematics. Learning must be able to show interest and motivation to learn. Learning must focus on material or learning materials that are considered important and become weak points in student learning and are very difficult for students to learn. Learning does not only emphasize student cognitively but the learning process, so it is hoped that when the process goes well, the learning outcomes will always accompany. The implementation of
continuous and collaborative learning is expected to improve the quality of learning (learning processes and outcomes).

One of the strategies used for the above problems is using lesson study. Lesson study is an effort to improve the learning process and outcomes which are carried out collaboratively and continuously by a group of teachers. Lesson study After more than two decades of subject study research, it is clear that this approach to teacher professional development has a strong potential [3]. It is in line with the opinion [4] that with lesson study, in addition to getting theory, students also immediately experience the learning process with the system during simulation sessions, design learning in design sessions, testing during peer teaching sessions, and its application to the model.

So that students do not get bored easily because the media used is only monotonous, the media must be varied in learning. One of the interesting media is based on information and communication technology. This media requires a supporting device or media such as a computer/laptop and an LCD projector. Even so, this is not an obstacle for a lecturer to develop this media, given the growing development of technology today. With the development of technology, a lecturer is required to be creative and innovative in utilizing technological advances. One of these uses is the use of information and communication technology-based learning media in the learning process. According to the opinion [5] that the potential of information and communication technology in facilitating student learning and improving learning outcomes. The use of technology can be done by anyone, as long as there is a willingness to learn. In line with [6] both men and women, as long as the math teachers worked, they had positive self-efficacy in initiating technology integration. The use of information and communication technology can also increase student interest in learning, this is according to the opinion [7].

Based on real conditions in the field, it is necessary to do lesson study in learning. Lesson Study is not a learning method or approach. Lesson studies are used to improve the quality of learning both in terms of students and lecturers. Lesson study activities are carried out collaboratively between lecturers to produce an effective learning process. Lesson studies are carried out on an ongoing basis, starting from planning, implementing and reporting. Lesson study activities are teacher self-improvement activities obtained from discussions with observers to improve the next learning process. Lesson study activities can maximize the process of student problem-solving abilities, because in it there is a higher-order thinking process. This results in students' problem-solving abilities will develop. Apart from lesson study, the use of learning media has a role in improving the quality of learning. One of the media is related to information and communication technology. Specifically, these media are using interactive learning videos and learning management systems. The media involves students in learning activities so that learning is more interesting and fun. Information and communication technology-based lesson studies are expected to improve the quality of learning so that lecturers are more creative and innovative in learning and students can increase their learning activities and problem-solving abilities.

Based on this description, a study was conducted using information and communication technology-based lesson studies in mathematics learning to improve mathematical problem-solving skills. The use of information and communication technology-based lesson study is expected to improve students' mathematical problem-solving skills and student learning activities.

2. Methods

This research is a quantitative type with a quasi-experimental research design. Quasi-experimental research was used because there were treatment classes and the sample was randomly selected. The population in this study were UMK Mathematics Education students. The sample of this research is the first semester students. The research design used in this study was "One Groups Pretest-Posttest Design", a research design that contained a pretest before being treated and a posttest after being given treatment. Thus it can be known to be more accurate because it can compare with what was held before being treated. The research design table can be seen in Table 1 below.

| Pretest | Treatment | Posttest |
|---------|-----------|---------|
| $O_1$   | $X$       | $O_2$   |
Information:
X: Application of information and communication technology-based lesson study
O₁: Test before treatment (Pretest)
O₂: Test after treatment (Posttest)

Table 1 above describes the research design in this article. In the first step, students are given a pretest to determine their initial ability. Then do the treatment by applying a lesson study based on information and communication technology. Finally, give a posttest at the end of the lecture.

In this study, there are two variables, namely the independent variable and the dependent variable. The independent variable used is lesson study based on information and communication technology, while the dependent variable is the ability to solve math problems. Test techniques were used as research data collection techniques. Mechanical tests were conducted to measure the ability of mathematical problem-solving students. The data obtained were analyzed using the normality test, the average difference test using the Wilcoxon test. The learning mastery test (one sample Kolmogorov-Smirnov) was also carried out to determine the completeness of mathematical problem-solving abilities after receiving learning with the application of lesson study based on information and communication technology.

3. Results and Discussion

Data analysis used the result of the value of mathematical problem-solving skills pretest-posttest in the subject of geometry. The prerequisite test is the normality test. The results showed that the data did not meet normality, so the next test used the Wilcoxon test to find out the differences before and after being given treatment. The data description of the pretest-posttest value of problem-solving abilities can be seen in Table 2 below.

| Treatment | Mean | Median | Variants | Maximum | Minimum |
|-----------|------|--------|----------|---------|---------|
| Pretest   | 55.7 | 60     | 152.9    | 80      | 30      |
| Posttest  | 60.4 | 57     | 123.6    | 90      | 42      |

The normality test used the Kolmogorov-Smirnov test using SPSS 22. The results of the normality test can be seen in Table 3 below.

| Treatment | Kolmogorov-Smirnov<sup>a</sup> | Statistics | df | Sig. |
|-----------|-------------------------------|------------|----|------|
| Pretest   |                               | .189       | 29 | .009 |
| Posttest  |                               | .208       | 29 | .002 |

Based on Table 3 above using the Kolmogorov-Smirnov test, the sig value is obtained. 0.009 for before treatment and sig. 0.002 for after treatment. These results indicate that sig. < 0.05, meaning that the pretest-posttest values were not normally distributed. Because the data is not normal then to test the average difference (hypothesis testing) using test Wilcoxon. To find out that there was a difference between before and after treatment, the pretest-posttest data on the ability to solve mathematical problems were analyzed by using the Wilcoxon test using SPSS 22. The results of the calculations can be seen in Table 4 below.

| Wilcoxon Test Results | POSTTEST - PRETEST |
|-----------------------|-------------------|
| Z                     | -2.251<sup>b</sup> |
| Asymp. Sig. (2-tailed)| .024              |

From Table 4 above, the sig. 0.024 <0.05, which means that there are differences in mathematical problem-solving abilities before and after being given treatment. The ability to solve mathematical problems after treatment is better than before treatment, this can be seen in Table 2 where the posttest mean is 60.4 greater than the pretest mean 55.7.

Meanwhile, to determine the completeness of the ability to solve mathematical problems after receiving learning with the application of lesson study based on information and communication technology.
technology using the learning mastery test (one sample Kolmogorov-Smirnov), the results can be seen in Table 5 below.

Table 5. Results of the One-Sample Kolmogorov-Smirnov Test

|                  | POSTEST - PRETEST |
|------------------|-------------------|
| Test Statistic   | .208              |
| Asymp. Sig. (2-tailed) | .002*         |

Table 5 above the sig value. 0.002 < 0.05, which means that the ability to solve mathematical problems after receiving learning with the application of information and communication technology-based lesson studies has experienced completeness (more than 67 or a minimum category of B).

The implementation of lesson study in this study is divided into three stages, namely planning (plan), implementation (do), and reflection (see). At the planning stage, at this stage the learning design is carried out, namely making lesson plans (Figure 1). Lesson plans are made based on the characteristics of the material, the learning process, and the learning media used. In this study, there is more emphasis on learning media. The learning media used are based on information and communication technology, namely by using video lessons (Figure 3) and learning management system "Sunan" (Figure 4). This is by the opinion [8] that the effectiveness of lesson plans using information and communication technology (Lectora inspire) has led to an increase in student learning outcomes and teacher responses to the teaching and learning process in the high category. Furthermore, making learning plans, preparing questions as a test of student problem-solving abilities. In this planning activity, researchers involve observers from the vice dean of academics and lecturers who are the subject of geometry.

At the implementation stage (do), the researcher as a model lecturer implements the learning implementation plan that has been prepared previously. The results of the problem-solving ability test obtained a class average score of 55.7 at the pretest and increased with a class average score of 60.4 at the posttest (see Table 2). Based on field notes, it shows that the overall learning process for lesson study based on information and communication technology can be followed by students effectively. Most students have the confidence to present the results of their discussion. There were no students who dominated the group.

In the reflection stage (see), the model lecturer gathers all observers to discuss the learning that has been done. Observer provides an explanation of the student's condition during learning. Students who are less active in discussing get attention and this is as input for the implementation of learning at the next meeting. In addition, at this stage, a discussion was also held regarding the learning process carried out by the researcher. Observers convey the advantages and disadvantages of the learning process carried out so that researchers can maximize learning activities at the next meeting.

The implementation of lesson study greatly affects the learning process, both lecturers and students. In line with the opinion [9], that lesson study is to deepen students' understanding of mathematical thinking. Lesson study helps them adjust the learning task accordingly if they find it difficult to innovate effectively. Lesson study also helps them in offering students autonomy to explore mathematical ideas.

Treatment using information and communication technology-based lesson studies resulted in better mathematical problem-solving abilities than before treatment and the results met learning completeness. Students can describe the meaning and prove the Pythagorean theorem. To make it easier for students to find the Pythagorean theorem, students are welcome to look for learning media and discuss each other. The lecturer asks students to look for media before learning. With this all-students can find references in advance. Students translate and define the Pythagorean theorem and students to use the media to prove it. The result is that students can prove the Pythagorean theorem in various ways.

This is because lesson study, a coaching model in improving performance, is carried out jointly by a group of teachers to realize performance in a better direction. During the activity, the researcher was accompanied by a collaborator of two people. Collaborators are tasked with seeing student activity, not assessing lecturer learning. Collaborators record every activity undertaken by students. The results of the notes were discussed with the researcher for the follow-up to the next activity. In learning activities, students are required to study independently, discuss with groups, and present the results of their discussions in front of the class. Initial activities of lecturers make lesson plans to make it easier to carry out learning activities. Examples of lesson plans can be seen in Figure 1 and the implementation stages can be seen in Figure 2.
In learning activities, students are required to find the results of the material being taught, so that students can understand the material with their own experiences. It is in line with the opinion [10] related to lesson study, that design principles result in the construction of metacognitive skills, metacognitive language, and metacognitive networks that can be theorized. The recommendations follow how lesson study practices can be theorized and facilitated through these design principles. According to [11] microteaching lesson study in the course method provides teacher candidates a great opportunity to learn how to teach with technology. The significance lies in practical opportunities, collaborative reflection, instant feedback, and learning from one another. It is also reinforced that lesson study is a form of professional development in which teachers collaboratively design research lessons and improve teaching using the evidence they have gathered about student learning and development [12]. Furthermore, lesson study in mathematics lessons describes the main characteristics namely, collective or individualistic teaching and learning, problem-solving lessons, and the distance between theory and practice [13].

In addition to learning strategies, the effectiveness of problem-solving abilities is also influenced by learning with information and communication technology (ICT). Learning with ICT fosters student interest and motivation in attending lectures. The learning of ICT in this activity uses learning videos for the discovery of the Pythagorean concept and uses the learning management system (LMS) application "Sunan" from the IT Development Team at Universitas Muria Kudus. With these activities, students will find it easier to understand the material. The results showed that learning using technology made learning achievement more effective [14]. In line with [15], the use of ICT in learning, directly and indirectly, affects learning to be more interesting. Analysis of how teachers manage several aspects of classroom teaching related to the use of applications such as including technology-mediated assignments aligned with pedagogical goals, preparing students to use technology efficiently, adapting formats for classroom activities, and extending curriculum scripts to the material being studied [16]. The use of ICT in this research can be seen in Figure 3 and Figure 4 below.
Figure 3 is a learning video about the discovery of the Pythagorean Theorem concept using props filled with water. Figure 4 is a learning management system application "Sunan" which is owned by Universitas Muria Kudus to carry out the learning process online. Both of these are a means of using technology in learning which has the effect of increasing student interest and motivation so that their problem-solving ability increases. The use of information technology-based learning media and communications student growing interest in learning. They are more active in participating in learning. Management of a good class in the use of technology to make the learning process a maximum. This is consistent with [17] that the use of technology in learning activities and improve learning outcomes significantly. Learning more student-centered and more collaborative learning. In line with the above opinion that learning to use technology (interactive multimedia) produce better learning achievement than conventional learning [18].

4. Conclusion
Learning mathematics using lesson study based on information and communication technology is effectively used to improve mathematical problem-solving skills. This is because learning provides a maximum learning experience for students. Students must try to use previous ideas and experiences to be able to solve their problems, and students are required to discuss and present the results as a form of responsibility. This learning is also supported by the use of technology that fosters student interest and motivation.

Learning by utilizing information technology and communications increase student interest and activity. Students are more interested in following the lecture. Lecture material is more easily accepted by students because the technology makes them more enthusiastic in following the lecture. Students now everything has already mastered the technology, so technology packaged in the form of learning makes the process of learning becomes enjoyable and effective.

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