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The Creative Problem-Solving Model in Animation-Based Multimedia to Improve Students' Creative Thinking Ability

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Abstract

Creative thinking is an ability that must be developed for every student, where creative thinking is often associated with problem solving activities. With the ability to think creatively, students will involve all of their thinking skills to find solutions to the problems they face. However, the current learning process has not been able to fully develop students' creative thinking skills. Therefore, this study aims to design animation-based multimedia with the Creative Problem-Solving model to improve students' creative thinking skills. From this study, the results obtained: 1) Multimedia is feasible to use, the average percentage of media experts is 86.68% with the "Very Good" category; 2) Multimedia that has been designed is able to improve students' creative thinking skills which refers to the four indicators of creative thinking, with the average value of students' creative thinking abilities as a whole, namely 55.12% in the "Creative Enough" category. In addition, a gain index of 0.48% was obtained with "Medium" effectiveness. 3) Student responses to multimedia show a percentage value of 92% with the "Very Good" category.

Keywords: Creative Thinking, Animation, Creative Problem Solving, Routing, Routing Statis, Routing Dynamic.

INTRODUCTION

Creativity is a complicated concept that can be conveyed in a variety of ways, including verbal, musical, mathematical, spatial, kinaesthetic, interpersonal, and possibly intrapersonal intelligences (Gardner, 1985). Torrance (1966) defined creativity as the process of becoming sensitive to a problem, deficiencies, gaps in knowledge, missing elements, disharmonies, and so on; identifying the difficulty; searching for solutions, making guesses, or formulating hypotheses about these deficiencies; testing and retesting hypotheses, possibly modifying and retesting hypotheses; and finally communicating the results. If someone has the ability to think creatively, this creativity will emerge.

The ability to discover new things that did not exist before, to be original, to invent fresh solutions for each challenge, and to generate new, diversified, and distinctive ideas are all examples of creative thinking. (Leen et al., 2014). Critical thinking is the most valuable skill that can be passed on by the school to its graduates and becomes a learning goal at all levels of discipline (Thompson, 2011).

Because the level of complexity in all parts of modern life is higher, creative thinking is extremely vital in this era of global competition. Two areas of the brain are required for creative thinking. It is critical to strike a balance between logic and intuition. If someone has the ability to think creatively, they will be able to address their difficulties in real life in a variety of ways. Pay attention to the value of creative thinking; consequently, the writers attempt to describe it.

Students that think creatively are more likely to develop in-depth knowledge through effective learning (Sdouh, 2013), which helps them start new knowledge, ideas, or products. Bill Gates, Steve Jobs, and Mark Zuckerberg are all highly skilled professionals who came up with new ideas and founded the Microsoft Corporation, the iPhone, and Facebook, respectively. It could also help people solve problems in novel ways when confronted with difficulties (Gibson, 2015). For example, Elon Musk, the founder of PayPal, demonstrates that unconventional techniques to money circulation can be superior than standard methods; innovation transforms the world.

Creative problem solving (CPS) is the association between problem solving process and creative thinking (Kirton, 2003). CPS was developed in 1952 by Osborn (1957) who presented 7 processes of CPS which were 1) orientation, 2) preparation, 3) analysis, 4) hypothesis, 5) incubation, 6) synthesis, and 7) verification. The latest CPS process consisted of 4 main steps and 8 minor steps which were 1) understanding the challenge: constructing opportunities, exploring data, and framing problems 2) generating ideas: generating ideas 3) preparing for action: developing solutions and building acceptance and 4) planning your approach: appraising tasks and designing process (Isaken et al., 2003).

Creativity and CPS are important in helping students deal effectively, independently, and resourcefully with a wide variety of complex opportunities and challenges. In preparing students for the increasingly complex challenges of the workplace, they can also have a very powerful, positive impact on students' personal lives and careers. Through knowledge of CPS tools and their ability to use them, students discover rich and varied new opportunities for personal growth and productivity, through which students discover and their passions, discovering and developing ways to be at their best. When people in a group talk about the best, most powerful learning experiences they have ever had, it is common for them to describe their encounters with creative learning. When people discover and use their creativity, they find that they feel healthier, happier, and more productive in a variety of ways (Treffinger, 2001).

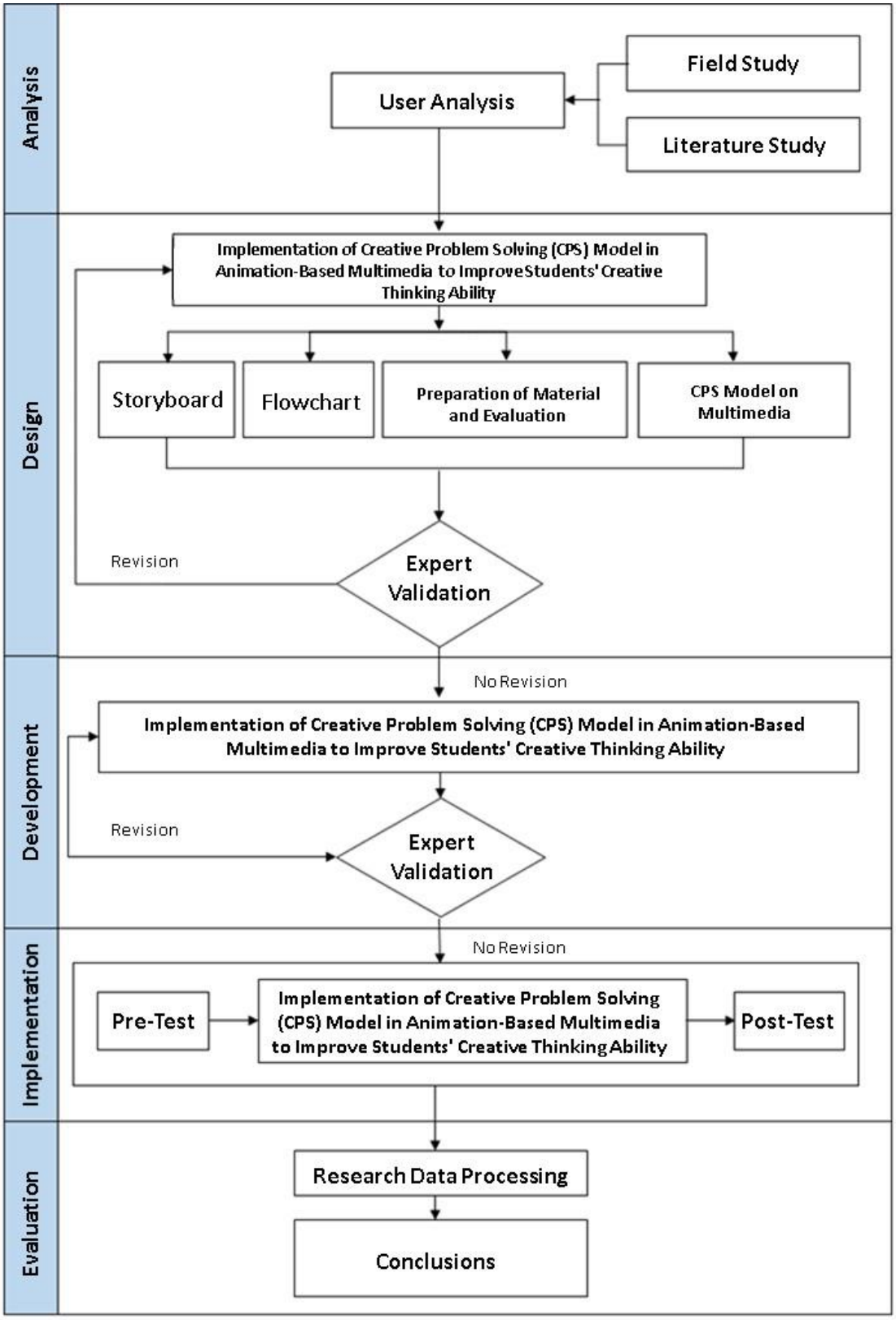
Santrock (2009) stated that there must be an effort to transform the information which is started from analysing and creating a conclusion in thinking activity. Creative thinking is an essential basic in empowering students' thinking ability (Songkram, 2015). Meanwhile, via way of means of owning innovative thinking, students are enabled to realise and grasp the standards given in an excellent way. As the consequences, their talents in reasoning, crucial thinking, selection making, innovative thinking might be established. Solving problem implementation in learning activity is one of the effective methods to increase students' creativity (Silver, 1997). It also enables students to assess information and by conducting fully consideration as well as find the undergirding cause of the problems arose (Aka, 2010). Creative thinking skill increases students' creativity in tackling problems (Çetinkaya, 2014).

Research Methods

This study uses a quantitative approach, using a Pre-Experimental Design research design, namely One-Group Pre-test-Post-test. The multimedia development method refers to the Complete Life Cycle method. This is because the purpose of this research is to develop an animation-based multimedia with a CPS model to improve students' creative thinking skills in the subject of network infrastructure administration, especially routing, static routing, and dynamic routing. There are 5

stages in the multimedia development method that can be seen in Figure 1.

Figure 1 *Flowchart of Research Procedure*



• The first stage is the analysis stage, at this stage the researcher conducts initial research needs based on literature studies and field studies. This is intended so that the data

obtained is valid. Furthermore, the results of the analysis stage will be formulated problem formulations and solutions related to these problems.

- The second stage is the design stage, at this stage it is used to design multimedia which will be developed based on the analysis stage which includes the design of flowcharts, storyboards, materials, test instruments, and the learning model used. Furthermore, the results of the design are validated by experts, with the intention that the design is as expected.

- The third stage is the development stage, at this stage the aim is to produce animation-based multimedia by applying the learning model that has been proclaimed. This development starts from interface development, coding, Blackbox testing, to expert validation tests to test the feasibility of the multimedia that has been developed.

- The fourth stage is the analysis stage, this stage is carried out after the multimedia designed is feasible to use based on expert validation. Furthermore, at this stage, a pre-test will be given to measure students' initial abilities before learning using multimedia, then learning using multimedia will be carried out, and at the end students are given a post-test to determine the increase in creative thinking skills, and distribute student response questionnaires to multimedia. This is done to determine the effectiveness of the multimedia used in learning.

- The fifth stage or the last stage, at this stage the researcher will collect the data obtained during the study. So that researchers can see the feasibility of the multimedia that has been made.

The research data were collected using a sample of class XII Computer Network Engineering 1 Vocational High School Pembangunan Umum Negeri, Bandung, Indonesia who had studied network infrastructure administration subjects totalled of 25 people. The research instruments used include field study instruments in the form of distributing questionnaires to students and semi-structured interviews to teachers, validation instruments by media experts and teachers, student response instruments to multimedia, and test instruments for increasing creative thinking skills. The media expert validation instrument refers to Multimedia Mania 2004 - Judges' Rubric of North Carolina State University using the Rating Scale, the student response instrument to multimedia refers to the Multimedia Mania 2004 – Student Checklist, and the creative thinking instrument refers to the four creative thinking indicators, namely fluency, flexibility, originality and elaboration.

Results and Discussions

This study aims to design animation-based multimedia with the CPS model to improve creative thinking skills. The design consists of several stages based on the Complete Life Cycle development method. The five stages carried out are as follows.

A) User Requirement Analysis Stage

In the analysis stage, the researcher conducted a literature study from various sources of books, journals, and other information related to multimedia design. Furthermore, researchers conducted a field study to determine the condition of students and the learning process carried out by distributing questionnaires to students and conducting interviews with teachers of the Network Infrastructure Administration subject. Based on the results of questionnaires and interviews there are several problems encountered, namely as follows:

a. Materials that are difficult for students to understand are routing material, static routing, and dynamic routing. This is because the subject matter is abstract.

b. The learning method carried out in the learning process uses the lecture method combined with practicum, with the Project Based Learning model. Where the learning model used is less effective because students rely on each other.

c. Submission of material during the learning process using conventional media,

namely written media mixed and matched with power point presentations.

d. Constraints in the learning process related to material mastery and low student motivation.

e. The demand for a lot of material in each semester causes the students' creative thinking skills to not be developed.

The analysis of the requirement for supporting software used to design animation-based multimedia with the CPS model is Unity 2019, Visual Studio Code, Adobe Illustrator CC 2019, Adobe After Effects 2020, Microsoft Power Point, Filmora, and the Windows operating system. The media documentation used is on a smartphone device. The hardware specifications used in designing and building CPS interactive multimedia can be seen in Table 1.

Table 1 *User Requirement*

Hardware	**Specification**
Processor	Intel ® Core™ i5-5200u CPU @2.20 GHz (4 CPUs)
RAM	8 GB
Memory	I Tb HDD
Resolution	1366 x 786 (32 bit) (60 Hz)

B) Design Stage

At the design stage, it consists of compiling the content of the material used, namely routing material, static routing, and dynamic routing, followed by the preparation of creative thinking test instruments in 57 questions referring to the four indicators of creative thinking, then validation by expert lecturers to determine the feasibility of the instrument used. has been designed. After being declared eligible, further testing was carried out on students outside the object of research, namely class XII Computer Network Engineering 2 students to determine the level of validity, reliability, discriminating power and the difficulty index of the questions.

Furthermore, the design of flowcharts, storyboards, and implementation of the CPS model on the media. The CPS model consists of several steps, namely problem clarification, opinion gathering, evaluation and selection, and implementation. The stages of the CPS model implemented in animation-based multimedia are as follows:

a) Problem Clarification

Based on Figure 2, at this stage the media poses a problem in the form of a case study that is packaged in the form of an animated video where users are expected to know correctly about the case studies they are facing and what solutions are expected.

b) Opinion Accumulation

Based on Figure 3, at this stage an input value is given for users to express their opinions on the issues raised.

c) Evaluation and Selection

Based on Figure 4, in the evaluation and selection of answers, the results of students' answers will appear on a Google spreadsheet where students together with the teacher and other group members discuss the issues raised. In addition, at the evaluation and selection stages, the media provides material in the form of animated videos.

d) Implementation

Based on Figure 5, at this stage students apply solutions until they find a solution to the problem from the case study that was raised in the form of drag and drop and input value.

Figure 2 *Problem Clarification Stage*

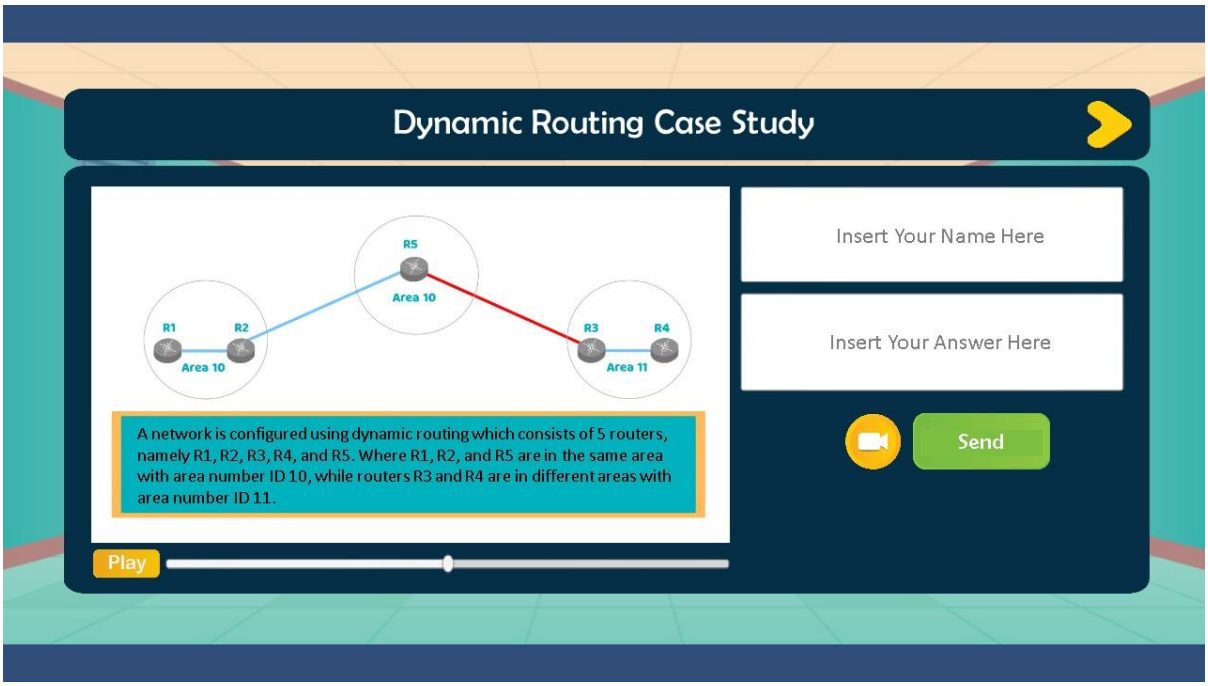


Figure 3 *Opinion Accumulation Stage*

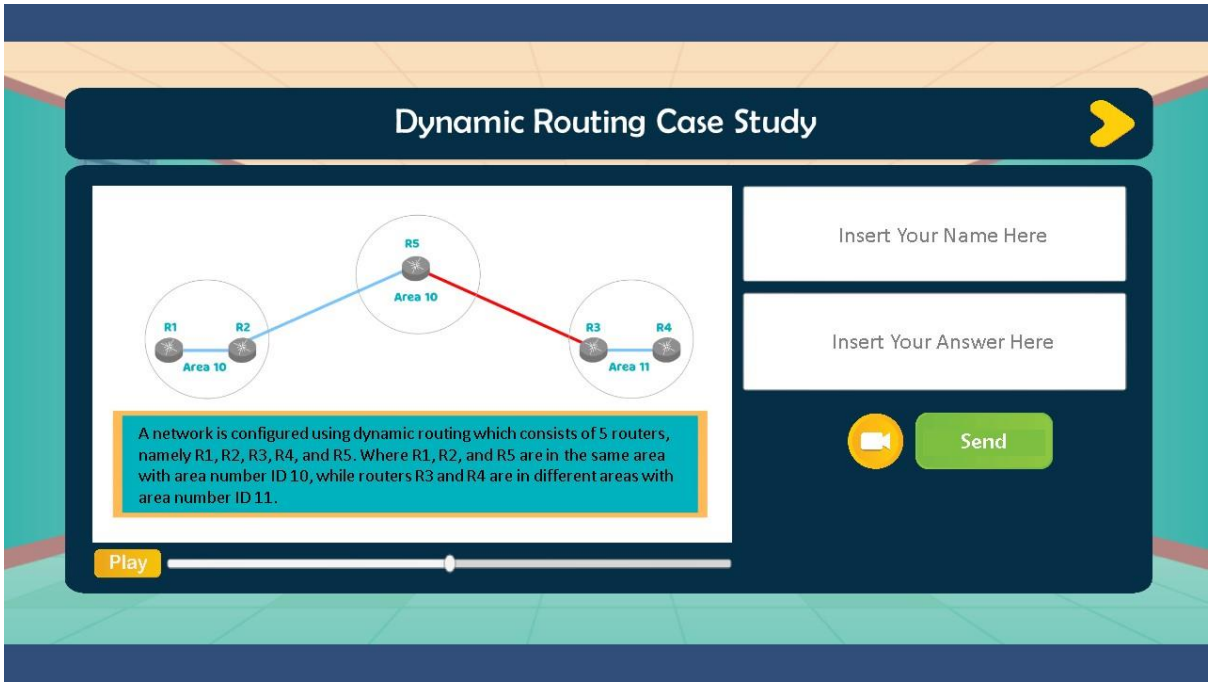


Figure 4 *Evaluation and Selection Stage*

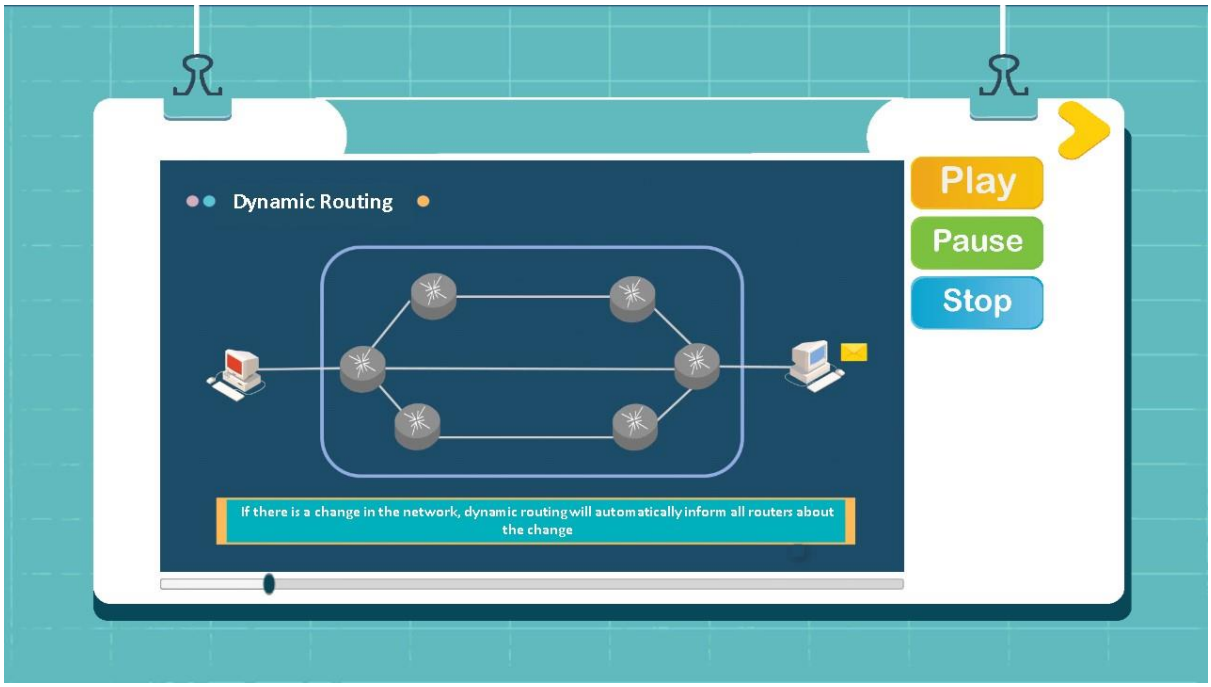
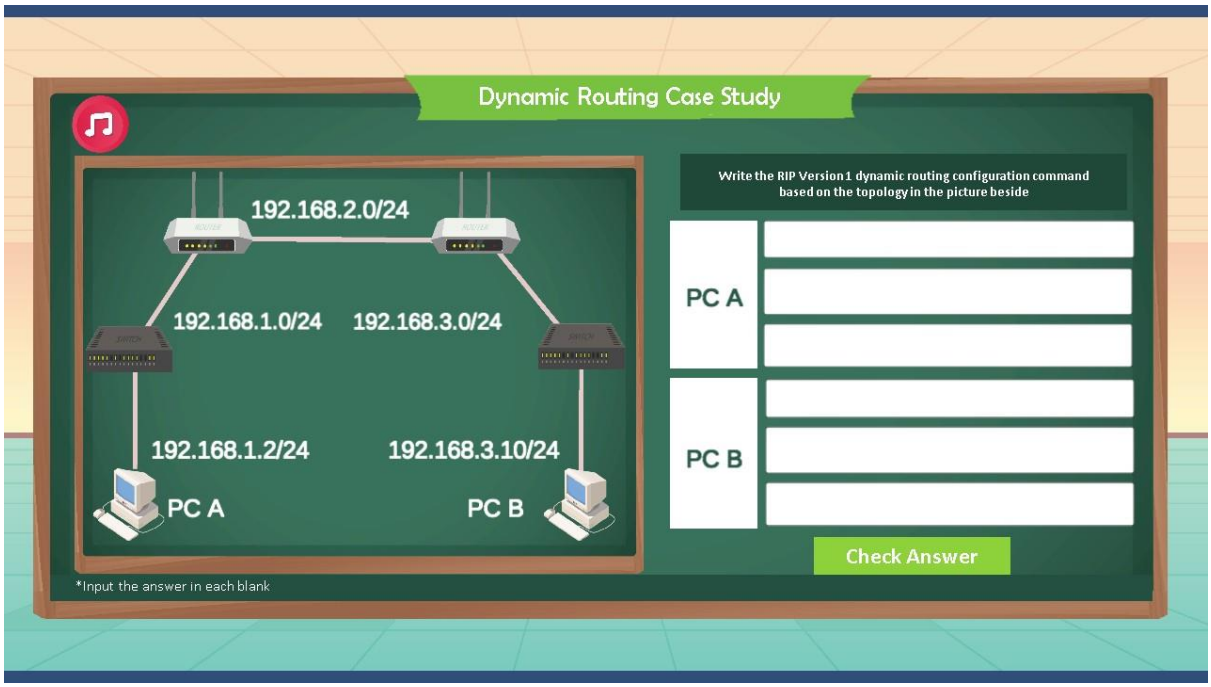


Figure 5 *Implementation Stage*



C) Development Stage

At the animation-based multimedia development stage using the CPS model, it is divided into several development stages, namely the creation of multimedia page design assets and animated videos created using the Adobe Illustrator CC 2019 application, the development of the media interface refers to the flowcharts and storyboards that have been made previously.

The stage of making the multimedia page design asset only contains the interface design, where every object in the interface cannot be used. Multimedia development using Unity 2019 supporting media, at this stage a coding process is needed to enter the commands used

for each object contained in the media design menu. The programming language used by researchers to build animation-based multimedia with the CPS model is C#. The following coding command is used.

After the multimedia design and development process is complete, then Blackbox testing is carried out to determine the multimedia input and output. The next step is to conduct a media feasibility test by media experts. The results of the media expert validation test can be seen in Table 2.

Table 2 *Media Expert Validation Results*

Aspect	Score	Ideal Score	Percentage
Mechanism	12.5	16	78%
Multimedia Element	8	8	100%
Information Structure	16	18	88%
Documentation	6	8	75%
Content Quality	45	66	68%
Average			**82%**

Based on the expert validation results in Table 2, it can be seen that the validation used to determine the feasibility of animation-based multimedia from the aspect of Mechanism is 78%, Multimedia Elements is 100%, Information Structure is 88%. 75% Documentation, and 68% Content Quality. The average result of the assessment by media experts is 82%. If it is implemented on a scale, it will be included in the good category.

D) Implementation Stage

The implementation phase is carried out to XII students of Network Computer Engineering 2 Bandung State Vocational High School. There are several stages including the following:

a) Pre-test: The implementation of the pre-test is the initial stage carried out in research. Where students are asked to work on pre-test questions in the form of multiple-choice questions totalling 20 questions that refer to indicators of creative thinking, namely Fluency, Flexibility, Originality, and Elaboration.

b) Media Use Preparation: The preparation process is carried out where each student must have installed the multimedia used on their respective smartphone devices.

c) Implementation: The implementation of the use of multimedia is carried out independently in their respective homes or done online. A total of 25 students used animation-based multimedia with the CPS model using their respective smartphone devices.

d) Student Response Questionnaire on Multimedia: The media student response questionnaire assessment.

e) Post-test: After students carry out learning using animation-based interactive multimedia, students are asked to do a post-test. The number of post-test questions that can be done by students.

E) Assessment Stage

a. Student Assessment and Response to Multimedia

In Table 3, it can be seen that the validation to determine the feasibility of multimedia from the mechanism aspect is 89%, the multimedia element aspect is 88%, the information structure aspect is 86%, the documentation aspect is 92%, the content quality aspect is 96%. The average aspect of multimedia assessment through student responses is 90%.

Table 3 *Results of Assessment of Student Responses to Multimedia*

Aspect	Score	Ideal Score	Percentage
Mechanism	89	100	89%
Multimedia Element	44	50	88%
Information Structure	86	100	86%
Documentation	46	50	92%
Content Quality	311	325	96%
Average			**90%**

b. Gain Analysis

Gain analysis was conducted to determine the increase in student learning outcomes. The results of the gain analysis are in Table 4.

Table 4 *N-Gain Analysis Results*

Group	Description	Pretest	Posttest	Gain	Gain Criteria
Upper	Maximum	75	80	0,35	Medium
	Minimum	68	80		
	Average	71.5	80		
Middle	Maximum	50	80	0,47	Medium
	Minimum	25	40		
	Average	37.5	60		
Lower	Maximum	20	95	0,64	Medium
	Minimum	20	30		
	Average	20	62.5		
Overall Average				**0.48**	**Medium**

Based on the results of table 3, it is known that the upper group obtained a gain of 0.35 in the "Medium" category, the middle group obtained a gain of 0.47 in the "Medium" category, and the lower group obtained a gain of 0.6 in the medium category. The average n-gain index as a whole is 0.48 with the effectiveness criteria being "Medium".

c. Creative Thinking Ability Analysis

Creative thinking ability analysis is intended to determine the improvement of each creative thinking indicator, namely Fluency, Flexibility, Elaboration, and Originality. The analysis of students' creative thinking skills can be seen in Table 5.

Table 5 *Creative Thinking Ability Analysis*

Indicator	Fluency	Flexibility	Originality	Elaboration	Average	Category
Pre-test	19%	47%	39%	47%	39%	Not Creative
Post-test	76%	76%	67%	66%	71.25%	Creative
Overall Average					**55.12%**	**Quite Creative**

Based on the analysis table of students' creative thinking skills in table 5, the results of the pre-test indicator fluency 19%, flexibility 47%, elaboration 47% and originality 39%, the average indicator value is 38% with the "not creative" category. The results of the post-test indicator fluency 76%, flexibility 76%, elaboration 47%, and originality 39%, the average indicator value is 71.25 with the "creative" category. The average value of creative thinking ability as a whole is 55.12% with the category "quite creative".

Conclusions

Creative thinking is an ability that must be possessed by students, especially those studying in the computer network engineering department. Creative thinking skills can help students in solving various problems, both network and programming. Through this research, animation-based multimedia is designed which aims to improve creative thinking skills.

Based on the research development, it showed positive results based on the pre-test and post-test where there was an increase in N-Gain of 0.48. Students assess that animation-based multimedia is feasible where the mechanism, multimedia element, information structure, documentation, and content quality aspects get a score of 92%. Students' creative thinking ability has increased from 39% to 71.25%. The findings indicate that students understand the learning that has been delivered using animation-based multimedia and shows an increase in creative thinking skills. but students still need to be given a stimulus so that creative thinking skills continue to increase and develop.

As a result of research and to improve better results, the school needs to develop animation-based multimedia with the implementation of creative problem solving (CPS) in other

subjects so that it can help students to improve their creative thinking skills. The findings of this study can help provide a foundation for future research so that creative thinking skills can be further enhanced to assist students in understanding lessons and mastering computer-related skills.

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