Student’s higher-order thinking skills on creative problem solving based on caring community

C F Lestari 1,2, Hobri 1,2, M Fatekurohman 1,3, D Lutvita 1,2, F Y W Ningrum 1,2
1 Department of Postgrad. Maths Edu., University of Jember, Jember, Indonesia
2 LS iMEL University of Jember, Jember, Indonesia
3 Mathematics Departement, University of Jember, Jember, Indonesia
Email: chichy18th@gmail.com

Abstract. The teaching and learning activities more effective and efficient if it is supported by high-quality learning device. This research aimed to develop the learning device by using Creative Problem Solving (CPS) based on caring community on "System of Linear Equations in Three Variables" and to determine its effect on student’s higher-order thinking skills. The type of study used is a mixed method that combines qualitative and quantitative method. Qualitative methods are used to obtain data related to the results of the development of learning tools and quantitative methods are used for statistical analysis. The subjects in this study were all students of class X in SMAN 1 Tegaldlimo, with samples consisting of 3 classes namely class X MIPA 1 as an experimental class 1 (with CPS), class X MIPA 2 as an experimental class 2 (with CPS based on caring community), and class X MIPA 4 as a control class (with conventional learning). Higher-order thinking skills were measured by using essay test. The data were analyzed by using normality, homogeneity and One-Way ANOVA tests using SPSS 19. The results of the study showed that (1) the learning device produced were valid, practical, and effective; (2) One-Way ANOVA test results obtained a sig. value of 0.000 < 0.05 which indicates that the implementation of learning device with CPS based on caring community had a significant effect on student’s higher order thinking skills.

1. Introduction

The rapid progress of technology in the 21st century offers competition and challenges in all aspects of life. This happens because life in the 21st century is so complex. The increasing complexity of the world certainly requires the creation of qualified human resources and skills to be able to face various risks and uncertainties that arise in line with environmental developments in the 21st century. Some of the skills needed, including the ability to work together, the ability to think in high level, creative, and have the ability to communicate [1]. From some of these abilities, higher-order thinking skills are one of the abilities that should be mastered by students in the 21st century [2, 3].

Higher order thinking skills (HOTS) is the ability to think deeply and extensively which involves processing information critically and creatively in dealing with and solving complex problems and involves the skills of analyzing, evaluating, and creating [4]. This ability is needed by students to compete and face challenges because it can help in making the right, careful, and logical decisions and considering things from various points of view. HOTS level in the revision of Bloom's Taxonomy involves the ability to analyze, evaluate, and create [5-7].

Mathematics is a universal science as well as a basic science that has an important role in the progress of science and technology and advancing thinking power. Ironically, the condition of
mathematics education in Indonesia is not as it should be. Marked by so many students’ complaint about the learning experience of mathematics in schools including math classes are boring, too many formulas to be memorized, teachers are not friendly, so that mathematics is considered a difficult subject. This becomes homework for educators so that the learning presented must be fun but provides critical and creative effects for each student [4].

The teacher as one of the important actors in the learning activities must be able to create a pleasant learning atmosphere and uses a variety of innovative learning models that can motivate students to develop their thinking skills. One of them is the Creative Problem Solving (CPS) learning model. CPS is a learning model that emphasizes the discovery of ideas to find the most efficient solutions using divergent and convergent thought processes [8]. Through CPS learning, students not only memorize solutions but also combine critical, logical, reflective, and creative thinking in completing them. The stages of CPS according to Mitchell and Kowalik include (1) object finding, (2) fact finding, (3) problem finding, (4) idea finding, (5) solution finding, and (6) acceptance finding [9, 10]. This series of stages is carried out with collaboration between teacher and student, students and students to foster a sense of mutual care and no one is ignored. This is in accordance with one of the characteristics of Lesson Study for Learning Community (LSC) namely caring community [11]. Caring community is a part of discussion activities where in its implementation it will raise and build a community concern in a class.

One of the learning materials for class X of senior high school mathematics related to the application of CPS and HOTS is the material "System of Linear Equations in Three Variables". Based on the interview with mathematics teachers in SMAN 1 Tegaldlimo, it was revealed that students had difficulty in the material system of linear equation in three variables, including (1) collecting important information in the questions, (2) making appropriate mathematical models, and (3) performed calculations algebra.

Considering the issues described, it was necessary to develop learning device by using CPS based on caring community. Learning device developed aims to direct students to foster mutual care for one another and develop student’s higher-order thinking skills.

2. Research method
The method used in this study aims to test the effectiveness of the process and the results of a particular product. The effectiveness of the process was examined using development research while the effectiveness of the results was tested using experimental research. Therefore, the method used in this study is Mix Methods [12]. This combination research process, starting with research development then continued with experimental research. The following is a description of each of these studies.

2.1. Development research
The development model used is a 4-D model developed by Thiagarajan, Semmel & Semmel [13, 14]. This development model consisted of 4 stages namely define, design, develop and disseminate. The learning device developed consisted of lesson plan, student’s worksheets, and learning achievement test. The instruments used in this study consisted of student and teacher activity observation sheet, and student response questionnaire. Research tools and instruments can be used in the learning process if they meet valid criteria. However, if it does not meet the valid criteria, then they must be revised again based on suggestions and input provided by the validator until they meet the valid criteria. Data collection in this research was carried out with observation, validation, and test, while the data analysis using descriptive analysis.

2.2. Research design
In the quantitative research, the form of research used is quasi-experimental. The research design used a pretest-posttest control group, a design that involved 3 classes, namely 2 experimental classes and 1 control class. The population in this study were all tenth grade students of SMAN 1 Tegaldlimo
Banyuwangi. The samples were selected by using cluster random sampling technique and 3 classes were chosen randomly out of 7 classes available. Class X MIPA 1 as the experimental group 1, class X MIPA 2 as the experimental group 2, and class X MIPA 4 as the control group. In the experimental group 1 the model teacher uses CPS learning, while in the experimental group 2 the model teacher uses CPS learning application based on caring community. Control group is a class using conventional learning which is a general learning model applied in schools, namely direct learning model. The research design implemented can be seen on the Table 1.

**Table 1.** Research design pretest-posttest control group.

| Experimental Class ($x_1$) | Experimental Class ($x_2$) | Control Class |
|---------------------------|---------------------------|---------------|
| Pre-test                  | Pre-test                  | Pre-test      |
| The learning model uses CPS | The learning device CPS based on caring community | The learning model uses conventional learning model |
| Posttest:                 | Posttest:                 | Posttest:     |
| HOTS test                 | HOTS test                 | HOTS test     |

Data collection techniques in this research used the test. The test used is a test of higher order thinking skills (pretest and posttest). The data analysis technique in this research was quantitative data analysis using SPSS 19. The data analysis technique was carried out in two stages, namely the initial data analysis and the final data analysis. The initial stage data analysis is performed to test the pretest data results consisting of normality and homogeneity tests. This pretest aims for class selection to be used as a research samples. While the final stage of data analysis is carried out to test the posttest result data which also consists of a normality, homogeneity, and hypothesis test using One-Way ANOVA analysis. The normality test uses the Kolmogorov-Smirnov test and the homogeneity test uses the Levene Statistical Test with a significance level of $P > 0.05$. While testing the hypothesis with a significance level of $P < 0.05$. The stages of research design are as follows.

**Figure 1.** Stages of research design.
3. Results Finding
This research was conducted in SMAN 1 Tegaldlimo, Banyuwangi Regency in 2019/2020 academic year. The research was done through two stages namely the learning device development stage and the learning device implementation stage. Before giving the treatment to the experimental and control classes, the learning device and research instrument development of the research was carried out. The aim of this study was to develop the learning device of CPS based on caring community which fulfilled the criteria of validity, practicality and effectiveness. The descriptions of these three criteria were explained as follows.

3.1. Validity
The validity was done by asking the consideration and assessment from three validators covering two expert lecturers of Mathematics Education of University of Jember and one mathematics teacher of SMAN 1 Tegaldlimo. The three validators gave an assessment based on the statement on the validation sheet. The three validators also gave suggestions and comments in written as the input to improve the learning device and instrument developed. Validation scores of each component are analyzed to determine the average score. The analysis of learning device and research instrument by the experts can be seen on the Table 2.

Table 2. Validation results of the learning device and research instruments.

| Learning device | Average | Criteria | Research instruments | Average | Criteria |
|-----------------|---------|----------|----------------------|---------|----------|
| Lesson Plan     | 3.83    | Valid    | Student Activity     | 3.83    | Valid    |
|                 |         |          | Observation Sheet    |         |          |
| Student Worksheet| 3.8     | Valid    | Teacher Activity     | 3.83    | Valid    |
|                 |         |          | Observation Sheet    |         |          |
| Learning Achievement Test| 3.76  | Valid    | Students Response    | 3.87    | Valid    |
|                 |         |          | Questionnaire        |         |          |

Table 2 shows that the results of the validation of the learning device and research instruments that have been validated by 3 validators meet valid criteria. Learning devices meet valid criteria with an average of 3.8 and research instruments meet valid criteria with an average of 3.84. Data obtained in the form of quantitative data which is then converted into qualitative data.

3.2. Practicality of learning devices
The practicality of learning tools can be seen from the activities of the teacher and the activities of students during learning. The description of the activity is described as follows.

3.2.1. Teacher activities during learning
The learning activities carried out as many as 5 meetings consisting of 1 meeting for the pretest, 3 meetings for the delivery of material and 1 meeting for the posttest. The first meeting, pretest was given to the students in the form of 3 essay questions that must be completed in 90 minutes. This pretest aimed to choose which class to be used as the research sample. Based on the homogeneity test, the significance value of 0.079 was obtained. Because the significance value greater than 0.05, then the ability of class X is homogeneous.

Submission of material took place at the second to fourth meeting with details (1) the second meeting discussed the material about compiling and discovering the concept system of line equations in three variables; (2) the third meeting discussing the completion system of line equations in three variables; and (3) the fourth meeting discussing the application system of line equations in three variables in daily life. The researcher observes the teacher's activity in learning to analyze the practicality of the learning device. Observation results of teacher activities can be seen in Figure 2.
Based on the observation sheet of teacher activity, at the first meeting the percentage of teacher activity reached 89%. This is because teachers are not accustomed to using learning tools developed by researchers. At the second meeting there was an increase in teacher activity by 3% because the teacher was getting used to the caring community-based CPS learning process. However, at this meeting the teacher had difficulty in the idea finding stage. At the third meeting there was an increase in teacher activity by 2% because the teacher understood all the stages in the caring community based CPS learning model, as evidenced by the highest percentage at the third meeting (94%). The average observations of teacher activity from all three meetings were 92%, this shows that the learning process was going well.

3.2.2. Student’s activities during learning
Classroom learning activities are carried out by forming groups of 4 students. In the experimental class 1 the model teacher uses CPS learning, whereas in the experimental class 2 the model teacher uses caring CPS learning device based on caring community. In contrast to the experimental class, learning in the control class is done through conventional learning where the teacher is the center of learning.

On learning based on caring community, the students were directed to collaborate in one learning community related to the vision of caring community which stated that the students should not be left alone or “no student was neglected” [15]. Therefore, in experimental class 2, students are guided to discuss in the groups, asked each other questions and explained so as to foster of care among friends.

The student’s activities in experimental class 1 and experimental class 2 on discussing, asking and explaining and sharing opinions within groups were presented on Figure 3 and Figure 4 (taken from one group as a sample).

On Figure 3 the group discussion in experimental class 1 went quite well. Student B was the most active student than the others. Student B was seen explaining the material to all members of the group, consequently student B did not have the opportunity to ask the other members. At the meeting, it was also apparent that D students were still less active in groups. At the next meeting, discussion activities went better, marked by a feeling of caring for friends who have difficulty. Student D starts to dare to ask and share material that is not understood even he starts to help student A who has difficulty understanding the material. At this meeting, all students seemed active in the learning community.
Figure 4. The group discussion in experimental class 2.

On Figure 4 the group discussion in experimental class 2 went well. Student B gave an explanation to all group members. At this meeting, the questions were addressed to Student B only. During the meeting, all students seemed active and shared knowledge in the learning community. This condition shows that students have high concern for their peers [16]. The group discussion that occurred in the control class using learning conventional is presented in Figure 5.

Figure 5. The group discussion in control class.

Unlike the experimental class 1 and experimental class 2, in the control class, there was no discussion in this group. Student E who understood the material by only giving answers or explanations to all members without receiving any responses or questions from other members, so that there was no group discussion occurred in the control group in the first meeting. The second meeting was not merely different from the first one. There were only two students involved in the question and answer session, they were student E and student F. Student E who understood the material only gave answers or explanations to the other members. Overall, the group discussion activities were only intended to answer questions from the given problems without fostering concern for students who did not understand the material presented by the teacher. The recapitulation of student activities during 3 meetings in the control class, experimental class 1, and experimental class 2 can be seen in Figure 6.

Figure 6. Recapitulation of student activities for 3 meetings.
In Figure 6 it can be seen that for three meetings the average activity of students in the control class is 45%, in the experimental class 1 is 69% while in the experimental class 2 is 81%. Based on these results it can be concluded that the activities of students in experimental class 2 with CPS learning based on caring community meet practicality criteria.

3.3. Effectiveness of Learning Devices

Researchers provide questionnaires for student responses that must be filled out by students after the learning process. Learning devices are considered effective if the number of students who give a positive response ≥ 80% of the number of subjects tested [14]. The results of the recapitulation of student responses are shown in Figure 7.

![Figure 7](image)

**Figure 7.** Results of student response questionnaire.

The results of the analysis of student responses that have been presented in Figure 6 show that in 2% of students disagree, 5% of students disagree, 12% quite agree, and 81% of students agree. Further the reason for students is because learning is done with a lot of practice, is fun, and encourages them to find new ideas. The worksheets presented are adjusted to the character of the students, equipped with pictures, so that students do not feel bored in doing the exercises. The difficulty of students in LKS is when they change story problems into mathematical models. Therefore, in the worksheet, the researcher gives more story questions so students can get used to working on them. The results of the analysis of student responses in Figure 6 show that the percentage of student responses of 81% indicates a positive response. In accordance with predetermined criteria, it can be said that the caring community based CPS model learning tool developed by researchers is effectively used in the learning process.

Assessment of the effectiveness of learning device is also measured based on the student’s learning achievement tests, that is posttest given at the last meeting to find out whether there is an influence of CPS learning based on caring community on students' higher-order thinking skills. Data analysis techniques used the One-Way ANOVA test. The requirement to use this test is that data must be normally distributed and homogeneous. These results can be seen in Table 3.

**Table 3.** Normality test by using Kolmogorov-Smirnov.

| CLASS              | Kolmogorov-Smirnov<sup>a</sup> | Shapiro-Wilk      |
|--------------------|-------------------------------|-------------------|
|                   | Statistic | Df | Sig.  | Statistical | df | Sig.  |
| HOTS CONTROL CLASS| .096       | 28 | .200  | .952        | 28 | .218  |
| EXPERIMENTAL CLASS 1 | .129      | 32 | .189  | .978        | 32 | .747  |
| EXPERIMENTAL CLASS 2 | .117      | 28 | .200<sup>7</sup> | .974 | 28 | .703  |

From Table 3 it can be seen that the significance value in the control class is 0.218, experiment 1 is 0.747, and for experiment class 2 it is 0.703. This shows that the significance value is more than 0.05, which means the post-test results from all three classes of normal distribution. Then homogeneity test
will be performed using Levene Statistics. Homogeneity test using Levene Statistics is shown in Table 4.

**Table 4. Homogeneity test by using Levene Statistic.**

| HOTS                  | Levene Statistic | df1 | df2 | Sig. |
|-----------------------|------------------|-----|-----|------|
|                       | 2.692            | 2   | 85  | .074 |

Based on Table 4, it can be seen that the significance of the Levene Statistic test for the variance equation is $0.074 > 0.05$ so that the learning outcomes of students' high-level thinking skills show homogeneity. After knowing the results of the posttest results of the three classes that are normally distributed and homogeneous, the next step is to conduct a hypothesis test to determine the effect of the development CPS learning model based on caring community by researchers on students' higher-order thinking skills. Hypothesis testing uses the One-Way ANOVA test. This was done because the research sample used by researchers was more than 2 classes (control class, experimental class 1, and experimental class 2). The One Way Anova Test results are shown in Table 5.

**Table 5. Test results using One-Way ANOVA.**

| HOTS                  | Sum of squares | Df  | Mean square | F     | Sig. |
|-----------------------|----------------|-----|-------------|-------|------|
| Between Groups        | 3233.214       | 2   | 1616.607    | 68.337| .000 |
| Within Groups         | 2010.786       | 85  | 23.656      |       |      |
| Total                 | 5244.000       | 87  |             |       |      |

Based on the One-Way ANOVA test results in Table 5, it is known that the significance results are less than 0.05. This means that the learning model of creative problem solving models based on caring community influences students' higher-order thinking skills. Therefore, these learning tools are effective for use in the learning process. Student's HOTS on CPS based on caring community, is shown in Figure 8.

**Figure 8.** Student’s HOTS on CPS based on caring community. Aspects and indicators of students' higher order thinking skills which include analyzing, evaluating and creating can be seen in Figure 9.
Figure 9. Students’ HOTS Level.

Based on Figure 10, information is obtained that the average high-level thinking ability of students in the control class, experiment 1, and experiment 2 in a row of 57.33%, 66%, dan 80.33%. In the experimental class 2 it can be seen that there is a significant influence than the other two classes. The results of student work on the analysis problem (C4) can be seen in Figure 10.

Figure 10. Results of students’ questions on analyzing questions (C4).
From the students' answers in Figure 10, it can be seen that the analyzing indicator, students are able to analyze the questions by dividing information into simpler parts so as to obtain existing patterns or relationships. To solve this problem, students must students have to analyze the information found in order to find solutions to solve mathematical models that are formed, apply concepts in accordance with the problems faced, and connect the parts that are found in order to obtain the right answer.

Following are the results of the interview between the teacher and students whose answers are shown above.

Researcher: How do you feel about learning activities using creative problem solving learning tools based on caring community?

Student: I think this activity is fun because students are directed to develop higher order thinking skills and can collaborate with friends.

Researcher: What makes you happy/unhappy while doing learning activities using the creative problem solving based on caring community component?

Student: Very happy because the steps are clear and also help me in completing the material

Researcher: What is your understanding of the material that has been explained?

Student: Initially did not understand but after being explained by the teacher and input from the group I finally understood and I could also explain to students who did not understand

Researcher: How do you solve problems like on student worksheets?

Student: I follow the steps that are already on the student worksheet

Researcher: Explain what material in your past learning was the most difficult?

Student: The material that makes it difficult for me is to make a mathematical model of a story problem

4. Discussion

In quantitative research, samples were analyzed using SPSS software version 19, which was previously subjected to a prerequisite test in the form of normality and homogeneity tests. The normality test uses the Kolmogorov-Smirnov test, while the homogeneity test uses the Levene statistical test with a significance level of 5%. Related to the effectiveness of the learning device shows that the learning device developed is effective. It can be seen from (1) students have a positive response to the media and the implementation of caring community-based CPS learning by 81% (2) there is a significant increase in the ability to think at the higher level experimental class. Meanwhile, based on observations, it is known that the application of the learning process in every aspect shows that it runs well with an average score of 92%. Meanwhile, from the observation of student activities, it was found that students gave a positive response to the learning tools in the implementation of caring community-based CPS learning as much as 81%. Based on the data above, it can be concluded that the practical test of learning tools developed meets the following criteria: (1) the level of implementation of the learning process is categorized as practical; (2). The results of the non-parametric analysis showed that there were significant differences in students' higher-order thinking skills in the experimental and control classes.

5. Conclusion

The results showed that the learning model of CPS learning model based on caring community fulfilled the criteria of valid, practical and effective. In addition, the application of CPS based on caring community has a significant influence on students' higher-order thinking skills. Positive responses were also given to students in CPS learning based on caring community.

Acknowledgement

I would like to express my gratitude to Postgraduate Program of Mathematics Education, Jember, Indonesia. I also want to thank the dean of the faculty of teacher training and education for his supports, University of Jember, Indonesia, CGANT, LSiMel and the research group.
Reference

[1] Annuru T A et al 2017 Increased high-level thinking skills in natural science lessons for elementary school students through learning models Treffinger. Eductehnologia, Universitas Pendidikan Indonesia 3(2) 136-144

[2] Pratama G S and H Retnawati 2018 Urgency of higher order thinking skills (hots) content analysis in mathematics textbook Journal of Physics: Conf. Series 1097 012147

[3] Haryanto P C and I S Arty 2019 The application of contextual teaching and learning in natural science to improve student’s hots and self-efficacy Journal of Physics: Conf. Series 1233 012106

[4] Hidayati A U 2017 Train high-level thinking skills in learning mathematics in elementary school students SKILLED Journal of Education and Basic Learning 4(2): 143-156

[5] Apino E and H Retnawati 2017 Developing instructional design to improve mathematical higher order thinking skills of students Journal of Physics: Conf. Series 812 012100

[6] Anggraini N P et al 2019 Analysis of higher order thinking skills students at junior high school in Surakarta Journal of Physics: Conf. Series 1211 012077

[7] Hadi S et al 2018 The difficulties of high school students in solving higher-order thinking skills problems Problems of Education in The 21st Century 76 (4): 520-532

[8] Wasiran Y and Andinasari 2019 Mathematics instructional package based on creative problem solving to improve adaptive reasoning ability and creative thinking ability Journal of Physics: Conf. Series 1167 012060

[9] Yuliani A et al 2019 Mathematical creative problem solving ability and self-efficacy: (a survey with eight grade students) Journal of Physics: Conf. Series 1157 032097

[10] Manurung S L et al 2019 Developing integrated creative problem solving (cps) textbook for logic and set Journal of Physics: Conf. Series 1188 012040

[11] Harisudin L et al 2019 The development of mathematics learning tools through the bridge games based on lesson study for learning community and its relationship with the higherorder thinking skills in probability theory Journal of Physics: Conf. Series 1211 012075

[12] Sugiyono 2017 Combined Research Methods (Mixed Methods) (Bandung: Alfabeta)

[13] Hobri 2010 Metodologi Penelitian Pengembangan (Aplikasi pada Penelitian Pendidikan Matematika) (Jember: Pena Salsabila)

[14] Hobri et al 2018 High-order thinking skills in contextual teaching and learning of mathematics based on lesson study for learning community International Journal of Engineering & Technology 7 (3): 1576-1580

[15] Atikurrahman M et al 2019 The development of comparison material tool with problem based learning based on caring community and its effect on the student’s connection ability Journal of Physics: Conf. Series 1211 012091

[16] Hobri 2016 LSLC: revier of short term on lesson study V in Japan Proceeding of Conference. 12-21, 28 May. (Pamekasan: Madura University)