# An Integration of "Online Interactive Apps" for Learning Application of Graph Theory to Enhance Creative Problem Solving of Mathematics Students

Sapti Wahyuningsih[✉],Darmawan Satyananda, Abd Qohar
Universitas Negeri Malang, Malang, Indonesia
Sapti.wahyuningsih.fmipa@um.ac.id

Noor Azean Atan
Universiti Teknologi Malaysia, Johor, Malaysia

**Abstract**—An Integration of "Online Interactive Apps" for learning can be a disruptive learning innovation in higher education. The material of the application of graph theory course has application topics in the real world. How students use the application can be used as a measure of creative problem solving. Mixed method was used in the study. The first phase of the study used one group non-randomized design pre-test and post-test. Participants were students who took courses in the application of graph theory. The second phase of the study involved an exploration of creative problem solving performance through qualitative interviews. Analysis of problem solving skills with creative problem solving instruments adapted from the CPS version 6. The average performance of students is very good in exploring data and building acceptance, performance is good in generating ideas and designing processes. Finding from this research is a significant improvement of students' Creative Problem-Solving by integrating learning the application of graph theory with "Online Interactive Apps". The results obtained that 69% of student opinions strongly agree on learning activity can improve creative problem solving. The implementation of "Online Interactive Apps" can be used as an alternative to disruptive learning innovation in mathematics teaching-learning.

**Keywords**—Online Interactive, graph theory, creative problem solving, powtoon applications, and kahoot application.

## 1 Introduction

### 1.1 Background

The development of technology is so rapid in various fields including the educational revolution in higher education. The challenges of the development of information technology lead to challenges in the education world and even require disruptive innovations in higher education. Integrating information technology in learning

becomes a necessity. There are many computer or online application programs can be used in the integration of online interactive learning. Online learning research in higher education continues to be carried out by researchers worldwide. Innovative online learning can be read on [1], the effectiveness of online learning [2], [3] and efficiency and effectiveness of online learning [4] and online learning in developing countries [5]. Implementation of online collaborative [6], online assessment [7], mobile learning applications for android [8] and model assessment in online courses [9].

Learning innovation by integrating ICT into learning is needed to keep up with the development of education 4.0. Learning will be more effective and efficient by integrating ICT. Research on integrating ICT in learning can be seen in [10]. The integration of ICT can be in the form of interactive leaning. Interactive learning can be seen in [11], [12], [13], and [14]. The use of ICT in learning mathematics can be seen in [15], [16], [17], [18] and [19]. Online learning is also associated with increasing problem solving abilities such as the effect of web learning on problem solving strategies [20], CPS on blended learning seen in [21], [22]. Other studies linking creativity with the development of ICT, for example creative through ICT can be seen in [23] and [24]. Integrating mobile applications to improve creative thinking can be seen in [25] and adoption of mobile applications as learning tools for higher education [26]. While the development of creative learning with e-learning can be seen in [27] and [28].

Material application of graph theory has a wide field of application in real life. The integration of ICT is needed in the implementation of learning the application of graph theory. By identifying the application of graph theory in real life can be used as a tool to measure students' problem solving competencies. Many researchers link problem solving competencies with creativity through online education. Research on the effects of CPS on university students can be seen in [29]. Whereas [30] use CPS for mathematics education. Research on the implementation of CPS in blended learning was conducted by [22] and [21].

Problem solving in lecturing the application of graph theory is obtained from direct experience of students in solving problems in related industries / institutions. From direct experience in the field, students present problems, model in graphs and determine appropriate methods to solve the problem. Based on research noted in the previous paragraph , the use of technology will be able to increase creativity and help solve real problems. Currently, studies that related to the findings are considered very limited in improving creative problem solving of mathematics student in higher education. There is no published data on an integration of "Online Interactive Apps" for learning graph theory application course. How to improve the performance of creative problem solving math students by integrating an online interactive app? How to describe the criteria of the CPS component for mat students in learning the application of graph theory? and what are the student's perception of creativity by implementing an interactive online app in learning the application of graph theory? That is what will be discussed in this article.

## 2      Methods

Mixed method was used in the study. The first phase of the study used a one group pre-test post-test non-randomized design. The second phase of the study involved an exploration of creative problem solving performance through qualitative interviews. Participants were students who took courses in the application of graph theory (N = 29, male = 8, female = 21) in the even semester 2018-2019. The students' quantitative data were collected in the form of pretest and posttest using Kahoot application. The instrument test was validated by an expert. In the other side, the qualitative data were collected from problem solving task of a real problems in the form of short videos based on Powtoon applications. Qualitative data were taken from task-based interviews, using a semi-structured format. The instruments of the research were taken problem solving skills with creative problem solving instruments adapted from the CPS version 6 [28]. Quantitative data analysis using the Minitab program. Qualitative data analysis are analyzed in some points: categorization, reduction, exploration, interpretation, and drawing conclusion.

## 3      Results

### 3.1      The CPS mathematics student performance

The CPS model version 6.1 which includes four indicators main steps (understanding the challenge, generating ideas, preparing for action and planning your approach) with eight indicators minor steps. Analysis of the data for the first research question "how to increase CPS mathematics student performance by integrating an interactive online application?" A kahoot-based interactive application was used in pretest and posttest. The result of normality test for the pretest can be seen in Diagrams 1. The results of the analysis with the application of the Minitab program found that $p < 0.05$, it can be seen in Table 1. This shows that there is a significant increase in CPS mathematical performance of students by integrating an interactive online application.
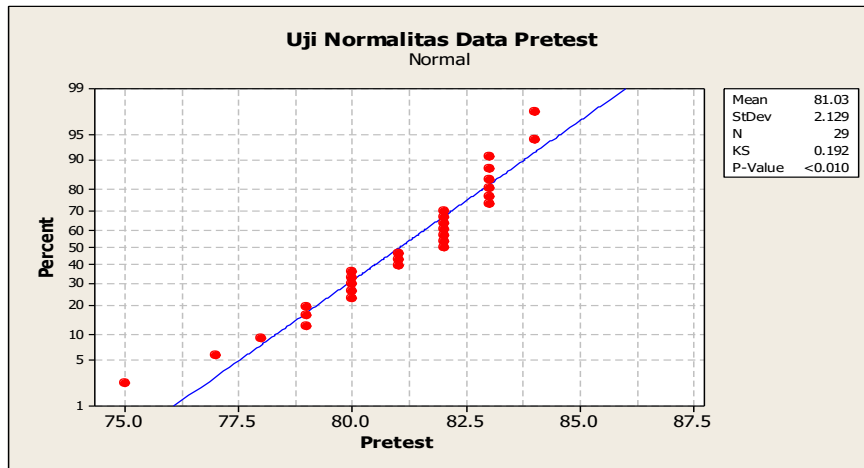
**Fig. 1.** Normality test

**Table 1.** Statistics result

|          | N  | Mean   | St Dev | SE Mean |
|----------|----|--------|--------|---------|
| pretest  | 29 | 81.034 | 2.129  | 0.395   |
| posttest | 29 | 85.862 | 2.100  | 0.390   |

95% upper bound for mean difference: -4.049

T-Test of mean difference = 0 (vs< 0): T-Value = -10.55 P-Value = 0.000

## 3.2 The description of the components of the CPS indicator for mathematics student (CPS version 6)

Analysis of the data for the second research question "how is the description of the components of the CPS indicator for mathematics student performance in learning the application of graph theory?" shown in Diagram 2 to Diagram 5. This shows the average performance of students is very good in exploring data and building acceptance, but performance is good in generating ideas and designing processes
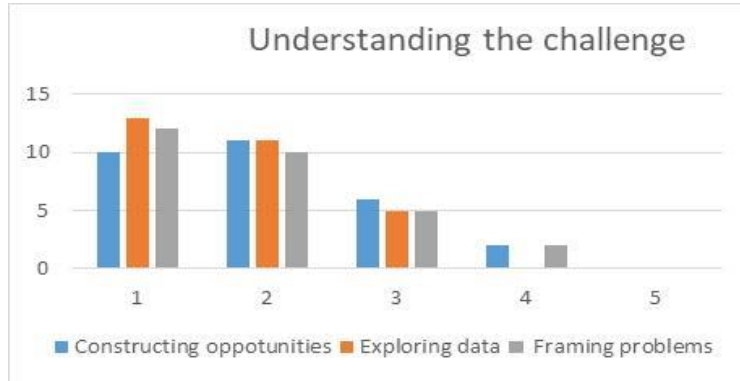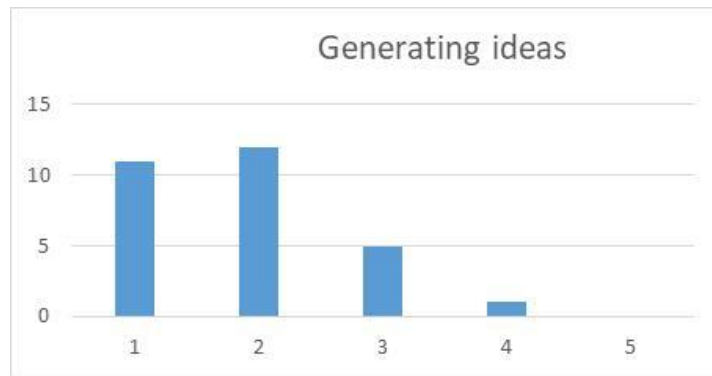
**Fig. 2.** Understanding the Challenge
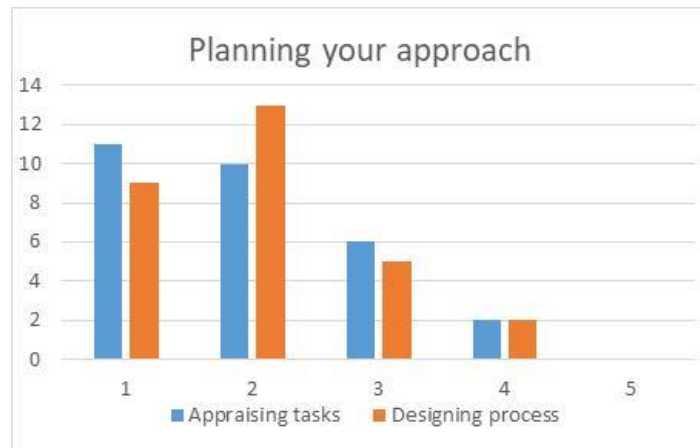


**Fig. 3.** Generating ideas



**Fig. 4.** Planning your approach

**Fig. 5.** Preparing for action

### 3.3 The student's perception

Data for the third research question "what is the student's opinions of creativity by implementing an interactive online app in learning the application of graph theory?" is analyzed by giving a questionnaire. Diagram no 6 shown that 69% of student opinions is very agree on learning activity can improve creative problem solving.
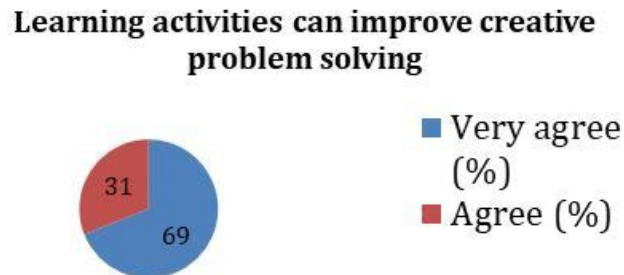


**Fig. 6.** Students opinions

## 4 Discussion

Integration of "Online Interactive Apps" in pre-test and post-test of this learning was using the Kahoot application. Based on the graphic in Diagram 1 of the pretest and post-test with the probability plot normality test, it can be seen that the points are approaching the diagonal line. It was concluded that the residual value was normally distributed. The normality assumption for the pre-test and post-test values applies so that statistical analysis can proceed to the analysis of Enhance Creative Problem Solving of Mathematics Students in the integration of "Online Interactive Apps".

The instrument for observing CPS performance of mathematics students was adapted from CPS version 6 [29]. The indicators of main steps and minor steps of the CPS model in the implementation of learning the application of graph theory are 1. Understanding the challenge (building problems in field surveys, exploring real data, problem modeling/designing real problem solving), 2. Generating ideas (compiling and design solutions with algorithms), 3. Preparing for action (developing problem, building acceptance of solutions), and 4. Planning your approach (checking the results of completion, designing process solutions and their interpretation).

The integration of "Online Interactive Apps" used in this study is a powtoon application. Field survey reports in the form of problem modeling, design solutions with algorithms, problem solving with program tools and real problem interpretation are visualized in the powtoon application. An example can be seen in the figure 1 to figure 6.
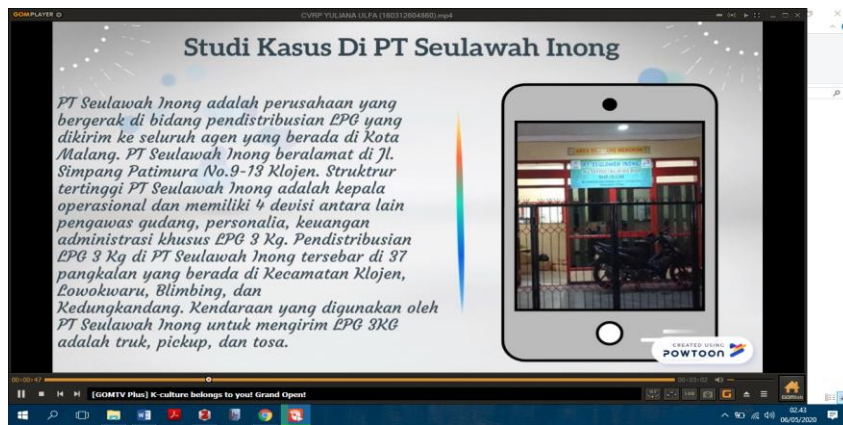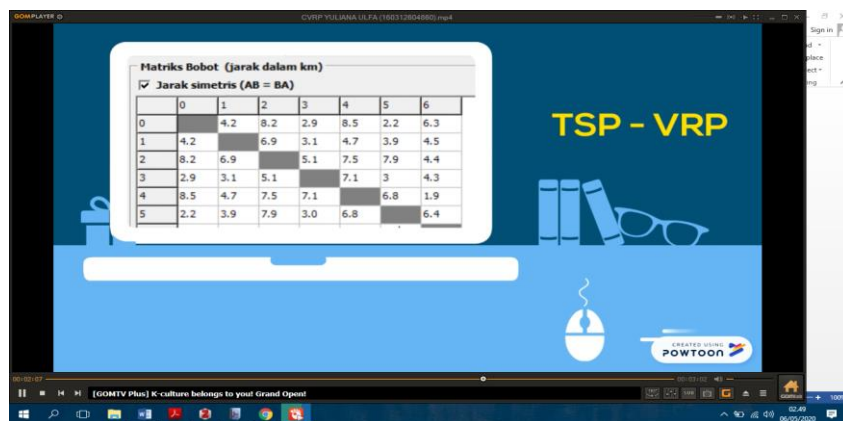


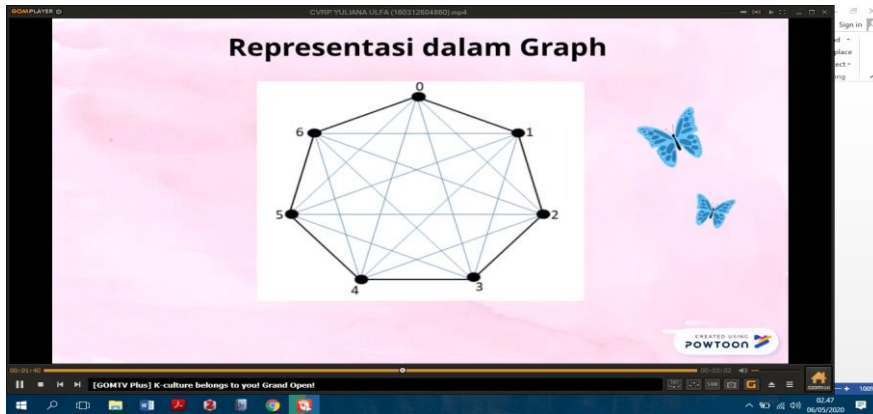**Fig. 7.** Building problems in field surveys



**Fig. 8.** Exploring real data
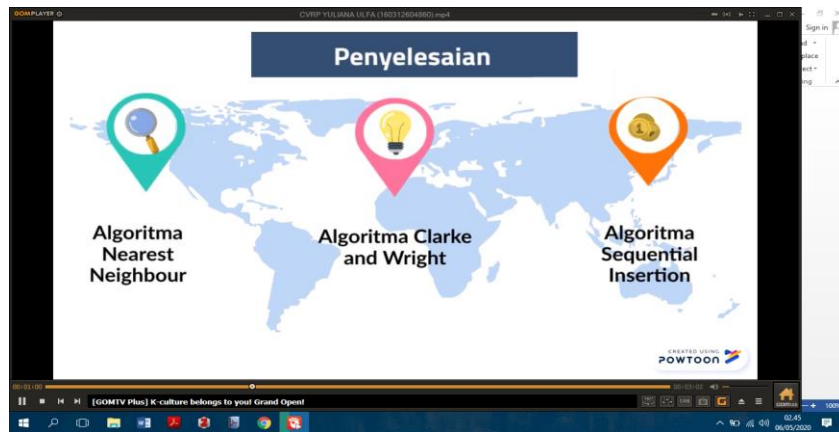
**Fig. 9.** Problem modeling
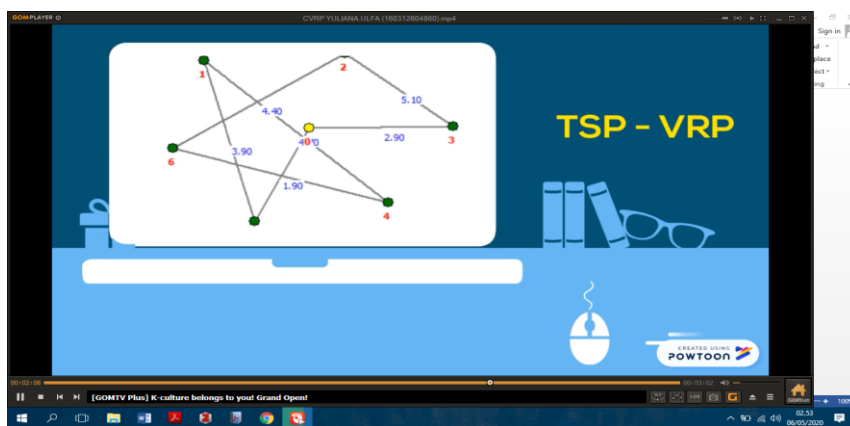


**Fig. 10.** Design solutions with algorithms



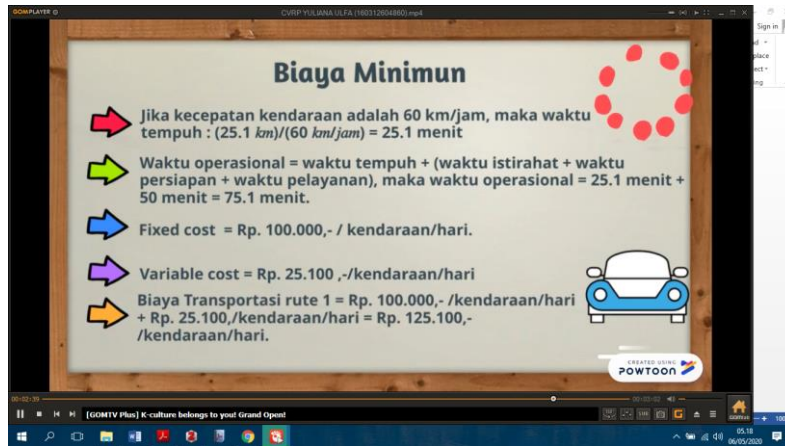**Fig. 11.** Building acceptance of solutions

**Fig. 12.**Designing process solutions and their interpretation

Finding from this research is a significant improvement of students' Creative Problem-Solving by integrating learning the application of graph theory with "Online Interactive Apps". The statistics result with the application of the minitab program was found $p < 0.05$. This result shows that there is a significant increase in CPS mathematical performance of students by integrating an interactive online application.

These findings confirm the previous studies by [20], and [21]. Refer to the previous research: Engineering Education using web-based Interactive multimedia applications [31], interactive learning using digital assistance [32], the effect of web-based professional improve teachers' Problem Solving Strategies [20], effective integration of interactivity into future online courses [14], and Integrating mobile applications to improve creative thinking [25] these results support the idea of integrating learning with "Online Interactive Apps".

Student's creative problem solving through blended learning [22], effectiveness of m-learning applications for design and technology subject [33], problem solvers are better leaders: facilitating critical thinking among educators through online education [34] these results support the idea of students' Creative Problem-Solving by integrating learning upport the idea of integrating learning the application of graph theory with "Online Interactive Apps"

Significantly, The implementation of "Online Interactive Apps" based on kahoot and powtoon applications can be used as an alternative to disruptive learning innovation in mathematics teaching-learning.

## 5 Conclusion

This paper has argued that the kahoot application is one of the online applications as a fun evaluation tool for learning graph theory. In this investigation, we assess the provision of interactive application-based tasks such as the Powtoon application to improve creative problem solving performance. Integrating an online interactive app

can improve the performance of creative problem solving math students. The criteria of the CPS version 6 used to identification of mathematics students in learning the application of graph theory. To confirm the result of CPS, a questionnaire was given to the students, and it can be described that 69% of students gave opinions of very agree on learning activity can improve creative problem solving.

It should also make recommendations for further studies or changes that should be made in practice. The integration of interactive online applications can be used for learning mathematics. The findings that has been discussed suggest that integration in online interactive learning applications in addition to powtoon applications such as visme, prezi, go animate, and emaze.

## 6 Acknowledgement

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# 8    Authors

**Sapti Wahyuningsih** is an associate professor at Faculty Science, and Mathematics, Universitas Negeri Malang. Her research interests include applied mathematics and disruptive learning innovations in higher education. Email: sapti.wahyuningsih.fmipa@um.ac.id,

**Darmawan Satyananda** is a senior lecturer at Faculty Science, and Mathematics, Universitas Negeri Malang. His research interests include graph application and computing method in distribution process. Email: darmawan.satyananda.fmipa@um.ac.id

**Abd Qohar** is an associate professor at Faculty Science, and Mathematics, Universitas Negeri Malang. His research interests include Mathematics education, IT based learning and curriculum development. Email: abd.qohar.fmipa@um.ac.id

**Noor Azean Binti Atan** is senior lecturer, Department of Science, Mathematic Education and Creative Multimedia Faculty of Education, Universiti Teknologi Malaysia. Her research interests include Creative and Innovative Technologies in Education. Email: azean@utm.my