Development of Problem-based Learning-based Interactive Media to Increase Internet of Things Learning Motivation at SMK Level

Hakkun Elmunsyah*, Wahyu Nur Hidayat, Muhammad Fadhilah Akbar

Program Studi Pendidikan Teknik Informatika, Universitas Negeri Malang, Indonesia
**Corresponding author. Email: hakkun@um.ac.id*

ABSTRACT

The Internet of Things is a new Internet revolution paving the way for change in the modern world. Currently, lectures are the primary approach for teaching the Internet of Things. The lack of engagement in learning material (such as printed books) causes students to lose interest, resulting in a low level of comprehension. This research aims to provide SMK teachers and students with engaging and useful learning resources. Interactive e-module suitable to a website for Internet of Things lesson. The employed development model is the Hannafin & Peck approach, which comprises three stages: needs analysis, design, and development and implementation. This study included 37 students from class X TJKT at SMK Negeri 5 Malang. Expert instruments in the field of media, material specialists, and student surveys were used to compile the data. The final data review by experts revealed that 91.67 percent of media experts and 93.33 percent of material specialists categorized it as highly viable. According to student comments on the built interactive modules, it is very viable, with an overall percentage of 87.60%, because the e-module offers interactive features that students find engaging.

Keywords: *Hannafin & peck, E-module, Interactive, Internet of Things.*

1. INTRODUCTION

The twenty-first century is known as the century of information openness or digital globalization. Due to the openness of human life and the information that continues to permeate through digitization, this period is also known as the digital era [1]. This is characterized by the growth of the internet of things which is increasingly reaching and affecting various levels of society [2]. The Internet of Things (IoT) is the idea of networks connecting the virtual and physical worlds [3]. Human resource improvement must be done in line with technology trends [4]. As a result, the most important thing now is to prepare digital talent. IoT in Indonesia will only thrive with digital skills as it requires application development with digital experience [5].

According to the Directorate General of Vocational Education (Ditjen Diksi), there are five aspects that human resources must master to face the digital era, namely the Internet of Things, artificial intelligence, human-machine interface, robotics and sensor technology, and 3D printing technology. IoT has become important to learn as a form of future preparation for the shifting types of work [6]. The introduction of the Internet of Things is included in the material taught in the Basic Subjects of the Computer Network and Telecommunications Engineering Expertise Program, according to the Decree of the Minister of Education and Culture No. 008/H/KR/ 2022 concerning learning outcomes for secondary education level independent curriculum.

According to the findings of observations and interviews with teachers teaching the internet of things at the SMK Center of Excellence in Malang city, learning generally still uses the lecture method and the learning resources used by teachers in teaching are printed teaching materials, and teachers still dominate in learning. As a result, students often rely on teachers to carry out learning activities. In addition, students need suitable teaching materials that allow them to learn anywhere and anytime. Because the teacher's media does not include or stimulate students in learning activities, students tend to have low learning motivation. Responding to the above problems, efforts can be made to increase student learning motivation through innovative and practical learning resources.

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E-modules are digitally packaged educational resources. E-modules can assist teachers in facilitating their students' learning [7]. The use of E-modules reduces teacher dominance during the learning process, allowing students to participate more actively. E-modules facilitate interactive learning by providing adaptive assessment and feedback [8]. This learning material encourages students to learn independently in a variety of settings [9]. According to research, e-modules in education have increased student learning motivation [10], [11]. The use of e-module teaching materials encourages students to be more independent in their learning activities rather than relying solely on direction from the teacher. It can be concluded that e-modules can increase student learning motivation. This affects student learning outcomes positively.

Choosing the right learning tactics in terms of teaching methods, learning media, classroom conditions, and student skills in general is an effort that can be used to boost student learning motivation. Innovative and creative learning strategies can help students improve their skills [12]. MThe learning model can increase students' comfort in learning as well as improve students' critical thinking skills [13]. Critical thinking in problem solving is one of the skills that students must have to face future challenges. Internet of Things technology transforms real objects around us into smart objects that can be connected via the internet [14]. In addition to understanding how it works, students are also instructed to interpret and solve problems in their environment using IoT. In this case, the Problem Based Learning (PBL) learning model can be applied.

This research aims to develop E-modules based on IoT material for problem-based learning for class X students of SMKN 5 Malang. The IoT material in this e-module has just been included in the independent curriculum of SMK Center for Excellence. The PBL model and teaching materials of the E-module will be used in this project. Available resources and student characteristics are factors in the selection of E-modules with PBL model. As a learning tool, these processes are integrated with the E-module teaching materials. The delivery of fun and interactive content with problem-based learning in the e-module is expected to increase student motivation, especially in the curriculum on the Internet of Things. This combination of learning models and resources will be an option for teachers who want to build and innovate in creative and innovative learning.

2. METHODS

This research is a development research with the Hannafin & Peck model which aims to develop a valid and practical interactive e-module. The model used in this development research refers to the Hannafin and Peck development model which consists of three main phases and these three phases are linked to the evaluation and revision phase [15].

Figure 1. Hannafin & Peck Research Design [16]

In the needs assessment stage, analysis activities are carried out, formulating problems to determine the objectives of developing learning media. Observations were made for several months between September and December 2021 at SMK Negeri 5 Malang. The results of the analysis at this stage produce essential concept points which will later be used as the basis for media design. Next is the design stage, a series of stages related to the preparation of media output steps. This stage is a media design that will be developed and implemented at a later stage. The development and implementation stage creates new learning media based on the media draft produced at the design stage. The learning media that has been developed then goes through several processes, namely, a)validation by material experts and media experts, b)evaluation and revision, and c)trials. The result of this stage is a learning media product that suits the needs of students and schools based on the results of the need assessment that has been carried out.

This study involved 37 students of class X SMK Negeri 5 Malang. This study collected data through observation, interviews, and questionnaires. Validator and student response questionnaires were used to collect data for this study. Media and material experts filled out the validator questionnaire to determine the validity of the product. Student response questionnaires were used to obtain information on the practicality of the product. Reality and practicality analysis were used in the data analysis methodology. The validity of the research was done by calculating the average score of the experts. Practicality analysis was conducted by calculating the average score of the student response questionnaire. The results can be seen in the practicality category based on the average score of the questionnaire.

3. RESULTS

At the needs analysis stage, observation activities were carried out, namely interviewing the IoT material teacher of SMK Negeri 5 Malang. Data collection through interviews with teachers regarding the

difficulties and problems faced during online learning on the Internet of Things material, methods, media used so far, and infrastructure in the learning process. Furthermore, the researchers conducted a learner analysis through a questionnaire given to students. The analysis carried out is about the obstacles experienced by students in the learning process and how the teacher teaches, especially the Internet of Things material. Based on the results of observations and interviews, it is concluded that learning conditions are less interactive, learning media are still limited and teachers still dominate with the lecture method. In addition, students also feel lazy to study the available material, because they are more interested in interesting pictures and videos. Students who still have difficulty modeling the material in everyday life. So the development of e-modules that are associated with real examples in everyday life to facilitate students' understanding of the material is needed.

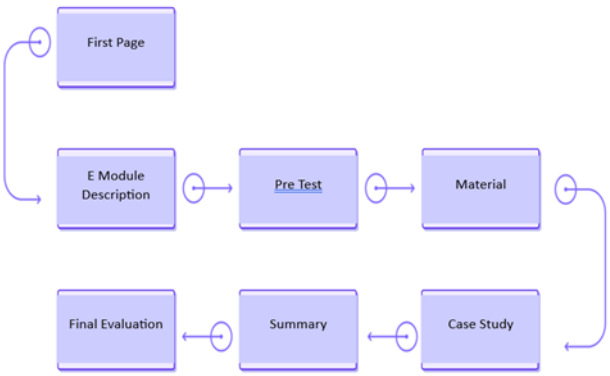


Figure 2. E-module Flowchart

In the design stage, the e-module is designed based on the results of the analysis that has been conducted. An important step to be done at this stage is to formulate and define the experiences that students need in learning activities. Interactive e-modules are designed to make it easier for students to understand the content as it allows direct interaction of the e-module. These interactive multimedia teaching resources include images, animations, videos and interactive content. In addition, students can learn it anytime and anywhere which makes this interactive e-module effective. This interactive e-module can also assess students' abilities and understanding independently through exams or practice questions included in the material. The presentation of the material in the e-module is organized by including problems that students can encounter in their daily lives in accordance with PBL syntax. In line with Baran's opinion, through PBL learning, students will be faced with real problems that are close to their daily lives in order to develop knowledge [17]. Through real experience, students' understanding ability, independence and confidence will increase [18]. The design stage produced a flowchart and storyboard of the e-module.

The e-module was developed in accordance with the design that had been made previously. The presentation of the material in the e-module is equipped with interactive content so that it is attractive to students. Furthermore, the e-module is hosted on the website so that it can be accessed online anytime and anywhere. Followed by validation activities by media experts and material experts.

Table 1. Storyboard E-module

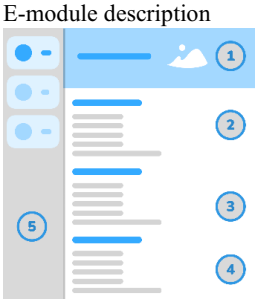
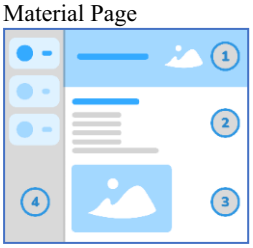
No.	Storyboard	Description
1.	Cover e-module 	Title of e-module Short description Lesson list
2.	E-module description 	Title Page Description of e-module Learning Outcomes Instructions for Use Navigation
3.	Material Page 	Title page Material Images, videos, interactive content Navigation

Table 2. Material Validation

No.	Aspects	Percentage	Category
1	Eligibility of Presentation	93.18%	Very valid
2	Content Eligibility	93.75%	Very valid
The average e-module feasibility		93.47%	Very valid

Remarks The average of all aspects tested obtained a percentage of 93.47% with a very valid category. Meanwhile, Table 3 is the result of media validation by media experts. lecturer validators who act as media experts who test the quality of the media on aspects of screen design appearance, ease of use, consistency, usefulness, graphics. The average of all aspects tested obtained a percentage of 93.33% with a very valid category.

Table 3. Media Validation

No.	Aspects	Percentage	Category
1	Display screen design	90%	Very good
2	Ease of use	85%	Very good
3	Consistency	91.67%	Very good
4	Expediency	100%	Very good
5	Graphics	100%	Very good
Average Feasibility of E-modules		93.33%	Very good

At this stage, revisions were made to the e-module based on input from media experts and material experts. The inputs from the media expert and material expert validators are as follows: Material experts suggested adding illustrations to the explanation of how the internet of things works and the elements that make up the internet of things. The material expert also suggested adding evaluation questions from 10 questions to 20.

Furthermore, the e-module was tested on 37 students of class X TJKT SMK Negeri 5 Malang. Product trials were carried out in two stages, namely small group trials and large group trials. Product trials were conducted to determine the effectiveness of using e-modules in increasing student learning motivation in Basic Graphic Design subjects through user response scales and pretest-posttest. Product trials in the first stage, namely the initial stage trial involving 12 randomly selected X TJKT 1 class students presented in table 4, the aspects assessed were pleasure, interest, activeness, seriousness, ease, interest. After conducting a small-scale field trial to users, the project-based e-module product was declared feasible and could be used in learning.

Table 4. Small group student response

No.	Aspects	Percentage	Category
1	A sense of fun	87.16%	Very good
2	Interests	86.71%	Very good
3	Liveliness	89.53%	Very good
4	Seriousness	88.51%	Very good
5	Ease	87.93%	Very good
6	Interest	86.82%	Very good
Average feasibility of e-modules		87.60%	Very good

Large-scale trials were carried out involving all students of class X TJKT 1 with a total of 37 students. Product trials at this stage were carried out through pre-experimental tests with the aim of knowing the effectiveness of using project-based e-modules in increasing student motivation in class X TJKT SMK Negeri 5 Malang on IoT material. Measurement of student learning motivation is done before and after the implementation of IoT learning using PBL-based e-modules. Measurement of learning motivation consists of aspects of the desire to understand and master what is learned, commitment to duties and obligations to learn, initiative to learn, and optimistic about learning outcomes. The results of the student learning motivation trial assessment showed that the gain value was 48% which was in the moderate category. Description of the results of student learning motivation before and after the implementation of learning using project-based e-modules can be seen in Table 5.

Table 5. N-gain of Student Learning Motivation

No	Indicator	N-gain Score
1	The desire to understand and master what is learned	0.38
2	Commitment to duty and obligation to learn	0.32
3	Initiative to learn	0.88
4	Optimistic about learning outcomes	0.46
	N-gain average of student learning motivation	0.48

After the implementation of learning using e-modules involving all students of class X TJKT 1, then students were given a user response questionnaire. The questionnaire was given to find out students' responses to the e-module which consisted of aspects of pleasure, interest, activeness, seriousness, ease, and interest. The frequency distribution of large-scale field trial results is presented in Table 6.

This learning media can be accessed through a browser on a laptop and android through the link http://www.classon.my.id/home/. The following are the e-module views, Figure 3 is the e-module cover view when opened via a laptop device. Furthermore, Figure 4 is the instructions for using the e-module to make it easier for students to operate the e-module. Furthermore, the material display is presented in Figure 5.

Table 6. Large Group Student Response

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Figure 3. Cover E-modul

Figure 4. Instructions for use page

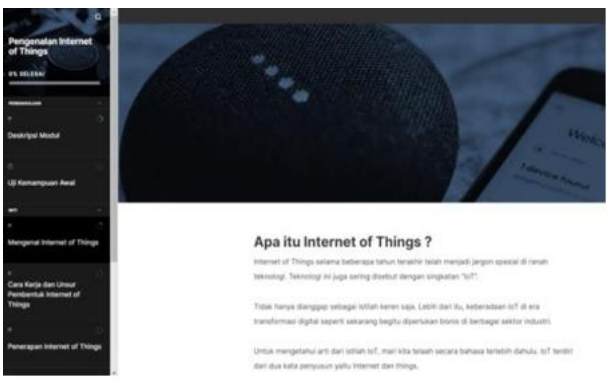

Figure 5. Material Page

4. DISCUSSION

The e-modules made have a very valid classification and can be used by students as a learning resource. E-modules are practical because they convey information or material that is in accordance with learning. Materials, core competencies, learning outcomes, and learning objectives are in accordance with those applied in SMK. Better learning quality can be improved by having clear indicators and learning objectives [19]. Learning with clear objectives, such as having a clear audience, behavior, conditions, and level of mastery can be used as a guide during the learning process [20].

The practicality test results obtained a practicality score in the very practical category. The results of the student questionnaire show this. Most of the students of class X TJKT 1 SMK N 5 Malang agreed that using e-modules in learning will make it easier to find the concept of learning material. Findings from the student response test show that the PBL-based e-module helps students in their learning. Students can become more involved in their learning and study at home with the help of IoT learning e-modules.

Students' learning motivation increases after using the e-module because it has interesting images and learning videos that accurately represent the subject matter. Through visuals and animations, the media can encourage and trigger the spirit of learning [21]. Because they are displayed visually, material with long and abstract explanations will be easier to understand. Images are used in the e-module content to increase learning motivation and simplify complex and abstract ideas into a more straightforward, transparent, and easy-to-understand form [22].

According to previous research findings, e-modules can increase student learning independence and improve learning outcomes [23]. According to the results of other studies, the use of e-modules can increase student learning motivation [24]. The benefits of e-modules are that students can flexibly carry them wherever they go and give an attractive impression because they can be accessed via mobile phones. In addition, the animation, video and audio in the e-module will attract students' attention to the lessons taught. To increase students' interest and desire to learn, this study created an e-module teaching material product with very good validity criteria. Teachers can learn new skills thanks to the availability of e-modules, which allows them to develop conventional teaching techniques.

PBL-based e-modules are excellent for engaging students in real-world problems and offering a learning environment related to their role as computer and telecommunication network service providers. Gen Z is excellent at communicating and learning online since they grew up in a digital environment [25]. For almost anything, they can instantly get information or instructional videos. They have excellent technological skills, allowing them to scan most internet platforms and search for information quickly. Gen Z is comfortable with digital devices and open to ICT-based education strategies [26]. E-modules design PBL activities that use internet resources to help students uncover missing

material, gather necessary information, clarify concepts, and construct answers, interactive electronic modules are created based on the suitability of technology to Gen Z.

5. CONCLUSIONS

The learning e-module created on the topic of Internet of Things for class X SMK is included in the very valid category according to the assessment of two validators, it can be seen from the data analysis and discussion. The results of the student practicality test received a very practical category. The results of the e-module effectiveness test are considered capable of increasing student learning motivation. A database system is needed for future development of this application so that teachers can easily manage data and track student progress in the program.

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