Implementation of Creativity Problem Solving Model Using E-Learning in Applied Graph Theory Course

S Wahyuningsih, D Satyananda, L T Octoviana, and R Nurhakiki
Departement of Mathematics, Universitas Negeri Malang, Indonesia
sapti.wahyuningsih.fmipa@um.ac.id

Abstract. One of learning alternatives that can be applied to improve students' activity and creativity is e-learning. Implementation of e-learning for applied graph theory course used e-module for course material, e-portfolio for student assignments, and online-based tasks that can be accessed by other students, hence it is could be as a pioneer of wider implementation of online learning. In applied graph theory course, students needed to have direct experience in solving problems in related industries/institutions. From direct application experience in the field, students raise problems, model problems in the graph, and determine appropriate methods to solve the problem. Creative thinking process could be identified from students’ problem solving task by using Creative Problem Solving (CPS) model. There are four indicators of main step (understanding the challenge, generating ideas, preparing for action, and planning approach) and eight minor step indicators (constructing opportunities, exploring data, problem framing, generating ideas, developing solutions, building acceptance, appraising tasks, and designing process) in the recent version. Purpose of the paper is to analyze result of CPS model implementation, and to discuss student’s responses to the implementation. By implementing the CPS model through e-learning, it could be identified that student’s creativity in real problem solving were good. The questionnaire indicated that the student response strongly agree with the implementation of this learning to develop creativity.

1. Introduction
Facing the challenges of the development of science, technology, as well as information, education reform is needed at higher education so that students have skill and ability to utilize technology. One form of learning that can be applied to improve student activity and creativity is e-learning [1]. In e-learning, lecture materials are in the form of e-modules, student assignments are in the form of e-portfolios, and web-based assignments that can be accessed by other students online.

Some research has been done related to the success of e-learning that can increase activity and creativity. Researches on the effectiveness of e-learning in higher education, for example, are done by [2], [3] who developed e-learning to develop creative thinking in higher education, and [4] that developed mobile learning in Kuwait higher education. Others are [5] about measurement of quality in the e-learning context, and [6] about mathematical creativity usage of technology. Another is [7] that connected problem solving with creativity through online education.

In [8] a research was conducted about the effect of Creativity Problem Solving (CPS) on university students. CPS is a model or framework for a creative approach of problem solving [9]. Some implementations of CPS are [10] that used CPS for mathematics education, [11] and [12] implemented CPS in blended learning.
In [13] described the development of Creative Problem Solving models. The original CPS model was first developed by Osbon in 1952, 1953 and 1957, which then later known as the version 1.0 and revised by Osbon in 1963, 1967 with version 1.1. This CPS version 1 model made the creative process explicit and deliberate. The CPS model developed by focusing on preparing CPS for an instructional program was version 2.0 and 2.1 by Parnes in 1966, 1967, version 2.2 by Noller et al in 1976, 1977, version 2.3, and version 2.4 by Parnes in 1988. The CPS model version 3 was developed with focus in linking person to process. Furthermore, Isaksen & Treffinger in 1991 developed version 4 with focus on breaking up the process. CPS version 5 with focus taking a descriptive approach developed by Isaksen et al (1994). CPS version 6 with a focus on integrating the model into a systemic framework was developed by Treffinger et al in 1998.

Treffinger et al [13,14] developed the CPS version 6.1 which includes four indicators of main step: understanding the challenge, generating ideas, preparing for action, and planning approach, with eight minor steps indicators: constructing opportunities, exploring data, problem framing generating ideas, developing solutions, building acceptance, appraising tasks, and designing process. The implementation of this CPS model guides to a creative process to find out the creative thinking process of students in solving the problem of applied graph theory.

Applied Graph Theory course in Mathematics Department, Universitas Negeri Malang, was intended to give direct experience in implementing science in real life and to have students’ ability in problem solving. This course has a wide field of application. One of assignments to students is to have survey in industry / related institutions. From direct experience in the field, students submit problems, model in the graph and determine the appropriate method to solve the problem.

Purpose of this paper is to identify creative thinking process of students in Applied Graph Theory course. The process comprises four indicators of main step and eight minor steps indicators. Writer analyze student’s response to study how CPS foster curiosity, motivation and creative attitude of students. This paper describes student responses to the implementation of the CPS model through e-learning in the applied graph theory course.

2. Method
Type of the research was descriptive qualitative, that use qualitative data on problem posing and problem solving. The results of creative problem solving identification were described to find out the creative thinking process of students in submitting the problem of applying graph theory in the field survey. The Creative Problem Solving (CPS) model used was the development of CPS version 6.1. The study was conducted in the Department of Mathematics, State University of Malang with the subject of 25 students of Mathematics Study Program year 2015/2016 (offering G, H and I) who were taking Applied of Graph Theory course in even semester 2017/2018.

The research phase were:
1. Develop a Semester Lecture Design (RPS). The design of this lecture uses the e-learning of UM (http://e-learning.um.ac.id)
2. The learning process
   a). Upload lecture materials in the form of e-modules
   b). Create the structured task of students in the form of e-portfolios
   c). Create groups to prepare field survey proposals
   d). Have a discussion forum: lecturers with students and among students
   e). Retrieve data from field surveys
   f). Submit problems, model problems, and design solutions with suitable methods / algorithms.
3. Data Analysis
   a). The results of problem submission and problem solving from students were analyzed using the CPS model version 6.1. Focus of CPS model is integrating the model into a systemic framework with two specific stages: appraising task and designing process. These are considered relevant to the characteristic of Applied Graph Theory course.
b). The results of the lecture response questionnaire were described to find out students' perceptions of CPS implementation through e-learning.

3. Result and Discussion

3.1. E learning implementation

The development of e-learning in the Applied Graph Theory course used Moodle Learning Management System (LMS). Important features that support lectures are assignments, quizzes, discussion forums, collaborations, and uploading various lecture material formats. E-learning can be useful to create an atmosphere of learning that is effective, innovative, and fun. In the lecture process, the teacher acts as a motivator and facilitator. Changes in the instructional based learning paradigm into constructional based learning make teachers design lectures that enable students to sharpen more skills with independent practice. To realize an effective, innovative, and fun lecture process that can activate students, the teacher utilizes all the facilities and infrastructure provided by the University. The advantages of e-learning are flexibility, comfort, and ease of learning anywhere without having to be in the same place. Another advantage is the ability of students to adapt and communicate with their peers with unlimited distance. The use of e-learning in the lecture process can increase student motivation and creativity by combining with CPS implementation. The results are supported by several researches that have been carried out related to the success of e-learning that can improve the activeness and creativity of students, among others by [1], [15], [7], [6], [16], [2], and [3].

In accordance with the researches of [10] and [17], this creative problem solving can be used to identify student creativity. The problem solving in the Applied Graph Theory course is derived from the students' direct experience in solving problems in the industry/related institutions. Applied Graph has a wide field of application in real life. From direct experience in the field, students submit problems, model in the graph and determine the appropriate method to solve the problem. Examples of proposed problem solving:

1. Distribution of Sosro Products Using Minimum Cost Flow Methods at PT Sinar Sosro Malang
2. Application of Network Analysis in Resolving Project Scheduling Problems in PT. Kharisma Menara Abadi Malang
3. Optimization of Newspaper Distribution Using Dynamic Traveling Salesman Problems in Radar Malang
4. Optimizing the Assignment of Workers of the Adi Bungsu Cigarette Company with Bipartition Matching Graph
5. Maximum Flow Application in Product Distribution at PT Gatra Mapan Malang
6. Optimization of Newspaper Distribution Routes in Radar Malang by using Vehicle Routing Problem With Time Window (VRPTW)
7. Optimizing the Distribution of Ice Cream Walls by Using Capacitated Vehicle Routing Problems at PT Lukindari Permata Malang
8. Application of Maximum Flow in Optimizing the Taking of Super Nett Shuttlecock Raw Materials
9. Determination of Optimal Route of LPG Distribution in Pertamina PT Dipo BBM Malang Using the Traveling Salesman Problem with Time Windows (TSPTW) Method

3.2. Analysis of CPS model implementation

In the implementation of CPS model, the problem solving solved by students is described based on four indicators of main steps and eight indicators of minor steps with a focus on integrating the model into a systemic framework developed by [13]. Data to identify the indicator came from problem posing, modeling, and designing solution by students, from problem they found in field survey. The students were asked to visit industry or institution to find a problem. Score for each indicator were grouped into five: very good (A), Good (B), fairly good (C), less good (D), and not good (E). The description results can be seen in Table 1.
Table 1. Creative Problem Solving Version 6.1 (CPS V6.1)

| Main steps                  | Indicators | Very good | good | Fairly good | Less good | Not good |
|-----------------------------|------------|-----------|------|-------------|-----------|----------|
| 1. Understanding the challenge | Constructing opportunities | 7          | 11   | 5           | 2         |          |
|                             | Exploring data | 8          | 12   | 5           | 0         | 0        |
|                             | Framing problems | 3          | 14   | 6           | 2         | 0        |
| 2. Generating ideas         | Generating ideas | 5          | 13   | 7           | 0         | 0        |
| 3. Preparing for action     | Developing solutions | 8          | 13   | 4           | 0         | 0        |
| 4. Planning your approach   | Building acceptance | 7          | 15   | 3           | 0         | 0        |
|                             | Appraising tasks | 9          | 11   | 5           | 0         | 0        |
|                             | Designing process | 10         | 10   | 5           | 0         | 0        |

From the results of the analysis, it can be seen that the students' creativity is good in solving the problem in Applied Graph Theory through e-learning. If each step minor indicator is described, it can be seen that 56% of student creativity is good on framing problems indicators, see Figure 1.

![Framing Problems Indicators](image1)

**Figure 1.** Framing Problems Indicators

Meanwhile, in indicator of building acceptance, 60% of students’ creativity is good, as depicted in Figure 2.

![Building Acceptance Indicator](image2)

**Figure 2.** Building Acceptance Indicator
3.3. Students’ Response to implementation of CPS model through e-learning

In the implementation of the CPS model in the Applied Graph Theory course, from student responses were identified that 68% strongly agreed that learning that encourages creative thinking, as illustrated in the Figure 3.

![Figure 3. Students’ Response about Learning Support Creative Thinking](image)

Student’s responses are very good to the statement that using open problem can deliver experience in interpreting problems and constructing different solutions.

One indicator of creative thinking skills is that students can use more than one way, and look for ways other than what they have used [18]. Student responses to this problem are over 58% agreeing that this encourages student creativity, which can be seen in the Figure 4.

![Figure 4. Students’ Response about Learning Support Student Creativity](image)

4. Conclusion

In this study, student creativity is good at the Applied Graph Theory course by implementing CPS model version 6.1, both in terms of indicators of main step and minor step. Against the implementation of learning this is a student response that 68% strongly agree that learning encourages creative thinking. It
can be described that response of students were satisfied by implementation of CPS model through e-learning, in Applied Graph Theory course. From this research, some courses which have problem solving characteristics (such as Operation Research, Mathematical Modeling) can apply CPS model to enhance student’s creativity.

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