Development of 3CM (cool-critical-creative-meaningful) learning model to increase creative thinking skill

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Abstract. This research aims to develop a 3CM learning model to support student to improve their creative thinking skills. The method used in this research was R&D with ASSURE development model consisting of six stages: 1) analyze learners, 2) state objectives, 3) select method, media, and materials, 4) utilize media and materials, 5) require learner participation, 6) evaluated and revise. The participants in the research is pre-service primary teacher students. Product validation was done through an expert’s assessment by using the expert’s validation sheet. The practicality of the product is tested with limited trials with college lecturers and some students with questionnaires and interviews. Product effectiveness was seen by implementing limited development testing to a particular class with a group pretest-posttest design and the result was analyzed by using a Paired-Samples T-Test. The result of this research is a 3CM learning model to support students' to improve their creative thinking skills. The validity and practical of the learning model was proven by the result of the expert assessment in learning and limited test by peers and students in small group, material and instructional media. The effectiveness of the learning model was also proven based on Paired-Samples T-Test of students’ pretest and posttest.

1. Introduction

One of the goals of Indonesian education is to develop the potential of students to be creative people [1]. In fact, this has become one of the reasons for the change in Indonesia's national curriculum from KTSP to the 2013 curriculum, which is to form creative students. Creative is the highest level of competitivenes in the latest Bloom taxonomy [2]. Creative not only in producing product objects, but creative in thinking, including mathematical creative thinking. The ability to think creatively grows from one's creativity. Creativity also arises because of the opportunity to do it. Creative is also one of the main components in 21st century education [2, 4]. Therefore, the contemporary curriculum emphasizes the development of creative thinking abilities for students [5, 6]. Thus, the creativity of students needs to be developed in education, including in prospective elementary school teachers.

The real problem in learning, not all of them provide opportunities for students to improve reasoning skills and creative thinking in solving problems [7–9]. This situation ultimately affects the pattern of learning when they become teachers and teach in schools. Mathematics is often a less interesting information that is forgotten. There needs to be a change in the paradigm of learning mathematics, namely learning mathematics that is fun and giving students the opportunity to think about contextual issues. Learning mathematics must be in accordance with the context of student
reality, because mathematics is part of human culture [10–12] and is part of social reality [5, 9]. Mathematics will easily to remember, imagine, represent, manipulate and compile by cognitive maps in good schemas [13]. This learning method will make the schema formation process run well so that the mathematical concept will be fully stored and become an interesting experience to remember [13].

In addition to being contextual, the aspect of language becomes very important in learning mathematics. Because the wrong language will give the wrong understanding, for example the mistakes of students in interpreting the words in the problem. Not because they do not know the problem because inappropriate language will give a different interpretation from what the teacher wants. So that the mathematical communication process in this case does not work well [14–17]. Good language will make mathematics an interesting information, easy to remember and stored for a long time in the brains of students with a correct and stable schema. The schema is going to use to solve the problem given. Someone utilizes memory, representation and manipulation to solve a given mathematical problem. This ability called problem-solving ability [18].

This result is the basis for further formulating how mathematics learning can provide opportunities for students to develop creative thinking skills in the field of mathematics in a cool and fun but critical and meaningful way. This will provide a balance between the work of the left-brain and right brain so that the functions of the left-brain as a source of logic and right brain function as a source of spiritual feelings [18]. Feeling is one component in the ability to think creatively (creativity) which is an important component in today's global life. With this balance, students will have good creative thinking skills.

So that learning is needed with the right theoretical studies in the hope of providing a cool learning atmosphere and the opportunity to think critically, creatively and meaningfully. Learning must provide memorable experiences and opportunities for students to use the left and right brain in activities that are cool, critical, creative and meaningful that will be called 3CM Learning. This learning model adopts and combines the contextual learning, realistic mathematics, and learning meaning Brownell and David Ausubel. Learning begins with the provision of contextual problems that are close to human activities, culture and social reality so that it becomes an experience that is easy to remember, imagined, represented, manipulated and strung together in cognitive maps so as to make it easier for students to learn mathematics without having to be burdened with so many mathematical formulas.

Besides, it is necessary to have wide learning rides for students to find information related to problem solving, from fluency, flexibility, originality, and elaboration aspects from many sources. This can be done by utilizing technology as a learning tool and learning resource. To package this kind of learning model requires special skills for a teacher. Not enough content, or pedagogical learning skills, but should be able to combine the two. Not only required a special ability that is the use of technology in learning (technological). By combining these three abilities then the classroom learning will be more interesting, efficient and meaningful for the students. Learning is packaged in face-to-face and online learning (blended learning). This lesson will give students the opportunity to look for problem solving information provided with creative new solutions. With this learning process will provide opportunities for learners to get many resources and a lot of learning from others to inspire them in solving the problems given.

2. Method
This research is Research and Development (R & D) with ASSURE Development model. The design model was developed in 6 stages: 1) analyze learners, 2) state objectives, 3) select strategy, technology, media, and materials, 4) utilize media and materials, 5) require learner participation, 6) evaluated and revise [20]. It is clearly seen in Figure 1.
2.1. Data collection technique
Data was collected through expert assessment (product validity), peer assessment and limited testing (practicality), and effectiveness testing in one class (effectiveness). Expert assessments included learning experts, learning media, teaching aids and resources, and assessment experts. Practicality of the model was measured through peer assessment and student response in limited testing (8 students). The effectiveness of 3CM learning model could be seen from the average difference of pretest and post test results with one group pre-test post-test design. Research Instrument in a form of expert judgement sheet, learning tools and questions for instructional test are discussed in Focus Group Discussion (FGD) forum together with learning and evaluation experts as well as practitioners in the field of education to obtain instrument feasibility and validity.

2.2. Data analysis
Data analysis techniques were carried out in three stages: analysis of the results of expert assessments, practicality tests (peer assessments and limited test results of students), and model effectiveness tests with T-test. Data from expert 1 and expert 2 assessment scores were summed and averaged, then the score was percentage using the following rules:

\[
P_N = \frac{\text{Actual Score}}{\text{Ideal Score}} \times 100\%
\]

| PN          | Percentage Number |
|-------------|--------------------|
| Actual Score| Score given by expert validator |
| Ideal Score | Maximum score between the number of items times a maximum score of each item. |

The 3CM learning model said to be feasible if the average percentage of the minimum percentage reaches a high category (\( \geq 61\% \)) according to the following Table 1 categories:

| Table 1. Model Feasibility Category |
|-------------------------------------|
| Interval   | Category |
| 81 - 100 % | Very high |
| 61 - 80 %  | High     |
The practicality of the 3CM learning model is done by analyzing the results of peer evaluation and the student's response to limited implementation. Peer assessment data according to criteria Table 1, recapitulated and totaled (actual score), then compared with ideal scores and made criteria based on the rules contained in Table 3. Data of student responses in total then made criteria in 5 categories which are Very Good (VG ), Good (B), Good Enough (GE), and Not Good (NG), Very Bad (VD), then the number of students from each category was determined to see the quality of the model so that it could be used to see if the practical model was used.

The effectiveness test was carried out by comparative analysis that is comparing the results of the mathematics learning design before and after the application of the model for one class with one group pretest-posttest design using the criteria of creativity, which includes aspects of fluency, flexibility, originality, and elaboration. Based on the results of these three criteria, the final score was determined. The final score before and after the implementation of the model was compared with the paired sample Samples T Test with the help of SPSS 23.

3. Results and Discussion

3.1. Result

3.1.1. Teaching Quality of 3CM Learning

Before having the test, the get the learning students with 3CM learning models for 10 weeks. Learning is done face-to-face and online. Implementation of 3CM learning is done in seven steps of learning (syntax) that is, motivation, contextual problem, critical issue, problem solving, concept implementation in creative product, confirmation, reflection. Based on these 7 steps of learning can be mapped according to the nature of 3CM learning in Table 2 below.

| Aspek 3CM Learning | Learning Syntax | Explanation |
|---------------------|-----------------|-------------|
| **Cool**            | 1. Motivation    | Make students happy and motivated by providing events and contextual problems so that students are ready and happy to learn. This became the initial capital so that students were able to criticize the problems. |
|                     | 2. Contextual Problems |
| **Critical**        | 3. Criticize the Contextual Issues | After students are comfortable and happy to learn, they are invited to criticize the given contextual issues to determine the solution of the problem |
|                     | 4. Troubleshooting |
| **Creative**        | 5. Implementation of concepts in creative products | After students are able to determine the solution of the problem, they are invited to think of creative products that can be produced as implementation of the problems and concepts learned |
| **Meaningfull**     | 5. Confirmation | Together with faculty, students discussed the results obtained to give meaning to the lessons learned and to determine the implementation of the concept in everyday life |
|                     | 6. Reflection |

The model that has been developed is then validated by experts including learning experts, media experts, teaching materials experts and learning resources, as well as learning evaluation experts.
Table 3. Results of expert assessment for 3CM learning models

| No | Indicator                          | Ideal score | Actual Score Expert 1 | Actual Score Expert 2 | Average | AP (%) | Category |
|----|------------------------------------|-------------|------------------------|------------------------|---------|--------|----------|
| 1  | Learning activity plan             | 60          | 54                     | 55                     | 54.5    | 91%    | Very high |
| 2  | Learning media                     | 30          | 22                     | 22                     | 22      | 73%    | High     |
| 3  | Teaching aid and source            | 35          | 25                     | 25                     | 25      | 71%    | High     |
| 4  | Learning evaluation instrument     | 55          | 40                     | 41                     | 40.5    | 74%    | High     |

Based on the feasibility criteria of the developed model, the results obtained were very high and high categories (percentage value ≥ 61%) so that the model was feasible to use. The next step is the model is implemented on a limited scale to see the practicality of the model. Limited testing is done to one lecturer with 8 students. The results obtained are shown in Table 4 and Table 5 below.

Table 4. Peer assessment (Model Practicality Test)

| No | Indicator                  | Ideal Score | Actual Score | AP (%) |
|----|----------------------------|-------------|--------------|--------|
| 1  | Lesson plan               | 60          | 51           | 85%    |
| 2  | Learning media            | 55          | 44           | 80%    |
| 3  | Teaching aid and resource | 30          | 23           | 77%    |
| 4  | Learning evaluation instrument | 35     | 26           | 74%    |

Based on the results of the assessment and implementation of the model by peers the value of learning designs (face to face and online), media and teaching materials developed in the category of very high and high (AP value ≥ 61%) so that the practical model is used.

Table 5. Students test limited response (Model Practicality Test)

| No | Aspect Responded          | Students’ respond |
|----|---------------------------|-------------------|
|    |                           | VD % | NG % | GE % | G % | VG % |
| 1  | Lesson plan               | 0    | 0    | 0    | 1   | 12,5 | 4   | 50  | 3    | 37,5 |
| 2  | Learning media            | 0    | 0    | 0    | 2   | 25   | 4   | 50  | 2    | 25   |
| 3  | Teaching aid and resource | 0    | 0    | 0    | 1   | 12,5 | 3   | 37,5| 4    | 50   |
| 4  | Learning evaluation instrument | 0    | 0    | 0    | 1   | 12,5 | 5   | 62,5| 2    | 25   |

*Very Good (VG), Good (B), Good Enough (GE), and Not Good (NG), Very Bad (VD)

3.1.2. Mathematical Creative Thinking Initial Level

Before and after learning in 3CM learning models, students are given a pretest and posttest initial gain ability and end ability in their creative thinking. The mean of pretest and posttest results are 60.52 and 75.96 with the standard deviation of 9.60 and posttest 6.36 with the standard of precast error 1.85 and posttest 1.22. These results indicate that the creative thinking ability to post results closer to the mean grade compared with the pretest results. Thus, the value of the posttest variation is smaller than the pretest seen from the mean value.

Pretest data shows that, students' initial ability before learning with 3CM learning model is in medium and low category that is 92.59% (25 people from 27 people). Only 7.41% (2 people) are in creative category. This result shows that students' creative thinking abilities still need improvement.
After following the 3CM learning method, there is an increasing number of students, who have creative and medium categories. Creative category improvement from 7.41% (2 people) to 40.74% (11 people). The number of students with moderate and weak categories decreased from 92.59% (25 people) decreased to 59.26% (16 people). This shows an increase in creative thinking abilities before and after following the learning with 3CM learning.

This result is supported by observations when they are working on test questions. Students work on the problem independently with the stages of solving the problems that have been directed and produce several solutions, although not yet according to the creative thinking aspects can be implemented optimally. Descriptions of observation results are seen in Table 6 below.

| Table 6. Observation Results of Student Activities When Working on Tests |
|--------------------------|----|----|----|
| CTS Aspect | Questions | 1 | 2 | 3 |
| Fluency | | 20 | 20 | 22 |
| Flexibility | | 18 | 16 | 15 |
| Originality | | 12 | 13 | 11 |
| Elaboration | | 11 | 11 | 12 |

To see more about the impact of the application of 3CM learning in learning, it is necessary to test the effectiveness of the model by using paired T tests. This was chosen because the study design used a quasi-experiment with one group pretest posttest design. There is a disadvantage of this design because it uses only one class. Here are the results of the normal test data as shown in Table 7 below.

| Table 7. The Normality Test of Creative Thinking Skills Pre-test and Post-test |
|----------------------|--------|--------|
| Statistic | df | Sig. |
| Pre Test | .930 | 27 | .068 |
| Post Test | .932 | 27 | .077 |

The number of students taken as a sample of only 27 people so that the results of normality are taken with the result of normality with Shapiro-Wilk. According to the data in Table 8 we get the Sig value. Pretest and Posttest of 0.068 and 0.077 are both greater than 0.05 so that both data are normally distributed. This is the requirement for the following steps: Paired Samples T Test. The results obtained can be seen in Table 8 and Table 9 below.

| Table 8. Paired Samples T-Test Creative Thinking Ability |
|-----------------------------|--------|--------|
| Paired Samples Correlations |        |        |
| Pair 1 | Pre Test & Post Test | N | Correlation | Sig. |
| | | 27 | .777 | .000 |

| Table 9. Paired Samples T-test Creative Thinking Ability |
|-----------------------------|------|-------|--------|
| Paired Differences | t | df | Sig. (2-tailed) |
| Mean | Std. Deviation | Std. Error | Mean |
| Pair 1 | Pre Test - Post Test | -15.44 | 6.14 | 1.182 | -13.06 | 26 | .000 |
Based on data of Table 8 and Table 9 it is found that the value of sig. 0.000 <0.05 and t arithmetic (13.06) > t table (2.05) it is found that there are significant differences between pretest and posttest results. Where posttest results are better than the pretest results. Thus, it can be concluded that the application of 3CM learning is effective in improving students' creative thinking skills in solving math problems.

3.2. Discussions

Based on the results of data analysis and hypothesis testing, it found that the 3CM learning model with blended learning could improve students' creative thinking skills in solving mathematical problems. This happens because the learning situation is prepared and implemented in accordance with the context of student life, and in fun activities package. This is according to the current paradigm of learning mathematics, where mathematics is close to humans, mathematics is part of human culture [9–11] and part of social reality [9–13]. This is also according to the research of [7, 9], learning with scaffolding in an interesting and correct way and using contextual problems can motivate students to want to learn mathematics and be able to solve mathematical problems. The interview results showed motivating with interesting, contextual, easy to imagine things, not always in the form of formulas and numbers, making them interested and willing to learn mathematics.

In addition, students can also experience directly through contextual events, students also get experience in online learning that has been prepared. After students look at the problem of fiber criticizing the problems contained in the video that has been given, students create creative products as stated in the form provided that is to produce creative works in the form of power point animations for even number patterns. This condition provides opportunities for students to have enough vehicles as learning resources that can be accessed whenever and wherever they like. In addition, this model allows students to see creative and unusual problem-solving ways with interesting approaches to inspire them to produce problem solving in new ways. This is in accordance with the principle of creativity arising because there is an opportunity. There are 3N activities (Niteni, Nerokke, Nambahi) taught by Ki Hajar Dewentara. This concept makes the thought that creativity will emerge if students are given the opportunity. The creativity that appears is still at a level that must see the example first. The results of the interview support this statement, students at the initial level tend to mimic so that raises ideas to think about other creative works. This is according to Hsieh's opinion [20] the teaching style of a teacher can influence students' learning reflections (in this case student). Therefore, if you want to produce creative students, the lecturer must be creative first in designing and implementing learning. This is in line with the opinion of Morais & Azevedo [22], a good teacher must be creative so that it can be an example for students to create further. In addition to creativity, something that can be exemplified, teaching creativity is also one of the best and always evolving habits of teaching creative thinking and developing [22].

The concept of learning is also in accordance with the principle of a teacher according to Ki Hajar Dewatara namely Ing Ngarso Sung Tulodo, Ing Madyo Mbangun Karso, Tut Wuri Handayani. Teachers must be able to be role models for their students, be able to build the spirit of students, but also must provide the widest possible opportunity for students to learn further to explore learning resources, elaborate so that students become independent people. Learning because of your own will, so learning does not have to wait to be given, but learns to find and find.

The success of this model improves mathematical problem solving abilities, also due to the obligation of students to produce creative work that is the result of their creative thinking in solving problems. Students are given wide opportunities to discuss with their team, find sufficient information and data and are not limited to the time and place and the role of lecturers directly. This is in accordance with the opinion of Boelens et al., [24] learning must be able to stimulate student interaction, facilitate their learning process, and encourage an affective learning climate. Each of their learning activities has been designed and prepared from the beginning and explained to the students.
the target products that must be produced and how they can meet these targets. So that they in the team will try to meet the predetermined target.

Student creativity in solving mathematical problems also supported by a learning environment that fosters creativity among students themselves [25]. There is an opportunity for each group to present the results in a face-to-face class, thus encouraging other groups to produce better work, and even better. This very positive learning environment triggers students with their teams to continue to improve their creative work. Lecturers in the form of learning simulations by lecturers using animation media, images and even videos of life realities that are close to students so that they are easy to understand also provide positive learning environment. This is consistent with the results of Tsai & Chung's research [26], that a positive learning environment will make students motivated and creative to produce something useful.

4. Conclusion
Based on the results of data analysis and discussion, it can be concluded that 3CM learning valid, practical and effectively improves students' problem solving in creative thinking abilities. This happens because learning gives students the opportunity to think systematically by beginning by criticizing the interesting contextual problems and ending with meaningful reflection with adequate learning resources both when face-to-face and online. Creative students because lecturers give them the opportunity to do something creative in creative activities. The thing that needs to be considered in this learning model is how to design creative activities to provide opportunities for students both individually and in groups to produce creative things, especially in thinking. The advice that can be given from the results of this study is, every student has the opportunity to do and produce something creative. Give the widest possible comfort to them to do creative things with activities that are contextual, critical and give meaning to themselves individually and together.

Based on the results of research and analysis has been conducted on the research results, the suggestions of the results of this study are lecturers are suggested to give their students a great opportunity to develop their creativity in solving mathematical problems. Gives students the opportunity to think systematically by beginning by criticising the interesting contextual problems and ending with meaningful reflection with adequate learning resources both when face-to-face and online.

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