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Interactive Procedural Knowledge Learning Resources Development in The Context of Competency-Based Training Instructional Approach and Interactive Media Design Subjects for Information Technology Vocational High School

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ABSTRACT

Many research has proven the good impact of digital learning resources on the knowledge acquisition by students. However, this research only focuses on factual and conceptual knowledge types. In contrast, the learning process in vocational high schools is dominated by procedural knowledge and practical activities. This research aims to produce a digital handbook appropriate in content, media, and utilization in the learning process of procedural knowledge at an information technology vocational high school. Digital handbook components were arranged based on the context of the Competency-Based Training (CBT) instructional approach and Interactive Media Design subjects. The digital handbook was developed under the Four-D model dan Cognitive Theory of Multimedia Learning. The content, media, and practicality appraisal were carried out to prove that the digital handbook is appropriate as a digital learning resource. The material, media, and practicality appraisal involves subject matter experts, multimedia learning experts, and potential users. The content validity average score is 97.80%, the media validity score is 95.50%, and the practicality score is 90.00%. Based on these, the digital handbook is declared practical and worth using as an interactive digital learning resource for procedural knowledge, potentially attracting students to hands-on or practical activities and guiding students to learn independently.

Keywords: digital handbook, interactive learning resource, procedural knowledge, vocational high school

INTRODUCTION

The availability of learning resources is one of the things that need to be considered by the teacher when carrying out the learning process. A collection of contents or materials arranged in such a way as to assist students in the learning process is referred to as learning materials or resources [1]. Students can feel the freedom of learning if they get an excellent opportunity to obtain learning resources that are appropriate and easy to access [2]. A study shows that using digital media as a supporting tool can positively impact student learning processes in mathematics and science clusters [3]. Mathematics and science are synonymous with conceptual knowledge. However, specific research related to the use of digital media to teach procedural knowledge in the vocational field is still limited. The need for digital media as learning aids is also increasingly urgent because there is a shift from print culture to digital culture [4]. Based on the research-based research problem, it is necessary to research how to make appropriate digital learning resources as learning support tools in the context of vocational education. This research is important because the learning atmosphere of academic education is very different from vocational education, where the material in vocational education is dominated by procedural knowledge as a provision for competition and professionalism in the workplace or industry.

Based on the ability of researchers to access research subjects, the study analyzed practical-based research problems in an information technology major vocational high school in Malang, Indonesia. The practical-based research problem is used to verify that the research-based research problem the researcher

has determined can be studied at the school. The subject used as the object of research material is the Interactive Media Design subject in Multimedia Department. The researcher observed the practical-based research problem using digital learning resources in instructional processes for two months. The initial condition of the instructional process is that the instructional approach is Competency-Based Training (CBT), the primary learning resource is a printed handbook, the curriculum is the 2013 Indonesian Curriculum (K-13), and students are less motivated to seek other learning resources because they are more interested in seeing something interesting to watch and learn visually. The condition causes students to be unable to learn independently related to the Interactive Media Design subject. Interactive Media Design (IMD) is a subject that teaches about the design concepts of interface flow design, application of interface flow design principles, application of application operating procedures, to the creation of interactive multimedia products using web pages. Therefore, learning activities in it involve many practical activities and procedural knowledge.

Based on the findings of the research problem and the characteristics of these research subjects, research activities can be carried out at the school so that research outputs can contribute in the form of enrichment of case studies related to the creation of digital learning resources for procedural knowledge in vocational schools. Supporting learning resources are needed in the form of digital handbooks whose components are arranged under the CBT instructional approach. The digital handbook was chosen as a research object as a digital learning resource because the handbook is one of the learning resource types that can help the student learn independently [5][6]. In Indonesian, "the handbook" is known as a "module". In the handbook, there are also steps to help students learn practical activities following the material studied by students. This handbook composition needs to be developed based on the CBT instructional approach, a competency-based learning approach that supports the process of achieving vocational student competencies, both theoretically and practical competencies needed and adapted to the competencies needed in the world of work or industry.

The use of interactive learning materials and attracting students' interest in learning activities can be demonstrated by the use of the internet and multimedia facilities available by the teacher [7]. However, the use of digital learning media must still create linkages and interactions between students and the media, or the media is a means of connecting the creation of interactions between teachers and students [8]. Digital and interactive elements such as using computers, smartphones, multimedia, and providing feedback need to be used in the digital handbook based on the Cognitive Theory of Multimedia Learning [9]. The research was conducted using the Four-D research model and used authoring tools named Flip PDF to become an interactive digital handbook and distributed online to make it easier for students to access the handbook via computer and smartphone devices with the help of an internet connection.

METHODS

This interactive digital handbook was developed using the Four-D model. This model was chosen because Four-D is appropriate to be used as the basis for developing teaching materials or learning tools. The developer stages consist of Define, Design, Develop, and Disseminate.

The initial stage in this research is defining (define). The definition is carried out by carrying out several activities such as students character analysis, curriculum analysis, core, and fundamental competencies analysis, material analysis, and digital handbook requirements. Then proceed with the design stage. Some of the components designed at this stage are the design of learning devices, the preparation of test standards, and the design of display formats. The next stage is development. There are several steps in this stage, namely the

development of interactive digital handbooks, preparation of testing instruments, and testing the validity and practicality of the handbooks. The last stage is dissemination. After the interactive digital handbook has been developed and tested and achieved the specified results, then this handbook will be deployed and ready for use.

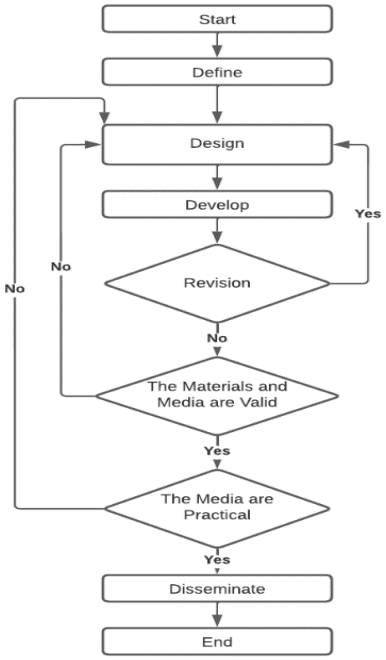


Figure 1. Research and Development Process Flowchart

RESULT AND DISCUSSION

A. Define

The define phase is carried out by carrying out several activities such as student character analysis, curriculum analysis, core competency analysis, and material/ content analysis. The first results of student character analysis were obtained from interviews with the IMD subject teacher with a high intensity of interaction with students. The teacher stated that students were less motivated to seek other learning resources. The teacher also mentioned that students are more interested in seeing something interesting to watch and learn. So, he said that the learning style of students is visual psychomotor.

Then, the result of the curriculum analysis was obtained from interviews with the academic and curriculum manager. The school is using the K-13 Indonesian Curriculum version 2018. There is a difference in using the K-13 curriculum between academic high school and vocational high school, i.e., curriculum content in vocational high school is adjusted to the business and industrial needs. Vocational high school students should have the latest information and skills to compete in the world of work.

Core competency and material/content analysis of IMD subject analyzed under K-13 Indonesian Curriculum version 2018. IMD studies the concepts of interactive multimedia based on web pages and interactive media. Learning activities involve many practical activities and involve direct learning experiences. The interactive digital handbook should contain core competencies number 3.3 and 4.4. This competency explained in Table 1 was chosen based on the direction of the IMD subject teacher when carrying out instructional activities, and there are related materials that require learning guides in the form of handbooks for coding practice activities using HTML.

Table 1. Core Competency Number 3.3 and 4.3

Core Competencies	Core Competencies
3.3 Understand the principles of user interface design in interactive multimedia based on web pages and interactive media	4.3 Creating user interfaces using user interface design principles on interactive multimedia based on web pages and interactive media

Furthermore, the last step in this stage is to define the functional and non-functional requirements needed in the interactive digital handbook that will be developed. This activity was carried out by interviewing the handbook's functional and non-functional requirements with the teacher. This activity was carried out to determine what functional and non-functional requirements are needed in the interactive digital handbook, and it is necessary to number the requirements as described in Figure. 2. The researcher made a list of functional requirements

described in Table 2 and compiled a list of non-functional requirements described in Table 3.

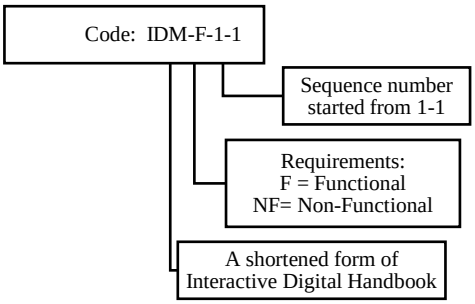


Figure 2. The Requirements Numbering

Table 2. Functional Requirements

User	Requirements Code	Task
Teacher and Student	IDM-F-1-1	The handbook must be able to display material in text form
Teacher and Student	IDM-F-1-2	The handbook must be able to display images that support the explanation of the material
Teacher and Student	IDM-F-1-3	The handbook must be able to display video tutorials that support the explanation of the material
Teacher and Student	IDM-F-1-4	The handbook must be able to move to the next or previous page
Teacher and Student	IDM-F-1-5	The handbook must be able to display practice questions as a form of evaluating learning outcomes or checking students' understanding
Teacher and Student	IDM-F-1-6	The handbook must be able to manage the answers provided by the user
Teacher and Student	IDM-F-1-7	The module must be able to display the information answer when the user answers the question correctly or incorrectly

Table 3. Non Functional Requirements

Type	Requirements Code	Task
Usability	IDM-NF-2-1	The system must have a user-friendly interface
Compatibility	IDM-NF-2-2	The handbook must be able to be displayed and used using a computer or smartphone device
Performance	IDM-NF-2-3	The handbook must use an internet connection to be used

B. Design

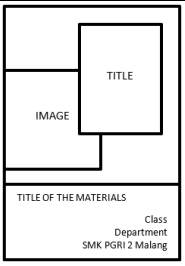
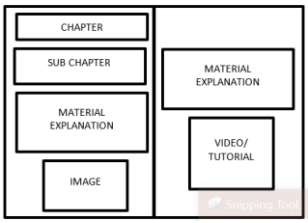
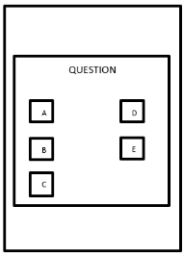
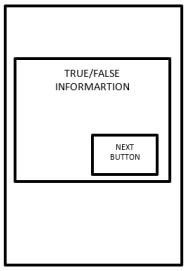
There are three steps in this stage. First, learning walkthrough preparation. This step obtained a lesson plan which was developed based on the syllabus. The school gave the lesson plans format, which was then filled in according to the researcher's design. The components contained in the lesson plan are the description of core competency, learning objectives, the type of learning model, the sequence of learning activities, and the assessment of learning outcomes. The lesson plan is a guideline for implementing learning steps using the CBT instructional approach. The steps of this approach are capability profiling, selecting a training program, producing a personal training plan, and asses the competency.

The second phase is test preparation. The researcher prepared the evaluation test with the teacher. The results obtained are a grid of questions in the form of multiple choice, totaling 30 questions with five answer choices, namely A, B, C, D, and E. Then, the teacher also suggests adding improvement and enrichment programs to improve the understanding and insight of students who have succeeded in achieving learning objectives related to the material that has been delivered. The improvement program is provided by giving six questions representing the entire material in the

interactive digital handbook, and the enrichment program is given by giving group assignments.

The third or the last step in this stage is display format design. The researcher made the initial design to display the components in this interactive digital handbook, as shown in Table 4. This handbook is displayed in Indonesian and formed like a book to make it look familiar and easier for students.

Table 4. Initial Design

No.	Design	Description
1.		The initial design for the handbook's cover.
2.		The initial design for the material's page
3.		The initial design for the evaluation page
4.		The initial design for the feedback page

C. Develop

The researcher developed an interactive digital learning media using the Flip PDF application as an authoring tool to make the handbook display interactively. Researchers also used supporting software such as CorelDRAW and Canva, the software used to design illustrations, videos, and audio as supporting materials. Then, after carrying out the design stage, here are some examples of interactive digital handbook display results.

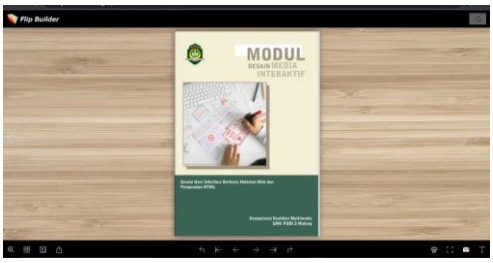


Figure 3. Cover Page View

Based on Figure 3, in the development stage, the researcher makes the initial page or cover using a simple design to maintain the formality of the learning handbook. The researcher also chose the color based on the color often used as a design template on the school's social media page. Based on Figure 4, the researcher created a material page explaining the learning objectives, concept maps, material texts, pictures, and video explanations that could be played. Based on Figure 5, the researcher created a competency evaluation page in which there were buttons for carrying out competency tests, improvements, and enrichments.

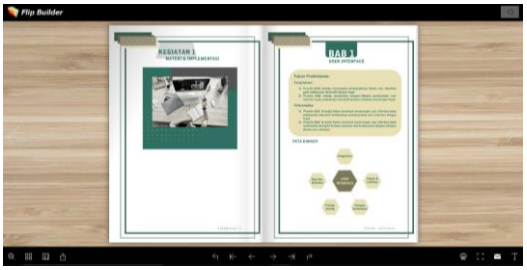


Figure 4. Material Page View

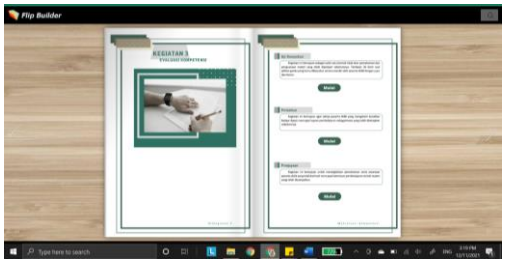


Figure 5. Evaluation Page View

After the handbook has been developed and approved by the teacher, the next step is testing. The testing process is also included in the development stage. There is two testing stage there are Validity Testing and Practicality Testing. Validity testing has two stages: material/ content and media validity or appropriateness checking.

The researcher designs a testing instrument before the testing starts. Measured aspects in the material validity test are Handbook Presentation and Handbook Appropriateness. Handbook Presentation aspect contained several indicators, and there must be an explanation of core and basic competency, learning objectives, conformity of the content of the handbook with the steps in the learning approach used, how to present handbook components, presentation of graphic elements, and presentation of measuring tools or tests to measure student understanding [10]. The appropriateness aspect contains several indicators adapted from handbook characteristics, and there are self-instructional, self-contained, adaptive, and user-friendly [11].

For the media validity test, there are two aspects to be measured: Multimedia Aspect and Software Development Product Aspect. The multimedia aspect contains several indicators adapted from the Cognitive Theory of Multimedia Learning, i.e., the diversity of media (images, videos, texts) used in the handbook, spatial continuity, time continuity, learning modalities, redundancy, personalization, interactivity, signalization, and individual differences [12]. Software Development Product contains several indicators, and the media conforms to user requirements, reliability, efficiency, integrity, reusability, maintainability, flexibility, portability, and interoperability [13].

Furthermore, for practicality testing, there are two aspects to be measured: The Use of The Handbook and The Attractiveness of The Handbook [8]. Practicality testing was carried out by providing a validation questionnaire with the Likert model scales where the value range is between (strongly agree) and 1 (strongly disagree) [14]. Formula 1 calculates the material, media, and practicality validity score as a percentage. Table 5 is an explanation related to the validity of descriptive criteria based on the percentage score.

$$\text{Score (\%)} = \frac{Total\ score\ obtained}{Maximum\ score} \times 100\% \qquad (1)$$

Table 5. Validity/Appropriateness Score Description

Percentage Score	Appropriateness/ Validity Category
0-20%	Very Low
21-40%	Low
41-60%	Moderate
61-80%	High
81-100%	Very High

Two subject matter experts (SME) are involved in the material/content appropriateness checking. The material validity result is provided in Table 6. Table 6 explains the results of the material validity score of the digital handbook presentation aspect from the first SME obtained 100.00%, and the second SME obtained 100.00%. The score of the material validity on the content feasibility aspect was obtained at 91.11% by the first SME and 100.00% by the second SME.

Table 6. Materials Validity/Appropriateness Score

Aspects	Validator		Mean	Category
	First SME	Second SME		
Handbook presentation	100.00%	100.00%	100.00%	Very High
Appropriateness	91.11%	100.00%	95.55%	Very High

Table 7. Media Validity/Appropriateness Score

Aspects	Validator		Mean	Category
	First MLE	Second MLE		
Multimedia aspect	91.00%	98.00%	94.50%	Very High
Software dev. Product aspect	93.00%	100.00%	96.50%	Very High

Table 7 explains the results of the media validity score on the multimedia aspect from the first Multimedia Learning Expert (MLE),

obtained at 91.00%, and from the second MLE, obtained at 98.00%. The media validity score on the aspect of software products from the first MLE obtained 93.00%, and the second MLE obtained 100.00%.

Table 8. Practicality Testing Results by Potential Students

Aspects	Mean	Category
The use of the handbook	79.00%	High
The attractiveness of the handbook	81.00%	Very High

Table 8 explains the practicality score by students (potential users) in The Use of The Handbook aspect obtained 79.00%, and The Attractiveness of The Handbook aspect obtained 81.00%. The main reason why the scores of students are not categorized as very high is that they are still not familiar with or still have their first experience using products in the form of digital handbooks. The hope is that students can use these digital learning resources smoothly over time. Table 9 explains the results of the practicality score by the potential teacher in The Use of The Handbook aspects obtained 100.00%, and The Attractiveness of The Handbook aspects obtained 100.00%.

Table 9. Practicality Score Results by Potential Teachers

Aspects	Practical Average	Category
The use of the handbook	100.00%	Very High
The attractiveness of the handbook	100.00%	Very High

D. Disseminate

The digital interactive handbook has been developed, tested, and achieved the specified results. Then, this handbook is distributed and can be used online by smartphone or computer. This interactive digital handbook is distributed to students and teachers and disseminated through the school's online learning platform. The teacher provided this digital handbook as a learning resource for students in and outside the classroom. This interactive digital handbook is distributed using a web link that can be accessed using a web browser.

CONCLUSION

This research's appropriate interactive digital handbook can be used as a support learning resource for Interactive Media Design subjects. The interactive digital handbook can support student learning activities in interactive media design subjects that involve many practical activities or procedural knowledge and attract students who tend to be active in hands-on activities. The material or content validity score showed results that the presentation and content of the material were appropriate under the aspects of handbook presentation and content feasibility. According to students' character analysis, an interactive digital handbook should be developed using the picture and word elements based on the Cognitive Theory of Multimedia Learning. This interactive digital handbook is appropriate for the multimedia and software product aspects as a learning medium or a learning system. This interactive digital handbook can also be used to attract students' interest in a hands-on activity. This attractiveness is indicated by the acquisition of practicality score results in which there are aspects of using the handbook and the attractiveness of the handbook. Based on the results of the practicality score, this handbook is declared practical and worth using.

Although these interactive digital handbooks already have the feasibility as learning resources for procedural materials, further research needs to be done to prove the impact of using this product on psychomotor learning outcomes, level of learning independence, and personalization of learning through experimental research designs. Other researchers can also compare the effectiveness of this digital handbook with printed learning resources in shaping student learning transfer.

Further research also needs to develop an interactive digital handbook for principle knowledge because procedural knowledge and principle knowledge are the main types of knowledge for workers to do routines and creatives job or tasks that need to be taught in vocational high school.

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