Developing an interactive multimedia of network topology based on visual, auditory, and kinaesthetic learning model for vocational students

E Junaeti*, Munir, S Mulya and Erlangga
Department of Computer Science Education, Universitas Pendidikan Indonesia, Bandung, Indonesia

*Corresponding author’s e-mail: enjun@upi.edu

Abstract. Network topology is a knowledge in basic network subjects that is often disregarded to be grasped by almost all vocational students whose learning activities are dominated by practicum. Whereas network topology is a basic concept that is important in order to comprehend the concept of networking further. This research was aimed to develop a concept and design of interactive multimedia of network topology to be implemented in visual, audio, and kinaesthetic (VAK) learning model. This study used the overall life cycle method to develop multimedia. The design of this media adopts the constitutive elements of situated learning in interactive multimedia. The multimedia features correspond to Gagne's events which serve well as a framework for the successful development of educational multimedia modules. The experiment was carried out at the vocational school Binawisata Lembang, Indonesia, involving thirty tenth grade students majoring in software engineering as the research subjects. The result of the experiment was then analyzed using a quantitative method approach. It was revealed that students’ perceptions of the media were very good. Based on the results obtained during experiment, the developed media was proven to have positive impacts on improvement of students’ cognitive abilities.

1. Introduction

Based on preliminary studies through observation and interviews with several vocational high school students in Bandung, the results showed that network topology was the hardest material (39%) of basic network subjects. This is due to the many indicators of cognitive abilities that must be mastered by students in the material while the learning activities that have been carried out are dominated by practicum activities that prioritize motor skills.

As things stand, an interactive media is needed to facilitate the learning of vocational students to understanding material, which the indicators of mastery of students’ competencies are mostly cognitive abilities. There have been many studies on multimedia development for vocational students. Setiawan et al. [1] developed a labyrinth game based multimedia for topology network and apply it in the scientific learning approach. Even though the used multimedia could increase the quality of learning and students’ comprehension were raised but students’ respond had not obtained the maximum value. Development of multimedia was also carried out by Junaeti et al. [2] and Fitriasari et al. [3] who built basic and web programming multimedia learning by including elements of adventure games in the steps of their...
learning activities. Students' interest in the elements of the game in the media resulted in the students' respond to the media were very good.

This research was aimed to develop an instructional interactive multimedia which be implemented in visual, audio, and kinaesthetic (VAK) learning model to facilitate vaeriate of students' learning styles. The subject material selected is topology network. In order to enhance attraction of students in using the media, it was also implemented the gamification of puzzle game characteristics in a number of learning steps from the VAK learning model in multimedia. The constitutive elements of situated learning in interactive multimedia [4] were adopted in designing multimedia. Furthermore, the multimedia features correspond to Gagne's events in educational multimedia modules development [5]. Having been implemented, the cognitive ability and students’ opinion were analysed to figure out whether the developed media is worth using. This study used following two methodologies. First, the overall life cycle method was used develop multimedia [6]. This method consists of: analysis, design, development, and implementation. Second, the data were analysed using quantitative method analysis technique [7]. This technique used quality approach to analyse the quality of multimedia. In addition, quantitative method approach was used to analyse students’ cognitive ability.

2. Methods
As mentioned briefly in the introduction, the process of this study, as illustrated in figure 1, used two methods, which are the overall life cycle method to develop multimedia and quantitative method approach to analyse students’ cognitive ability.

2.1. The Munir's overall life cycle method as a development model of instructional media
The the overall life cycle method [6] was used a reference for the development of the media that contains the following steps: (1) Analysis: the software and hardware that would be used to develop the media was analysed correspondence to the design of the desired media; (2) Design: consisted of flowcharts, storyboards, and characteristics of the media; (3) Development: the development of software and experts validation; (4) Test: black box approach to examine whether the functions worked properly was performed.

![Figure 1. Research process.](image-url)
2.2. *Quantitative method approach to analyze experiment data*

This study implements a quantitative approach \[7\] to analyse the experiment results. The analysis was present in the form of index Gain \[8\] between pre-test and post-test to analyse the enchantment of student’s cognitive ability.

The experiment was performing by 33 students of tenth grade at Binawisata Vocational School Lembang which chosen as the sample purposively. The sample was chosen by considering the teacher suggestion, class schedule and the number of class needed.

The data were gathering through observation, tests, and documentation. The collected data were then analysed to be presented using tables and graphics to support the description and inference.

2.3. *Designing the Concept of Interactive Multimedia*

2.3.1. *Multimedia design based on the constitutive elements of situated learning in interactive multimedia.* According to the constitutive elements of situated learning in interactive multimedia \[4\], multimedia have to provide a framework of the roles and responsibilities of three mutually constitutive elements of the learning process: the learner, the implementation and the interactive multimedia program, which are outlined in nine requirements, namely: Authentic context, Authentic activity, Expert performances, Multiple perspectives, Collaboration, Reflection, Articulation, Coaching and scaffolding, Integrated assessment.

2.3.2. *Features of multimedia correspond to Gagne's events.* The Gagne's \[9\] nine events of learning serve well as a framework for the successful development of educational multimedia modules include (1) gaining attention, (2) informing the learner of the lesson objectives(s) and activating motivation, (3) simulating recall of prior learning, (4) presenting the stimulus material, (5) providing learning guidance, (6) eliciting performance, (7) providing feedback, (8) assessing performance, and (9) enhancing retention and learning transfer. Multimedia features correspond to Gagne's events and represent the functions categorize by (1) screen design, (2) interaction and feedback, and (3) navigation \[5\].

2.3.3. *Gamifications and Stages of VAK learning mode included in the multimedia.* The developed multimedia stages were arranged based on the step of VAK learning model \[10\]. In some parts of the multimedia stage, fuzzle game elements are included in the activity. Here are the detail stage of VAK learning model which included in the multimedia.

(1) Preparatory (preliminary activities)
   - The media provides motivational words so students want to be passionate about learning network topology through video performances about the benefits of network topology on a daily basis.

(2) Submission (exploration)
   - The media displays videos on network topology material and simulations make types of network topologies.

(3) Training Phase (elaboration)
   - The media assign exercises in the form of a quiz consisting of 3 stages, with each stage consisting of 2 types of puzzle games.

(4) Performance results (confirmation)
   - The media evaluates students' abilities through multiple choice questions and entries, then the media provides feedback on students' answers.

2.3.4. *Syllabus on multimedia.* The material discussed in the media is a network topology material for students of class X semester 2 of SMK, which consists of:
(1) Definition of network topology
(2) Types of network topologies, as well as their advantages and disadvantages
(3) Benefits of various types of network topology in everyday life
(4) Simulation making several types of network topologies.
3. Results and Discussion

3.1. The Implementation of Multimedia Based on The Proposed Design

The developed design was implemented in the multimedia. Below is the illustration of the multimedia interface discussed in the previous chapter:

(1) Preparatory. Figure 2 show preliminary activities which displayed by a video. The video provide authentic context and activity as well as expert performance through the depiction of the function of network topology in everyday life for a worker in an office [4].

![Figure 2. Preliminary activities.](image)

(2) Submission. Exploration activity illustrated in figure 3 presenting video and simulation of network topology construction. The figure provide critical information (video title) at the beginning of a message and place prompts or navigational buttons at the bottom of the screen corresponding to screen design of feature in Gagne’s event framework [5].

![Figure 3. Exploration activity.](image)

(3) Training Phase. Figure 4 show elaboration activity which included element of puzzle game in the training phase.

![Figure 4. Elaboration activity.](image)
In the puzzle game (Figure 4a) students must take the device to build a topology according to the command questions specified in the maze that has been provided. At this level students are required to be careful, because if the character takes the wrong device, the score will decrease. In addition, if students take the wrong device or device that is taken less, then the topology that must be built (Figure 4b) becomes incomplete.

In this training stage the type of puzzle given is different for each stage. The other puzzle games contained in this media are compiled randomized puzzles according to predetermined positions (Figure 5a) and drag and drop images of the types of topologies in the boxes provided (Figure 5b).

![Figure 5. Puzzle game.](image)

(4) Performance results. Students' abilities through multiple choice questions and entries, then the media provides feedback on students' answers found on confirmation stage which illustrated by figure 6.

![Figure 6. Performance result.](image)

Figure 6 shows that there are 3 types of evaluations carried out on the media. The value of the first evaluation is called game score ('game score'), which is the value obtained from the value of the problem exercises performed at the training stage (puzzle game 1). Besides that the training phase is also equipped with 'KUIS' activities where students will get challenges or questions (puzzle game 2). The result of this quiz value is stated as question score ('question score'). Finally, after students complete the training phase students will be given a multiple choice evaluation question which is a combination of all the material in the three stages of training. This result of this evaluation is stated as an evaluation score ('evaluation score').

3.2. Experiment

3.2.1. Experimental design. This section discusses the experiment design. The experiment was necessary to be carried out in order for the developed concept and multimedia can be tested and analysed. After the multimedia has passed the validation phase of the multimedia expert and material expert, multimedia is tested first to class XI students majoring in Software Engineering Lembang Binawisata Vocational High School who have learned the Basic Network with Network Topology material, then
the respondents are given an assessment questionnaire to multimedia to find out the multimedia value in the eyes of the respondents. The trial was carried out twice as many as 15 respondents.

The experiment was then conducted three times to 33 students with the implementation time adjusted to the schedule prepared by the school. The details of the activities from the implementation of the experiment are as follows in table 1:

| Activity     | Explanation                                                                 |
|--------------|-----------------------------------------------------------------------------|
| 1st day      | Pre-test Students are given a multiple choice test of 15 questions to find out the initial abilities that students have. |
|              | Preparation The teacher opens learning by greeting students and assigning class leaders to lead prayers. Next the teacher checks the attendance list of students and provides motivation and learning objectives to students. |
| 2nd day      | Core Activity On the second day students learn about network topology using the media that has been built. Previously the teacher provided an explanation of how to use the media and guided students to use during the learning activities. Some students are given the opportunity to convey their learning experiences by submitting a summary of the results of the learning activities that have been carried out. Then the teacher gives feedback on student presentations, and learning activities are closed with a joint prayer. |
|              | Closing Students are given a test again to find out the results of student learning with different problems of multiple choice test of 15 questions. |
| 3rd day      | Post-test Students are given a test again to find out the results of student learning with different problems of multiple choice test of 15 questions. |

At the highest and highest performance, it was stated that the questions given were 15 different questions. Even so, the compositions of the level of voluntary questions and indicators that must be achieved by students were the same. Each indicator mentioned earlier, which were each indicator has at least one question tested. The following are indicators of student learning achievement, i.e. students capable to:

1) Know the meaning of network topology
2) Know the design of network topology development
3) Explain factors for network topology
4) Categorizes the type of network topology
5) Understand bus, star, tree, and mesh topology designs
6) Identify bus, star, tree, and mesh topology advantages
7) Identify bus, star, tree, and mesh topology losses
8) Understand the needs of bus, star, tree, and mesh topology
9) Categorize bus, star, tree, and mesh topology
10) Know the logic topology
11) Know the physical topology.

In accordance with the established syllabus guidelines, the topology learning process should be carried out for three hours of learning for which activities can be held at one meeting. However, in implementing the implementation, the study used three times the meeting with the total number of lesson hours was three hours of learning.

3.2.2. Results of Experiment. After performing some experiments following the scenarios explained in the previous subsection, we obtained data of the pretest and posttest values displayed in the form of group data in figure 6 and figure 7.
Based on figure 7 and figure 8, there is an increase from the pre-test value to the post-test value. Furthermore, the gain value is sought to find out how much the increase is. Further matching is done to find out whether the gain index belongs to the low, medium or high category. The gain value obtained is equal to 0.51 in the medium category. From these calculations, it can be concluded that multimedia has an influence on improving students’ understanding of learning material for Network Topology.

In addition, students were asked to fill out questionnaires in the form of responses to multimedia. The questionnaire consists of three aspects, namely aspects of software, learning, visual communication. The results of the average assessment of the four aspects are illustrated in table 2.

**Table 2. Students respond.**

| Indicators                       | Percentages |
|---------------------------------|-------------|
| Aspects of Software             | 85%         |
| Learning Aspects                | 85%         |
| Visual Communication Aspects    | 84%         |
| Average                         | 85%         |

According to average value of percentation, it can be concluded that students’ responses to multimedia used are in very good categories.

4. Conclusions
Based on the research that has been done, it can be concluded as follows: (1) A concept and design of interactive multimedia of network topology to be implemented in visual, audio, and kinaesthetic (VAK) learning model had been made. (2) Students’ perceptions of the media were very good. (3) The developed media was proven to have positive impacts on improvement of students’ cognitive abilities.

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