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DEVELOPMENT OF INTERACTIVE MULTIMEDIA TO IMPROVE UNDERSTANDING OF NETWORK DESIGN CONCEPTS IN VOCATIONAL SCHOOLS

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Abstrak
Pemanfaatan media pendidikan telah secara signifikan membantu guru dalam penyebaran informasi selama proses pembelajaran di kelas. Namun, ada tantangan yang terkait dengan proses pembelajaran, proses pembelajaran yang menggunakan media seperti PowerPoint dan materi pdf dianggap tidak efektif, Penelitian ini bertujuan untuk mengembangkan multimedia interaktif berbasis Canva sesuai dengan masalah yang telah diidentifikasi. Perancangan, Pengembangan, dan Penyebarluasan adalah tiga fase dari paradigma desain *Four-D*. Hasil validasi dari ahli materi dan media menunjukkan bahwa multimedia pembelajaran berbasis Canva materi dan medianya valid dengan rata-rata skor *pre-test* dan *post-test* pada tingkat kognitif pengetahuan dan pemahaman mengalami peningkatan. Hasil analisis awal ini menunjukkan bahwa pengembangan berhasil dilakukan dan sesuai dengan yang diharapkan. Dengan demikian produk layak untuk digunakan untuk pembelajaran rancang bangun jaringan di Sekolah Menengah Kejuruan.

Kata Kunci: Multimedia Interaktif; Rancang Bangun Jaringan; SMK; Pengetahuan; Pemahaman

Abstract
The use of educational media has significantly assisted teachers in disseminating information during the classroom learning process. However, there are challenges associated with the learning process. Learning processes that use media, such as PowerPoint and PDF materials, are considered ineffective. This study aims to develop Canva-based interactive multimedia in accordance with the identified problems. Design, Development, and Dissemination are the three phases of the Four-D design paradigm. The validation results from material and media experts indicate that the Canva-based learning multimedia material and media are valid with an average pre-test and post-test score at the cognitive level of knowledge and understanding experiencing an increase. The results of this initial analysis indicate that the development was successful and met expectations. Thus, the product is suitable for use in network design learning in Vocational High Schools.

Keywords*: Interactive Multimedia; Network Design; Vocational School; Knowledge; Understanding*

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INTRODUCTION

Every aspect of life is influenced by the increasingly rapid technological revolution in creating change. This is evident in the current development of Industry 4.0. Gradual digitalization and computer-based automation have become an essential part of the transformation associated with Industry 4.0. To carry out this transformation, we must have the courage to face the future. Based on smartphone usage in Indonesia in 2018, Indonesia ranked first in the world. During the learning process, teachers must pay attention to the use of learning media. Therefore, learning media should be more innovative and creative so that the learning process becomes more enjoyable and motivates learners (Sudjana, 2013).

Learning media are physical and communication tools used for educational purposes to deliver messages that convey learning materials, including technology (Arsyad, 2011). According to Heinich (2005), learning media include print, visual, audio, moving images, web-based media, and multimedia. A study on the availability of ICT-based learning media found that 63% of schools were categorized as very lacking and 24% as lacking in providing ICT-based media (Isnarto et al., 2017). Interviews conducted at a vocational school in Malang City revealed that the use of media such as PowerPoint and PDF materials was considered ineffective in attracting learners' interest, resulting in no significant improvement in learning outcomes. In contrast, a study by Wardani (2024) developed Pancasila Education materials for fifth-grade elementary school students as interactive media using Canva, which improved the effectiveness and efficiency of the learning process by making the content more interactive; based on random samples from five respondents, the results showed 90% in the good category, while media expert evaluations reached 80%, it can be seen that the targeted media was effectively utilized by participants as reflected in the categorized results.

According to Sugiyono (2018), this development research employs a research and development methodology to create the intended media and to evaluate its effectiveness. Furthermore, Mulyatiningsih (2016) states that this study adopts the Four-D (4D) Development Model developed by Thiagarajan and Semmel in 1974, which consists of four stages: Define, Design, Develop, and Disseminate. The Four-D model is used due to its close relevance to comprehensive development research, and according to Trianto (2010) as cited in Agungtastra (2015), one of its advantages is that it can serve as a structured, top-down guide for improving instructional materials or learning processes to address learning problems in accordance with instructional conditions. Oktavia (2024) explains that the study aims to: (1) describe the process of developing interactive multimedia using Canva on the topic of Plants and Sources of Life on Earth for eighth-grade elementary school students; (2) explain that the development of Canva-based interactive multimedia begins with an understanding of instructional content related to Plants and Sources of Life on Earth; and (3) demonstrate how the implementation of Canva-based interactive multimedia can improve learners' understanding of the material. The research was conducted at SDN 56/I, located in Aro Village, Batanghari Regency, Indonesia, using stages that include analysis, measurement, development, implementation, and reporting. Data were obtained through content, media, and language validation processes. The findings of this development study indicate that fourth-grade elementary school students who followed the ADDIE model were able to use interactive multimedia developed with Canva to learn Earth history and geography, with a material validity score of 4.88, a media validity score of 4.87, and a practicality validity score of 5, all of which are categorized as very valid.

Munir (2015) states that the term multimedia consists of two words, multi and media. Separately, multi refers to many elements or aspects, while media originates from the Latin word medium, meaning a means or channel for communicating or conveying information. Daryanto

(2010) classifies multimedia into two categories: linear multimedia and interactive multimedia. Linear multimedia does not require separate control during its use, where the term linear refers to a fixed sequence or predetermined steps in the process. In contrast, interactive multimedia includes interactive tools that allow users to manipulate and adjust the process according to their needs. Interactive multimedia delivers messages or information by providing users with opportunities to interact with the media (Munir, 2015); therefore, multimedia can be classified as interactive when users are able to control their own learning process (Nafi'a et al., 2020). Based on various expert definitions, interactive multimedia is a type of media that enables users to control the flow of content according to their preferences while facilitating interaction in multiple ways. Various forms of interactive multimedia have been developed, such as tutorial multimedia (Amalia et al., 2020), interactive multimedia in vocational education contexts (Anas et al., 2018), and drill-and-practice multimedia (Gunawan et al., 2020). Based on the theoretical explanations above, one of the most effective ways for teachers to deliver learning materials in the classroom is through the use of instructional media, as it enables teachers to present content more easily, helps students understand the material more effectively, increases student engagement, and makes the learning process more enjoyable, thereby providing teachers with more effective instructional tools.

METHOD

This study employs a research and development (R&D) methodology. Sugiyono (2018) states that research and development is a research effort aimed at creating new media through a systematic development process, accompanied by a series of tests to determine the effectiveness of the resulting product. The procedures used include analyzing field conditions, designing the product, testing the product, and producing the developed product, as stated by Mulyatiningsih (2016). This development model was first introduced in 1974 by Thiagarajan and Semmel. According to Trianto (2010), one advantage of the Four-D (4D) model is that it is suitable as a foundation for developing instructional tools or learning media.

The Define stage involves analyzing learners, conducting interviews or observations, analyzing learning materials, and determining plans to solve problems identified during the analysis process. The Design stage, as stated by Hasibuan (2007), uses interviews to obtain important data from respondents, collect information relevant to the research objectives, and identify issues in the field. Interviews are conducted to gather information from informants or respondents in order to understand existing problems in the learning environment. The data collected include the use of teaching materials, learning activities, and the skills that learners must acquire. Questionnaires are used to obtain data from learners to determine whether the developed learning materials meet established standards. A Likert scale is applied to measure respondents' perceptions, ranging from "very satisfied" to "very dissatisfied." In this study, questionnaires are used to assess media quality and ensure the accuracy and authenticity of the content. Additional design activities include the preparation of lesson plans (RPP) as references for learning implementation and the development of storyboards to design the flow and initial sketches of the media.

The Develop stage involves testing the developed product to assess its validity. Subject-matter experts and media experts act as validators to evaluate the theoretical and practical validity of the media. At this stage, experts provide feedback on the theoretical soundness of the media design, particularly from instructors specializing in network design and implementation. Validator recommendations are used to revise and improve the developed media. Questionnaire results are analyzed by content and media experts using descriptive percentage analysis. Checklist data are grouped according to variables, and the percentage for each variable is calculated using the formula in which P represents the percentage value, S the total score obtained, and N the

maximum possible score. Validity criteria are categorized into four intervals: percentages of 80–100% are considered valid, 60–79% sufficiently valid, 50–59% less valid, and 0–49% invalid.

Data normality is examined to determine whether the analyzed data follow a normal distribution, using the Shapiro–Wilk test in SPSS 24.0. A significance value less than 0.05 indicates that the data are not normally distributed, whereas a significance value equal to or greater than 0.05 indicates a normal distribution. The average learning outcomes after using the developed instructional media are used to determine the effectiveness of the media. In addition, a t-test is conducted to measure media effectiveness by comparing students' pretest and posttest results.

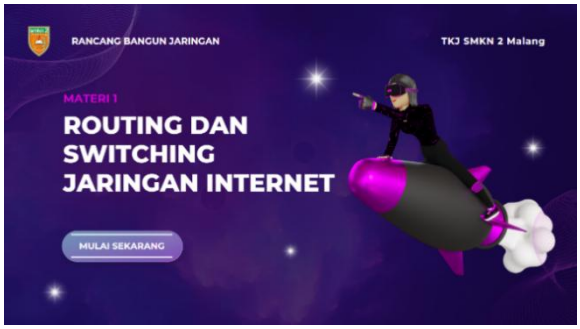
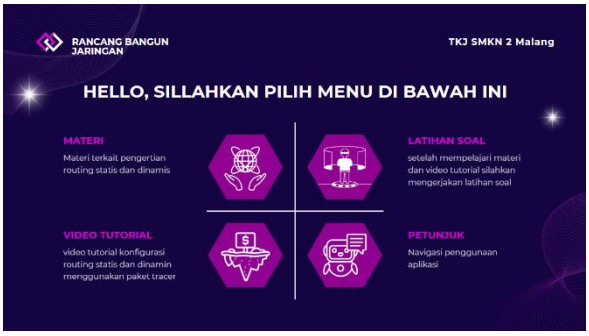
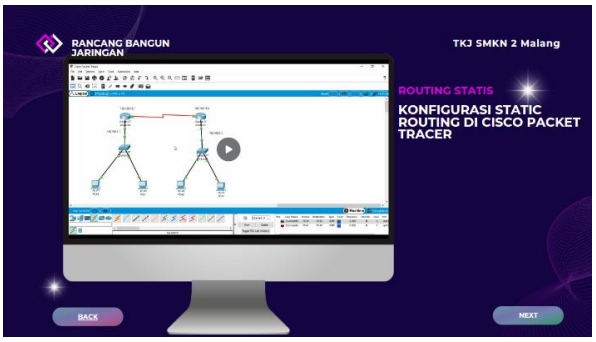
The Disseminate stage involves distributing the validated learning multimedia. The developed media are implemented and tested in the learning process of class XII TKJ1 at SMK 2. The purpose of this stage is to evaluate the effectiveness of the developed instructional media during classroom learning. The effectiveness of the learning media is measured after learning outcomes are collected and systematically analyzed.

RESULT

Canva Professional media is used to develop instructional aids and generate web-based links that can be accessed online. This interactive, multimedia-based learning tool presents images, text, and tutorial videos and can be used on all Windows versions while operating online, which means an internet connection is required. The platform provides educational resources such as lectures, video tutorials, and literature related to protocol configuration. Based on a study of learning characteristics, the average age of twelfth-grade students ranges from 17 to 18 years, placing them in the formal operational stage, which reflects their ability to think abstractly and solve problems through experimentation. Twelfth-grade students at SMK 2 demonstrate diverse academic abilities, ranging from low to high achievement levels. Content analysis of the course materials indicates that the topics covered in this study include static and dynamic routing, routing configuration, and various types of routing protocols, in accordance with the established basic competencies, and the instructional approach combines classroom instruction with hands-on practical experience.

This section presents the results of the learning media validity test conducted by subject-matter experts. The results of the questionnaires distributed to the experts indicate that the interactive multimedia-based learning media are considered appropriate for use in educational settings. Findings from the content validity evaluation, obtained through questionnaires completed by the subject-matter experts, show that the Canva-based learning media are valid and suitable for use in the learning process, with an overall validity percentage of 94.111% from both experts. The complete results of the material validation are presented in graphical form. The results of the media validation test are followed by an analysis of pretest and posttest scores in the knowledge aspect. In this aspect, the pretest and posttest results demonstrate an improvement in students' learning outcomes, with an average pretest score of 57.85 and an average posttest score of 75.35. These results indicate that the average posttest score exceeds the minimum mastery criterion (KKM) applied at SMK 2, which is set at 75. An analysis of pretest and posttest scores in the comprehension aspect is also presented. The learning outcomes based on pretest and posttest scores show a significant improvement after the implementation of the learning activities. The average pretest score was 46.75, with a median of 60.00 and a maximum score of 66.50, while the average posttest score increased to 80.11, with a standard deviation of 6.0 and a maximum score of 93.

Table 2. Learning Media Display

Learning Media	Description	Page Name
	There is a title, the name of the media, and a button to start the media.	Front Page
	This material design contains learning content and several buttons to navigate forward or backward, as well as to select other available menus.	Main Page
	There are tutorial videos that learners can practice.	Tutorial

Data normalization and t-normalization were performed for both the pretest and posttest. Data normality was examined using the Shapiro–Wilk test, where the Asymp. Sig. values for the pretest and posttest were 0.054 and 0.112, respectively. These results indicate that the data are normally distributed, as the significance values are greater than 0.05. After the normality test was completed, the data were analyzed using a t-test to compare the pretest and posttest results. A paired-samples t-test was applied, yielding a significance value of 0.00. The findings indicate a significant difference between the pretest and posttest scores, as the significance value is less than 0.05.

DISCUSSION

In the define phase, an analysis was conducted to determine appropriate methods for developing instructional media that meet users' needs. According to Mulyatiningsih (2014), activities in this phase include curriculum analysis, observation of learner characteristics, material evaluation, and the formulation of learning objectives. Several basic competencies, as outlined in Basic Competencies 3.16 and 4.16, were used in this study. Based on a literature review, the learning topics include static and dynamic routing, static and dynamic routing configuration, and various types of routing and switching protocols. This study applies an instructional approach that combines lectures and practical activities. Twelfth-grade learners are generally aged 17–18 years,

which corresponds to the formal operational stage, indicating their ability to think abstractly and conduct experiments. Students of class XII TKJ1 at SMK 2 exhibit diverse academic abilities, ranging from moderate to very high levels.

For the developed learning media, various plans or sketches were produced during the design phase. According to Thiagarajan (1974), the design process consists of four steps: establishing evaluation standards, selecting media, determining the media format or presentation, and creating media sketches or designs. A test blueprint and fifteen multiple-choice questions were developed as part of the assessment design. Achievement indicators describe the analysis of the instructional materials and the construction of test items, which cover various routing protocols. At this stage, both the test instruments and the lesson plan (RPP) were developed. The lesson plan outlines the activities to be carried out by the educator to achieve the learning objectives, with the planned learning activities consisting of two meetings, each lasting 45 minutes.

During the media planning or design phase, media flow menus, flowcharts, and storyboards were produced. Sutopo (2003) states that a storyboard is a sequence of images arranged to illustrate multimedia objects and their interactions. The attached files contain the storyboard images that were developed. The learning media begins with an opening page that displays the initial screen before the main menu. After this page, users are directed to the main menu, which includes options for materials, resources, practice questions, and an exit button. After the learning media was developed, the next stage involved refining the product and selecting the most appropriate format for its delivery.

The development phase focuses on validating the developed instructional media through evaluations conducted by subject-matter experts and media experts, as proposed by Thiagarajan (1974). This process consists of two main steps: assessing the feasibility of the designed media and conducting trials of the developed product. The results of the feasibility validation include expert judgments from both content and media specialists, along with their recommendations for improving various aspects of the instructional content and media presentation. The material expert validation results address content quality and instructional objectives. Experts awarded a score of 100% for the accuracy indicator, which was categorized as very good. For the importance indicator, content experts assigned a score of 75%, classified as adequate. The completeness indicator received a score of 90%, categorized as very good. In terms of instructional quality, the motivation indicator received a score of 95.83%, categorized as very good. The flexibility of instruction and its alignment with other learning programs received a score of 87.50%, also categorized as very good. Social interaction was rated at 93.75% and categorized as very good. The quality of tests and assessments received a score of 92.50%, categorized as very good. The impact on learners, teachers, and the learning process received a perfect score of 100%, categorized as very good. For technical quality, material experts awarded 100% for readability, ease of use, and display quality, all categorized as very good. The handling of responses and program management received a score of 87.50%, categorized as very good, while documentation quality received a score of 93.75%, placing it in the very good category.

Initial validation by media experts provided an evaluation of content quality and objectives. Media specialists assigned a score of 100% for the accuracy indicator, categorized as very good. The completeness indicator also received a perfect score of 100%, categorized as very good. The suitability indicator was likewise rated at 100% and categorized as very good. Technical quality continued to demonstrate strong validity, with media experts awarding 100% for readability and ease of use, both categorized as very good. The display presentation indicator received a score of 84.37%, which was also categorized as very good. The response-handling indicator received a

score of 75%, categorized as adequate. However, for program management, media experts awarded a score of 100%, placing it in the very good category. Finally, documentation quality received a score of 87.50%, which was categorized as very good.

The final step involved ensuring the validity of the test instruments. According to Arifin (2016), there are two types of tests: teacher-made tests and standardized tests. This study employed teacher-made tests. At this stage, learners also conducted trials using the developed media to determine its effectiveness. Pretest and posttest results were used to evaluate effectiveness, and t-test results were applied to examine differences in learning outcomes. According to Thiagarajan (1974), the dissemination phase consists of three stages: implementing the developed instructional media for the actual target learners, evaluating the achievement of learning objectives, and packaging the media, followed by the adoption stage in which the media is used by others. A single-group pre-experimental design was applied, utilizing pretest and posttest measures to examine learning conditions before and after treatment. This design enables an understanding of learning progress by comparing pretest and posttest results. Due to the absence of control and experimental groups, the study was conducted using only one group, as described by Sugiyono (2018).

The learning phase results of this experiment were obtained using pretest and posttest scores in the comprehension aspect. The pretest score was 46.75, with a standard deviation of 26.0 and a mean score of 66, while the posttest results showed a mean score of 80, with a normal distribution value of 60 and a maximum score of 93. In the knowledge aspect, the average pretest and posttest scores were 57.85 and 75.35, respectively. The final step involved conducting an evaluation to determine the effectiveness of the study and to identify effective instructional tools. According to Ghozali (2013), the t-statistic is used to examine how independent variables influence dependent variables. A significance level of 0.05 was applied for all tests, where a significance value greater than 0.05 indicates that the hypothesis is rejected, meaning the independent variable does not have a significant effect on the dependent variable, whereas a significance value of 0.05 or lower indicates that the independent variable has a significant effect on the dependent variable, thus supporting the hypothesis. The findings of this study support the use of Canva-based instructional media in classroom learning, as the pretest and posttest scores differed significantly with a significance value of less than 0.05.

CONCLUSION

The product was successfully developed in accordance with the identified needs and expectations for addressing learning problems. The interactive multimedia development process followed the stages of the Four-D (4D) model, through which the curriculum, learners, and instructional materials were systematically identified. During the development stage, validation tests were conducted, and the results indicated that both the content and the media were valid. Subsequently, a trial was carried out by implementing the multimedia learning media in a single class, for which pretest scores had been collected. Post-learning testing using the same set of questions produced significantly different results, showing a clear improvement in learning outcomes. This improvement was observed in the cognitive domains of knowledge and comprehension, as expected. For future research, further studies are recommended to examine the impact of this interactive multimedia on network design learning in different classes and to involve a larger number of research participants in order to strengthen and confirm these initial findings.

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