Development of Web-Based Computer Programming Training Media on Informatics and Computer Technology Education Faculty of Engineering, Universitas Negeri Medan

Amirhud Dalimunthe[1], Fahmy Syahputra[2]

{amirhud@unimed.ac.id[1], famybd@unimed.ac.id[2]}

Department of Information and Computer Technology Education, Faculty of Engineering, Universitas Negeri Medan, Indonesia[1,2]

Abstract. The competence of students of Information and Computer Technology Education in the basic concepts of programming has not yet fully achieved the expected results. The problem is due to the lack of time in the learning process, limited ability to access devices that support practical laboratories, and the COVID-19 pandemic situation. Efforts to overcome this gap by conducting training in the field of computer programming. This training is designed to be carried out outside of lecture time. The training process is carried out outside of lecture time providing broad opportunities for students as training participants. This training is also designed so that it can be carried out interactively via the internet. The interactive training process requires media by utilizing e-learning technology known as web-based training technology. Web-based training media has succeeded in facilitating learning and also demonstrating practical activities. The media produced in this study is web-based interactive multimedia.

Keywords: training media, computer programming, web-based training

1. Introduction

The human resources needed by industry 4.0 today are those who have competence in the use of digital technology. This competency is intended to realize smart factories such as the Internet of Things. The application of industry 4.0 in principle will not replace the role of human labor, but can encourage increased competence to understand the use of the latest technology in the industrial world [1]. According to [2], to obtain competitive human resources in industry 4.0, the educational curriculum must be designed so that the graduates produced have the competence to overcome new literacy. This new literacy includes data literacy, technology literacy, and human literacy. Data literacy is related to the ability to read, analyze, and draw inferences based on the data and information (big data) obtained. Technological literacy is related to the ability to understand how machines work. Human literacy is related to communication, collaboration, critical thinking, creative, and innovative skills [3].

Information and Computer Technology Education, Faculty of Engineering, Universitas Negeri Medan is a study program in the field of information and computer technology. One of the goals of Information and Computer Technology Education is to produce graduates who are able to

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work professionally in the fields of computer programming, computer networks, multimedia and entrepreneurship. The achievement of this goal is credited to several courses, such as Basic Programming, Data Structures, Object Oriented Programming, Mobile Programming, Web Programming, and so on. The achievement of competencies possessed by students after taking these courses is basically the ability to use various computer programming. Graduates of the Information Technology and Computer Education study program are expected to be able to fulfill competencies in the field of computer programming. Therefore, students at the elementary level in this study program are always equipped with basic programming. Understanding and mastery of students in various computer programming languages is a mandatory competency for students in the field of information technology and computers.

One of the efforts to overcome this gap in the mastery of basic programming competencies is by conducting training in the field of computer programming. [4] stated that training is a learning process about a discourse of knowledge and skills aimed at implementing learning outcomes that are in accordance with certain demands. [5] explains that "Training can be defined broadly is the techniques and arrangements for fostering and experiencing learning. The focus in on learning". [6] defines training as a systematic effort to master skills, rules, concepts, or ways of behaving that have an impact on increasing competence. Furthermore, according to [7] training basically includes the teaching and learning process and exercises aimed at achieving a certain level of competence. In the world of education, training can be used as a supporting tool to improve the knowledge and skills of students in meeting competency achievements [8].

This computer programming training is designed to be carried out outside of lecture time and is not related to the tasks that must be completed by students in lectures. The training process that is carried out outside of lecture time provides broad opportunities for students as training participants. The computer programming training process is also designed so that it can be carried out interactively via the internet. The interactive training process as described above requires the use of e-learning technology in the field of training known as web-based training technology. Web-based training is an innovative approach to remote training in which the training material is transformed by the technology and attitudes of the internet or intranet. The web-based training specification is the presentation of live content, in a structure that allows for independent and self-directed instruction on any topic [9].

Web-based training is a form of training that can be developed by utilizing the internet network [10]. The presentation of web-based training allows training information to be real time and interactive. Training activities in a web-based training system are offered to serve as regular training [11]. Thus, it can simply be said that web-based training is a training activity that utilizes networks as a method of delivery, interaction and facilities as well as support for various other forms of learning services [12]. According to [13] there are four components in the implementation of web-based training. The four components are the administrative component, assessment component, content delivery component, and community component. [14] added that basically the learning content in web-based training consists of text-based content and multimedia-based content.

2. Method

The product development model used in this research is the waterfall development model, which consists of (1) Requirements Definition, (2) System and Software Design, (3) Implementation and Unit Testing, (4) Integration and System Testing, and (5) Operation and Maintenance [15]. At the Requirement Definition stage in system development, communication is needed that aims to understand the software expected by the user and the limitations of the software. The information is analyzed to get the data needed by the user. The requirements specifications from the previous stage will be studied in the System and Software Design phase. System Design helps in determining hardware and system requirements and also helps in defining the overall system architecture. In the Implementation and Unit Testing stage, the system is first developed in small programs called units, which are integrated in the next stage. Each unit is developed and tested for functionality which is referred to as unit testing. In the Integration and System Testing stage, all units developed in the implementation stage are integrated into the system after testing each unit. After integration the whole system is tested to check for any failures or errors. At the Operation and Maintenance stage, the finished software is run and maintenance is carried out. Maintenance includes fixing errors not found in the previous step. Improvement of system unit implementation and improvement of system services as new requirements.

The web-based training media validation instrument used in this study consisted of three assessment aspects including usability aspects, functionality aspects, and visual communication aspects. The analysis of the validity of the research product was carried out by processing the data in the form of a questionnaire (instrument) given by the experts. The data obtained was then analyzed using the Aiken's V formula so that the content validity coefficient (V) value was obtained. The formula used to calculate this data is [16]:

$$V = \frac{\sum S}{[n\,(c-1)]} \quad (1)$$

where:

S = total score of validator = r – lo

c = The highest validity score

lo = lowest validity score

r = Number given by validator

3. Result and Discussion

3.1. Result

3.1.1. Results of Web-Based Training Media Development

Web-based training designed and developed as a medium for training is focused on supporting practical activities in computer programming training. The Home display of the developed web-based training media can be seen in Figure 1 below:

Fig. 1. Home Screen of Web-Based Training

In this study a responsive web platform was developed to teach the syntax and logic of the C programming language. This environment gives students the ability to independently investigate the C programming language continuously through an always accessible platform. The display of the programming language material used in this web-based training media can be seen in Figure 2 below:

Fig. 2. Display Material on Web-Based Training media

The practical activity of writing program code (coding) in this computer programming training is carried out on an online compiler that has been embedded in the developed web-based training media. Training participants can simulate writing program code on the online compiler. The interface display of the online compiler on the developed web-based training media can be seen in Figure 3 below:

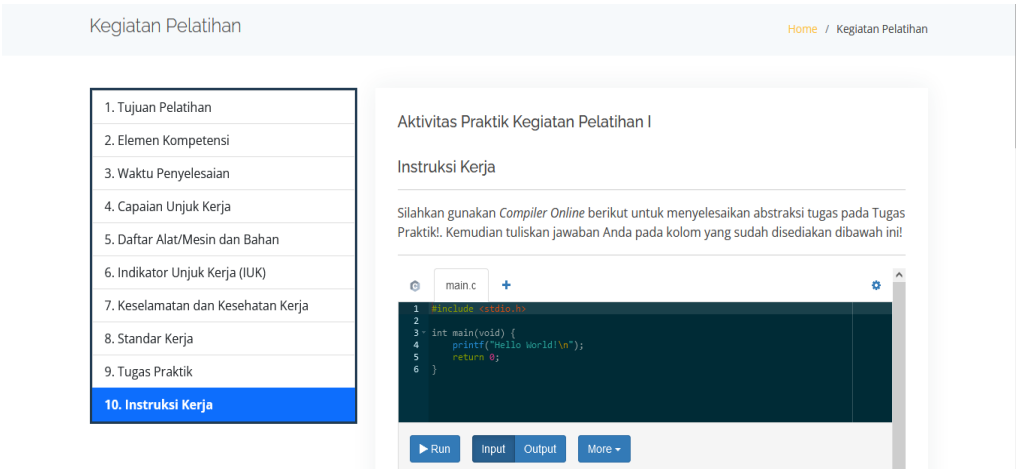

Fig. 3. Online Compiler Display on Web-Based Training

In this study, content development on web-based training is not focused on being able to accommodate the implementation of a learning management system as e-learning in general, but rather on web-based online training activities.

3.1.2. Results of Web-Based Training Media Validation

Media validation in the development of Web-Based Training media is a feasibility test activity on the web used in the computer programming training process. The feasibility test is carried out using a questionnaire given to validators who are experts in the fields of media, information technology, and information technology. Experts provide an assessment of the validation questionnaire with a Likert scale using quantitative techniques with a scale of 1 to 5 with the answer choices strongly agree, moderately agree, quite agree, slightly disagree, and moderately disagree. The results of the validity test of web learning media and the Aiken's V value can be seen in Table 1 below:

Table 1. Results of Web-Based Training Media Validity Test

No	Assessment Aspect	Aiken's V
1	Usability Aspect	0,833
2	Functionallity Aspect	0,800
3	Visual Communication Aspect	0,813
Average		**0,815**

The value of validity (V) for web-based training media is 0.815. This value is greater than 0.677 indicating that the web-based training media is valid for use.

The results of the test of the validity of the training material needs based on the assessment of computer programming material experts and the Aiken's V value can be seen in Table 2 below:

Table 2. Results of the Validity Test of Training Material Needs

Elements of Competence	Aiken's V
Creating programming logic flow	0,857
Using data types and basic structures of structured programming languages	0,857
Creating simple programs and compiling programs	0,825
Creating programs using modular programming principles	0,849
Applying the basic techniques of general algorithms on array elements	0,817
Average	**0,841**

The value of the validity test (Aiken's V) for the need for training materials is 0.841. The value is greater than 0.677, indicating that the material compiled to meet the competency of the training material is valid. The results of this validation indicate that the material designed for computer programming training material competencies is feasible and can be used according to the training objectives.

3.2. Discussion

Efforts to achieve competence in the field of computer programming are pursued through training. As stated by [4], that training is a process where students achieve certain abilities to help achieve organizational goals. The specific ability referred to here is the ability in computer programming as one of the objectives of the Information Technology and Computer Education study program, Faculty of Engineering, State University of Medan. Computer programming training is carried out online based on the web through the developed web-based training media. The use of web-based training means that the process of this training is carried out online.

The material trained in web-based computer programming training in this study is one type of procedural programming language. As part of procedural programming, it is very important to strengthen students' understanding in the field of information technology and computers to master syntax and logic in the C programming language. The C programming language is a programming language that can be used as the basis for understanding other programming languages. Until now, the C programming language has also been widely implemented in building applications or simulators in the engineering field.

The use of the web as a medium in training to understand computer programming was investigated by [17] in his research entitled A Web-Based Serious Game to Increase the Programming Knowledge Levels of Computer Engineering Students. The difference between the research conducted [17] and this study is in the media used and embedded in the web. The media they use are game elements to produce a responsive web platform, while in developing this web-based training media they use an online compiler so that they can produce an interactive web platform. The trainees can perform simulations for practice in writing programming code, and the online compiler can immediately show the truth. When an error occurs, the online compiler can also directly provide information on which part is wrong.

The web-based training product which is a medium in the computer programming training process includes an assessment of usability aspects, functionality aspects, and visual communication aspects that have been validated. The results of the validity test on web learning media gave an average validity value (Aiken's V) of 0.815. A validity value greater than 0.677 indicates that the web learning media is valid and feasible to use.

The training materials containing elements of competence and performance criteria for computer programming training have also been validated by experts in the programming field. Elements of these competencies include competence in making programming logic flows, using data types and basic structures of structured programming languages, making simple programs and compiling programs, making programs using modular programming principles, and applying basic general algorithmic techniques to array elements. The results of the validity test based on the Aiken's V formula on the analysis of training material needs gave an average validity value of 0.841. This value is greater than the validity index of 0.677. This validity value indicates that the material compiled to meet the competency of the training material is valid. These results indicate that the competence of the material designed for computer programming training is feasible and can be used according to the training objectives.

4. Conclusion

The validation of the web-based training media that has been developed is carried out using an instrument that has been prepared to determine the validity value. Experts provide an assessment of the media that has been developed based on the feasibility aspect and provide suggestions and comments regarding the content of the media that is used as a reference for revision and improvement of the media. Validation has been carried out and declared feasible to be implemented in training activities. The development of this media can add references for students of Information Technology and Computer Education in particular in increasing competence in the field of computer programming.

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