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Development of Discovery Learning-Based Digital Teaching Materials for Network Service Technology Subjects at Vocational Schools in Turen Malang

Pamela Paula Maldini [1,*], Muladi Muladi [2], Muhammad Ashar [3]
Faculty of Engineering, Universitas Negeri Malang, Malang, Indonesia
[1]pamela.paula.1405334@students.um.ac.id; [2]muladi@um.ac.id; [3]muhammad.ashar.ft@um.ac.id
*Corresponding author

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ABSTRACT

The subject of Network Service Technology (NST) is a subject in the Computer and Network Engineering class XI expertise program. This subject is a new subject in the Revised 2013 Curriculum. Based on interviews and observations conducted with NST subject teachers and class XI Computer and Network Engineering students, it was found that it was necessary to develop teaching materials to support the learning process in these subjects because these subjects were relatively new and there were still few teaching materials and learning media available. The teaching materials developed are interactive digital teaching materials with the epub extension and can be accessed with Android, Windows, and iOS operating systems. The development model used is the Sadiman model development method. After the teaching materials have been developed, the teaching materials are validated by learning multimedia experts. Then a trial of teaching materials was carried out to students. The trials conducted on digital teaching materials were divided into three stages, namely one-on-one trials, small group trials, and large group trials. The average result obtained from material expert validation is 94.75%. The result of media expert validation is 87.5%. The average results of one-on-one, small-group and large-group trials conducted on students were 87.5%. From the three results obtained from material experts, media experts and students, it can be concluded that the teaching materials developed can be declared very valid and feasible to use because they get an average score percentage of above 80%.

I. INTRODUCTION

Teaching materials are one type of learning resource used by teachers/instructors in learning activities [1]. Teaching materials contain an array of learning tools, materials and evaluations that can create an environment that allows students to learn. To create a conducive learning environment, the selection of teaching materials should be adjusted [2] to the learning curriculum being implemented in schools [3], the characteristics of students [4], and the characteristics of the material being taught.

Reflecting on the characteristics of the SMK Negeri 1 Turen school, since the 2017/2018 school year, this school has adopted a full day school system which results in more hours of lessons on one day. So that digital teaching materials are the right choice, which can make it easier for students to access materials [5] and also make it easier for students not to bring too many books.

Based on interviews conducted with Network Service Technology (NST) subject teachers, the discovery learning model has been widely applied to the learning process in Computer and Network Engineering Expertise Competencies, one of which is in NST subjects [6]. The model is used because it is considered in accordance with the characteristics of NST Subjects. Furthermore, it was found that the TKJ students had a low level of independence. This has an impact on the mastery of competencies indicated by the low value of learning. By

using the discovery learning method, the teacher hopes to increase mastery of competencies. The discovery learning model can improve individual discovery abilities in addition to the initially passive learning conditions to become more active and creative [7]–[11]. However, the learning process using the discovery learning method in SMK Negeri 1 Turen is not optimal because it has not been supported by teaching materials that can be studied by students independently.

II. METHODS

The research and development of digital teaching materials uses the Sadiman development model. The stages of the development model according to Sadiman [12] consist of: (1) identification of needs; (2) formulation of objectives; (3) formulation of material points; (4) formulation of success measurement tools; (5) media script writing; (6) testing; (7) revision; and (8) manuscripts are ready for production. These stages are described in the form of a flowchart as shown in Fig. 1.

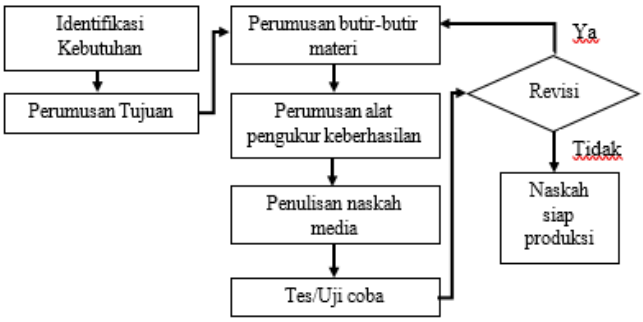


Fig. 1. Development and Research Model

This development procedure describes the procedural steps taken in the manufacture of a product. In the first stage, identification of problems and identification of needs in the field is carried out to find out the causes of problems in learning, especially in the subject of Network Service Technology.

Based on the results of observations made at SMK Negeri 1 Turen with the subject of 30 students of class XI Computer and Network Engineering 1 and 20 students of class XI Computer and Network Engineering 2 as well as interviews conducted with one of the teachers, it was found that several problems arose in learning, especially in Learning Network Service Technology subjects. Some of the existing problems, namely: (a) the unavailability of teaching materials (modules and jobsheets) for Network Service Technology subjects that are presented systematically; (b) Network Service Technology is a new subject in the Revised 2013 Curriculum so it definitely requires teaching materials to support the learning process; (c) The learning system at SMK Negeri 1 Turen uses the Full Day School System, so that there is more learning done by students in 1 day so it is not possible for students to bring printed books

At the goal formulation stage, the objectives to be achieved in the development of digital teaching materials for Network Service Technology subjects are as follows: 1) designing digital teaching materials containing Discovery learning for Network Service Technology subjects according to the Revised 2013 Curriculum; 2) developing digital teaching materials containing Discovery learning for Network Service Technology subjects; and 3) Testing the validity and feasibility of digital teaching materials on Network Service Technology.

The next stage, the stage of formulating the material points, is carried out with the development of digital teaching materials that are adapted to the KI and KD for the 2013 Revised Curriculum Network Service Technology Subject and guided by the syllabus used in schools. The materials that will be presented in this digital teaching material are: a) Softswitch, b) VoIP, and c) PBX

At the stage of formulating success measurement tools, success measuring tools are developed in accordance with the objectives to be achieved in each of the materials presented. Success measuring tools developed in digital teaching materials for Network Service Technology subjects in the form of tests, assignments (independent and discussion) and observations (students make observations on an object). The media script writing stage is done using storyboards. The storyboard developed consists of a cover design, a start page, and a description page of learning materials.

The next stage after the development of digital teaching materials according to the storyboard is the test/trial stage. This stage is carried out to collect data that is used as the basis for whether these teaching materials are suitable for use in the learning process as a means of achieving learning objectives. The trial activity was carried out on teachers of the subject of Network Service Technology and students of Computer and Network Engineering expertise skills at SMK Negeri 1 Turen. The trial activity was carried out in 3 stages, namely: (1) media expert trials, (2) material expert trials, and (3) student trials.

The revision was carried out after student trials, validation tests from media experts and material experts were carried out. The results of the trial notes and validation tests are useful for making improvements to the developed digital teaching materials.

III. RESULT AND DISCUSSION

The teaching materials developed are interactive digital teaching materials for Network Service Technology subjects based on Discovery Learning. Digital teaching materials are developed based on the Syllabus and Learning Implementation Plans. The results of the developed media interface display are cover pages, material lists, basic competencies and learning

objectives, mind maps, material descriptions, and interactive quizzes.

The cover is made with a simple display design. The cover is equipped with the Malang State University logo, K13 Logo and the Logo of the Ministry of Primary and Secondary Education. The display can be seen in Fig. 2.

Fig. 2. Cover Page

The Material List page contains a list of materials/KD presented in the teaching materials. This material list contains a link which, when clicked, will immediately open the intended material page. The display can be seen in Fig. 3.

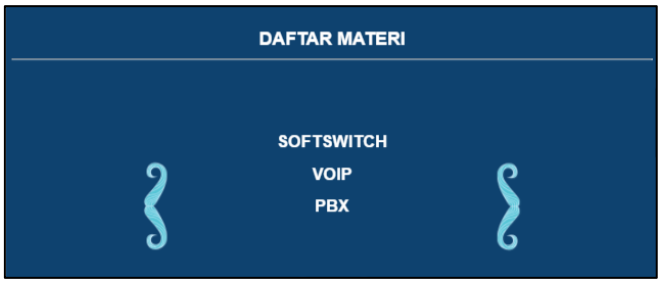


Fig. 3. Material List Page

The Basic competencies and learning objectives page contain a list of basic competencies and learning objectives to be achieved in the material. The Basic Competencies on this page are guided by the 2013 Curriculum Syllabus. The display can be seen in Fig. 4.

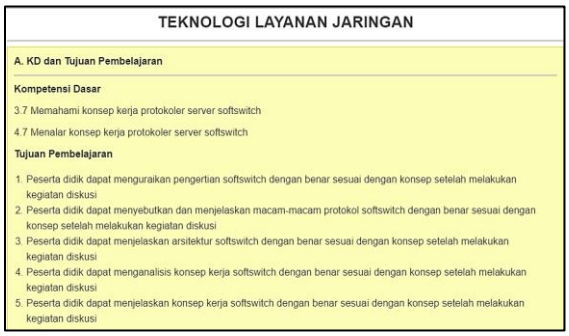


Fig. 4. Basic Competencies and Learning Objectives Page

Mind Map is a feature that contains a map of the coverage of the material that will be discussed in each material presented in the teaching materials. The Mind Map contains an illustration of the relationship between the material and the sub-material which when clicked will immediately open the page of the intended material. The Mind Map view is shown in Fig. 5.

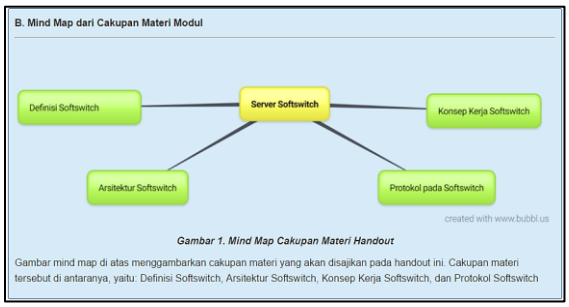


Fig. 5. Mind Map Page

The Material Description page contains an explanation of the topic/material. The Material Description page is equipped with voice over. With the voice over feature, it is hoped that it can accommodate students who prefer learning by listening to sound/audio compared to reading or students who still want to learn but are bored with reading the material. The display can be seen in Fig. 6.

Fig. 6. Material Description Page

Interactive Quiz contains interactive questions. The questions on this page are useful for confirming students' knowledge after reading and exploring the material on the Material Description page. Due to the nature of the questions

on this Interactive Quiz only confirming or checking, so there are not too many questions needed. The types of questions that are displayed vary. Starting from the types of questions with True-False answers, Multiple Choice questions, and questions with more than one answer that can be chosen, which can be seen in Fig. 7.

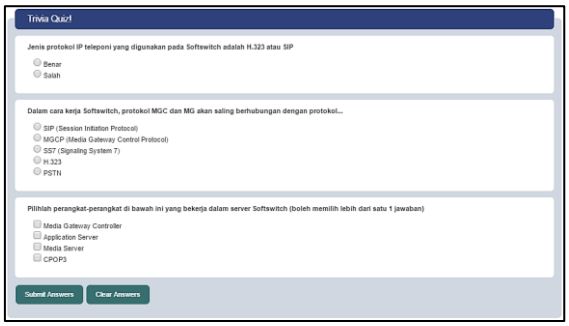
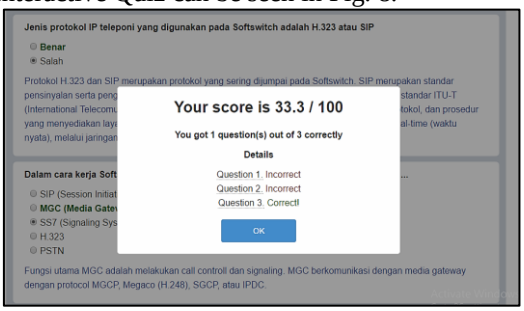


Fig. 7. Interactive Quiz Page

Interactive Quiz in its use after the user clicks the Submit button has a feedback response in the form of a score, notifying the correct answer and also providing an explanation of the question if the selected answer is wrong. The feedback response of the Interactive Quiz can be seen in Fig. 8.



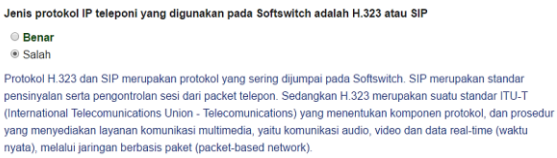


Fig. 8. Interactive Quiz Feedback Page

Referring to the table of eligibility criteria, the final result of the validation by material experts is included in the "Very Valid" category with an average percentage of 94.78%. The two material experts in the validation session also gave a recommendation "Eligible without revision" with suggestions in the form of adding questions to the interactive quiz. The results of the Material Expert Validation are presented in Table 1.

TABLE I. MATERIAL EXPERT VALIDATION RESULTS

Aspects	**Validity Score 1**	**Validity Score 1**
Content Quality	93,3 %	96,6 %
Learning Goal Alignment	95 %	100 %
Feedback and Adaptation	90 %	100 %
Motivation	93,3 %	96,6 %
Presentation Design	91,4 %	100 %
Interaction Usability	80 %	100 %
Accessibility	90 %	90 %
Standards Compliance	100 %	100 %
Average	91,6 %	97,9 %

The second validation carried out was validation by media experts. The final result of the media expert validation in Table 1 shows that the product developed has a validity value of 87.5%. Referring to the table of eligibility criteria, the validity level falls into the "Very Valid" category. The aspect with the lowest validity value is Standards Compliance with a validity value of 80% which is included in the "Sufficiently Valid" category because there is no data entered in the metadata that represents information about the media.

The aspect with the highest validity value is Interaction Usability, with a percentage of 93.3%. In contrast to material experts who only give this aspect a score of 80%, media experts give the highest score on this aspect because media experts think that the delay in the media is very short and not disturbing. Not only that, another factor that affects the level of validity of this aspect is that feedback from interactions made on digital teaching materials is very responsive and helpful. For example, there is a navigation board, all buttons on digital teaching materials work, as well as consistent and predictable interface functions. In this validation session, the media expert also gave a recommendation "Worth No Revision". The following are the results of media expert validation presented in Table 2.

TABLE II. MEDIA EXPERT VALIDATION RESULTS

Aspects	**Validity Score**
Content Quality	86,6 %
Learning Goal Alignment	85 %
Feedback and Adaptation	90 %
Motivation	86,7 %
Presentation Design	88,6 %
Interaction Usability	93,3 %
Accessibility	90 %
Standards Compliance	80 %
Average	87,5 %

The results of the one-on-one trial show that there are several aspects that have low validity values compared to other aspects, namely the Accessibility aspect and the Standards Compliance aspect with a percentage of 80% because students still rarely encounter the format of the teaching materials being tested and there is no available data. is inputted into metadata

that represents information about the media. In addition, in initial access to media, students must download files using the internet so that students who do not have internet access are difficult to access.

The trial aspect with the highest score is Content Quality, Learning Goal Alignment and Feedback and Adaptation with a percentage value of 100% validity. The Feedback and Adaptation aspect gets the highest percentage of validity values because the media can provide feedback according to the needs and activities of students. For example, when students click the Submit button on an interactive quiz, students get feedback in the form of scores and explanations of questions. Feedback on interactive quizzes is useful for confirming and giving instructions to students regarding certain sub-materials if students are still wrong in answering questions.

Based on the table of eligibility criteria, the final result of the one-on-one trial falls into the "Very Valid" category with the percentage of student 1 being 88.6% and student 2 being 93.2%. For details of the percentage of each aspect can be seen in Table 3.

TABLE III. ONE-ON-ONE TRIAL RESULTS

Aspects	**Student Score 1**	**Student Score 2**
Content Quality	93,3 %	100 %
Learning Goal Alignment	100 %	100 %
Feedback and Adaptation	90 %	100 %
Motivation	90 %	96,6 %
Presentation Design	88,5 %	85,7 %
Interaction Usability	86,6 %	93,3 %
Accessibility	80 %	90 %
Standards Compliance	80 %	80 %
Average	88,6 %	93,2 %

The results of the small group trial showed varied results. The aspect with the lowest validity value is the Standards Compliance aspect of 76% because the file type of the developed product is still rarely encountered by students and there is no data entered in the metadata that represents information about the media. Based on the table of eligibility criteria, the final results of the small group test fall into the "Very Valid" category with an average percentage of 84.705%. For details of the percentage of each aspect can be seen in Table 4.

TABLE IV. SMALL GROUP TRIAL RESULTS

Aspects	**Percentage Average Score**
Content Quality	88,6 %
Learning Goal Alignment	89,5 %
Feedback and Adaptation	82 %
Motivation	92 %
Presentation Design	89,1 %
Interaction Usability	83,3 %
Accessibility	77 %
Standards Compliance	76 %
Average	84,7 %

The results of the large group trial show that all aspects get a validity value in the "Very Valid" category. In the large group trial, there was an increase in scores on the aspects of Accessibility and Standards Compliance. In the small group trial, these two aspects only had validity values of 77% and 76%, respectively. To improve the validity value, several things were carried out in the large group test, namely; 1) before the large group trial begins, students are encouraged to install the digital teaching material reader application on their devices, both on laptops and on smartphones so that, after the distribution of digital teaching materials, students can immediately use them; and 2) revised by adding data to the media metadata so that students can see information about the media clearly

The final result of the large group test got an average percentage of 86.9%. Based on the table of eligibility criteria, the product developed is declared eligible for use. For details of the percentage of each aspect can be seen in Table 5.

TABLE V. LARGE GROUP TRIAL RESULTS

Aspects	**Percentage Average Score**
Content Quality	88 %
Learning Goal Alignment	89,16 %
Feedback and Adaptation	83 %
Motivation	85,8 %
Presentation Design	88,8 %
Interaction Usability	88 %
Accessibility	86 %
Standards Compliance	86,7 %
Average	86,9 %

After several tests have been carried out, the results of each validation and trial stage are compiled into one final data which will be used as the basis for analysis to determine general conclusions from the research results. The comparison of the results of the validation of material experts, media experts and trials on students is presented in Fig. 9.

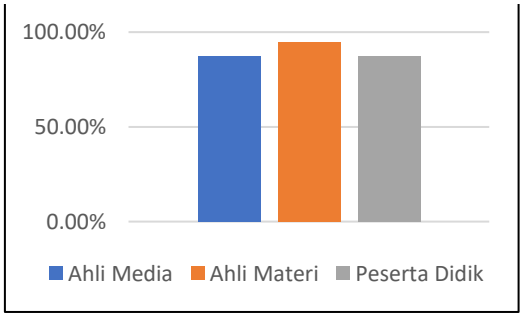


Fig. 9. Comparison Graph of Validation and Trial Results

The information that can be obtained from the graph above is that the three results from material experts, media experts and students show very valid results and are declared eligible to be used because they get an average score percentage of above 80%. From the three results, it can be concluded that the digital teaching materials developed can meet the criteria for both material experts, media experts and students.

IV. Conclusion

This research produces interactive digital teaching materials for the Network Service Technology Subject Class XI Semester 1 at SMK Negeri 1 Turen. This research has three objectives, namely planning digital teaching materials, developing digital teaching materials and testing the feasibility of the developed digital teaching materials. Based on the results of the development research that has been carried out, the following is the formulation of the objectives that have been met.

The design of digital teaching materials is carried out by referring to the Learning Implementation Plan and based on Discovery Learning. So that at the design stage, it is necessary to prepare a Learning Implementation Plan first, guided by the steps of learning based on Discovery Learning.

Digital teaching materials have been successfully developed using the Sadiman development model. The stages of Sadiman's development, namely: Identification of Needs, Formulation of Objectives, Formulation of Material Items, Formulation of Measurement Tools, Writing of Media Material Manuscripts, Tests/Trials, and Manuscripts Ready for Production. In this study, digital learning materials were produced with advantages, including (1) this digital teaching material is an interactive digital teaching material that is a supplement, (2) digital teaching materials can be used with or without teacher guidance, (3) digital learning teaching materials has been prepared in accordance with KI and KD for Network Service Technology Subjects for class XI Semester 1, (4) digital teaching materials are arranged based on the stages of learning Discovery Learning (5) digital teaching materials can be accessed offline, (6) digital teaching materials design is very interesting and interactive.

The results of the validation and testing of digital teaching materials can be concluded as follows; (1) the results of the validation by a material expert, namely Pramesthi Handaru, S.Pd., a teacher in charge of the Network Service Technology Subject at SMK Negeri 1 Turen was declared "Very Valid/Very Eligible" with an average percentage of 91.6%; (2) validation results by media experts, namely Dila Umnia Soraya, S.Pd., M.Pd. as a lecturer in the Multimedia Workshop Course at the Department of Electrical Engineering, State University of Malang was declared "Very Valid/Very Eligible" with an average percentage of 87.5%; (3) the results of a one-on-one trial conducted by two students of class XII of the Computer and Network Engineering Expertise Program were declared "Very Valid/Very Eligible" with an average percentage of 90.9%; (4) the results of small group trials conducted by 10 students of class XII of the Computer and Network Engineering Expertise Program were declared "Very Valid/Very Eligible" with an average percentage of 84.705%; (5) the results of large group trials conducted by 30 students of class XII of the Computer and Network Engineering Expertise Program were declared valid with an average percentage of 86.9%.

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