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Feasibility Test of Interactive E-Module Project Based Learning Model in Manufacturing Engineering Drawing Learning

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ABSTRACT: The purpose of this study is to: (1) Develop an interactive E-module of project based learning model in learning Manufacturing Engineering Drawing in SMK with expertise in Machining Engineering; (2) Determine the feasibility of an interactive E-module of project based learning model in learning Manufacturing Engineering Drawing in SMK with expertise in Machining Engineering. This study is a research and development study. The research model used is the 4D model which is implemented in 4 stages, namely the define, design, develop, and disseminate stages. Validation of the e-module was carried out by material experts and media experts. The product trial was carried out at SMK Negeri 2 Karanganyar. The results of this study are: (1) The interactive E-module of Manufacturing Engineering Drawing was developed using the 4-D model is an interactive E-module based on LMS Edukati designed using the Project Based Learning (PjBL) learning model; (2) The level of suitability of the interactive e-module is assessed based on validation by (a) Material experts at 76% with the category "very suitable", (b) Media experts at 88% with the category "very suitable", (c) Student responses at 85% with the category "very suitable".

KEYWORDS: interactive e-module, Manufacturing Engineering Drawing, 4D model, feasibility

I. INTRODUCTION

The main component in improving the life of the nation is education (Saputro 2018). Throughout the world, a person is put into various types of schools after receiving a comprehensive education up to a certain age (Ozer and Perc 2020). The implementation of educational activities is the responsibility of a country in producing the next generation of the nation (Helda and Syahrani 2022). In essence, education is an effort to bring humans closer to civilization, which is very important for the life of the nation and is needed to improve the standard of living as a whole (Agustian and Wibowo 2015). Getting an education is an obligation for all people in the world. With education, it will have an impact on progress in the development of the nation's life and quality and broad-minded human resources. A country can be said to be advanced if the education system in the country is also of high quality. The level of progress of the nation can be seen from how well the education system in the nation is progressing (Rohman 2016).

Referring to Article 1 paragraph 1 of Law Number 20 of 2003 concerning the National Education System, which states that education is a conscious and planned effort to create a learning atmosphere and learning process so that students actively develop their interests and potential to have spiritual religious strength, self-control, personality, intelligence, noble morals, and skills needed by themselves, society, nation, and state. The main objective of education at the national level is to advance the nation and state. In Indonesia, citizens are required to receive education.

Vocational education aims to create a work-ready generation (Suharno, Pambudi, and Harjanto 2020). In general, according to Hanafi (in Santika et al. 2023), currently, the goal of vocational education is often limited to training students to work as workers in certain sectors. Vocational education graduates need to be better prepared to face rapid technological developments, massive information, and complex problem solving (Towip, Widiastuti, and Budiyanto 2022). Vocational high school graduates must now be ready to face the challenges of 21st century *skills in order to remain competitive in the industrial world* (Megayanti, Busono, and Maknun 2020). Students need to be prepared to have skills in manufacturing drawing design, so special teaching and training are needed. Students who need to be taught are focused on developing their cognitive, emotional, and psychomotor skills. If these three competencies are achieved, then vocational education can be said to be successful (Mutohhari et al. 2021). To equip students in this field, students are required to take Manufacturing Engineering Drawing lessons. The Manufacturing Engineering Drawing subject is available at the Vocational High School with expertise in Machining Engineering where this subject applies the use of *Computer Aided Design* (CAD) in its learning process. CAD knowledge will be useful and can lead students towards readiness to enter the world of work. The purpose of vocational education is clear, namely to educate someone who is ready to become a workforce.

Media is a useful tool in learning activities (Prabawati, AM, and AM 2021). Lack of media and learning information is one of the obstacles in the learning and teaching process. Lack of media in learning will result in less than perfect learning. As stated by Miftah (2013), improving student learning outcomes is highly dependent on the availability of adequate media and learning materials. Teachers and students need and utilize media in the educational process. Therefore, to teach the subject of Manufacturing Engineering Drawing effectively, appropriate learning media are needed.

Technological advances have influenced the way we acquire knowledge and learn (Szymkowiak et al. 2021). Although many educational initiatives use technology to improve learning effectiveness and motivation, the demands of today's job market are often faced with increasingly rapid technological developments (Scavarelli, Arya, and Teather 2021). There are many ways to use technology in learning (Hernandez-de-Menendez, Escobar Díaz, and Morales-Menendez 2020). One of the uses of information and communication technology in learning is through learning using e-module media. E-modules are learning activities that utilize electronic devices (Yusuf et al. 2020). Therefore, e-modules that are developed in accordance with design principles and methodologically will be successful and feasible for use in learning (Kadek Suartama et al. 2020).

The lack of interactive materials or media in learning activities is a challenge faced by many educational institutions, especially in Vocational High School in the context of learning manufacturing engineering drawings. Not all teachers are ready or able to utilize existing technology to facilitate interactive materials or media (Lusiana and Maryanti 2020). Conventional learning materials that are static and less interactive tend to be less interesting for students, and this can hinder the process of understanding complex technical concepts. Information technology is increasingly dominating, there is a growing need to develop technology-based educational resources, such as interactive e-modules. Interactive e-modules have the potential to offer a more engaging and dynamic learning environment, allowing students to take an active role in their education and receive rapid feedback. The effectiveness of improving learning outcomes can be associated with the influence of the completeness of media and learning devices on education used during the learning process. (Mariana 2018).

The application of innovative learning models is necessary in the context of education, including in Vocational High School in learning manufacturing engineering drawings. To create an innovative learning process, it requires skills and critical thinking in particular that must be improved appropriately from teachers by implementing the right learning model (Nurtanto, Sofyan, and Pardjono 2021). The dominant conventional learning model tends to be less motivating and not optimal in developing students' skills and understanding holistically.

Learning models can be interpreted as guidelines for achieving existing learning objectives by considering strategies, techniques, methods, and learning assessment tools (Afandi, Chamalah, and Wardani 2013). The limitations of learning models mastered by teachers are an important issue in the context of education, especially in Vocational High Schoolin learning manufacturing engineering drawings. The use of learning models that are limited or focused on conventional approaches can limit the ability of teachers to provide interesting and effective learning experiences for students. Sometimes, teachers may be less familiar or less trained in implementing innovative learning models, such as *Project based Learning* (PjBL), which requires a more collaborative and project-based learning approach. This can hinder the development of student skills that are in accordance with the demands of the world of work in the ever-growing mechanical engineering industry. Therefore, it is important to identify and address these limitations by providing appropriate support to teachers in adopting innovative learning models.

One of the innovative learning models that can be a solution is *Project-based Learning* (PjBL). *Project-based learning* is a learning model that is intended as a solution to a problem that certainly has great benefits for students in preparing skills for the future (Sunarto and Amalia 2022). PjBL emphasizes project-based learning that allows students to face real challenges and work collaboratively to achieve concrete solutions. The application of PjBL is expected to enable students to develop practical skills, such as problem solving, critical thinking skills, and teamwork, which are very relevant in the mechanical engineering industry.

Lack of teacher readiness in preparing learning media is one of the problems that affect the effectiveness of learning, especially in Vocational High School in the context of learning manufacturing engineering drawings. Teachers who are less prepared can face difficulties in developing quality learning materials that are relevant to the needs of students and industry. Factors such as lack of time, resources, and knowledge of innovative learning approaches such as *Project based Learning* (PjBL) can be significant obstacles. As a result, learning becomes less interesting and less able to motivate students to study seriously. Therefore, efforts are needed to improve teacher readiness in preparing effective and interesting learning media.

The lack of effectiveness of modules used in *Project Based Learning* (PjBL) learning is an important concern in the current educational context. PjBL is a learning approach that emphasizes students' practical and collaborative experiences in completing authentic and real-world projects. The success of PjBL implementation is highly dependent on the quality of the learning modules used to support this learning process. Through project-based learning, students can utilize their unique skills and apply creativity and innovation to solve problems (Sadrina and Mustapha 2016). Ineffective PjBL modules can result in students' lack of understanding of the concepts taught, unclear learning objectives, or difficulty in integrating project learning with the existing curriculum. Factors such as lack of interactivity, lack of structured project task arrangements, or mismatch between module content and student needs and curriculum can cause PjBL modules to be less effective.

The process of improving the quality of learning and supporting the teaching and learning process of the Manufacturing Engineering Drawing subject is carried out by using media and learning models as an innovative approach that needs to be explored and developed. With the rapid development of technology, the quality of learning must be improved by providing the necessary experience and skills. Appropriate learning media must be designed by considering the character of students in the class and the competencies that students should be able to achieve after receiving the material taught. Therefore, improving the quality of the PjBL module is very important to increase the effectiveness of learning and provide meaningful learning experiences for students. By conducting appropriate research and development, the PjBL module can be improved to optimize project-based learning and ensure the successful implementation of this innovative learning model in the educational environment.

II. METHOD

The research method in this study is research and development. The purpose of the research and development (R&D) approach in science is to create a particular product by evaluating the effectiveness and feasibility of the product (Sugiyono 2015:407). The research model used is the 4D model proposed by Sivasailam Thiagarajan. According to the 4D model in this study, it is implemented in 4 stages, namely the definition, design, development, and dissemination stages. The subjects of this research and development trial are initial/limited field trials and extensive field trials. Initial field trials are conducted to validate the developed product, in this case involving material experts, media experts, and Manufacturing Engineering Drawing subject teachers. After going through the validation stage by experts, the product is then tested on a larger scale through extensive field trials, involving grade XI students from SMK Negeri 2 Karanganyar.

This research uses quantitative descriptive data analysis techniques. Data analysis in this research was used to determine the feasibility level of interactive e-modules. The preparation of the instrument questionnaire was carried out using the method introduced by Rensis Likert, known as the Likert scale, with five answer choices. To assess the feasibility of a product, it can be said to meet the requirements of being feasible or very feasible if in the feasibility assessment it gets an average score of ≥ 61% and ≥ 81%.

III. RESULT AND DISCUSSION

A. RESULT

1. Subject Matter Expert Validation

Material experts assess the suitability aspects of the interactive E-module with the material delivered. Material expert assessments for the module are seen based on aspects of content, language, presentation and graphic suitability. Teachers and lecturers assess the suitability aspects of the e-module with the material delivered. Teacher assessments for the module are seen based on aspects of content, language, presentation and graphic suitability.

Table 1Validation by material experts

No	Aspect	Score obtained	Maximum score	Percentage (%)
1	Content Eligibility	23	30	77%
2	Linguistics	21	25	84%
3	Presentation	16	20	80%
4	Graphics	12	20	60%
Amount		**72**	**95**	**76%**

Based on the feasibility test table from the material expert, it can be concluded that the total score obtained is 72 out of a maximum score of 95, with an overall feasibility percentage of 76% and is included in the "feasible" category. Of the four aspects assessed, the linguistic aspect received the highest percentage of 84%, indicating good and appropriate language use. The presentation aspect has a percentage of 80%, followed by the feasibility of the content with 77%, indicating that the material is generally relevant and appropriate. However, the graphic aspect received the lowest score, namely 60%, indicating that the visual presentation still needs improvement to achieve more optimal feasibility. From the assessment of the material expert, the average feasibility percentage was 76% and was included in the "feasible" category. Based on the validation results by the material expert, the feasibility score was 76% and was included in the "feasible" category. This validation from the material expert is in line with research (Hidayat 2020) . The following is a presentation of the material expert assessment data in the form of a diagram:

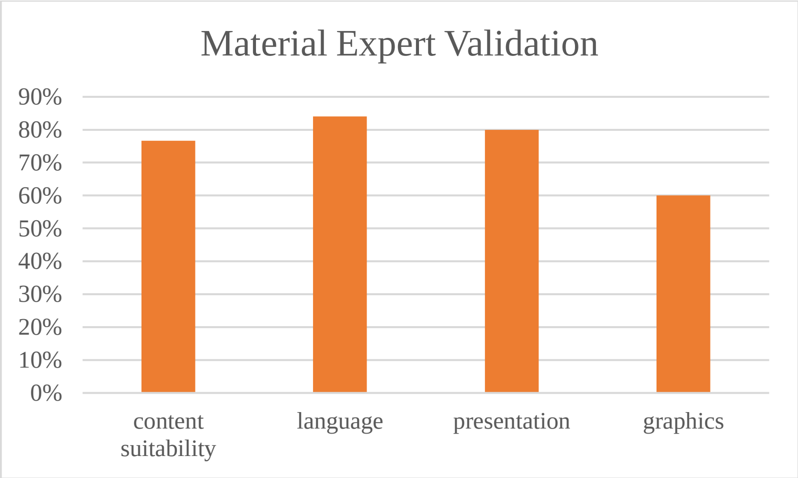

Figure 1Material Expert Validation Diagram

2. Media Expert Validation

Media expert assessments for e-modules are based on aspects of format, organization, attractiveness, font shape and size, space (white space), and consistency.

Table 2Media expert validation

No	Aspect	Score obtained	Maximum score	Percentage (%)
1	Format	15	15	100%
2	Organization	13	15	87%
3	Attractiveness	12	15	80%
4	Shape and size of letters	12	15	80%
5	Space (blank space)	15	15	100%
6	Consistency	12	15	80%
Amount		**79**	**90**	**88%**

Based on the feasibility test table from media experts, the total score obtained was 79 out of 90, with an overall feasibility percentage of 88%, so it is included in the "very feasible" category. The format and space (white space) aspects received a perfect score with a percentage of 100%, indicating that the presentation format of the material is very neat and orderly, as well as the use of proper spacing. The organizational aspect received a percentage of 87%, indicating good organizational arrangements between materials. Meanwhile, the attractiveness, shape and size of the letters, and consistency each received the same score with a percentage of 80%, indicating that these aspects are good but can still be improved. The following is a presentation of the material expert assessment data in the form of a diagram:

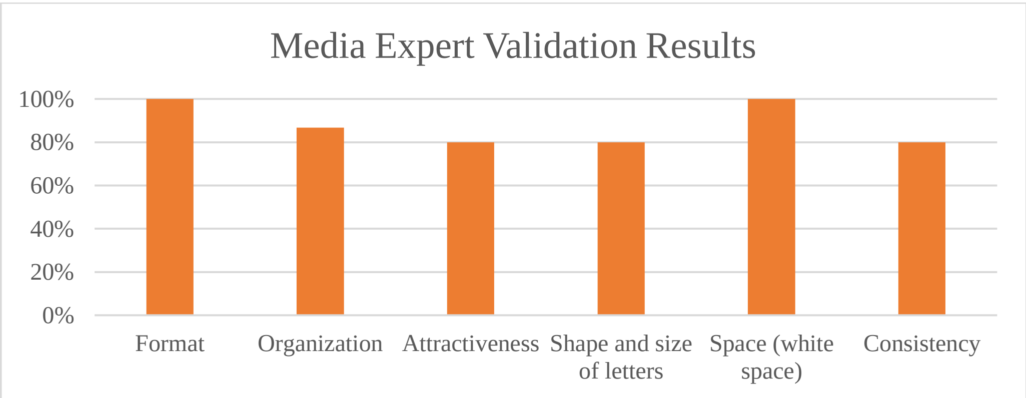

Figure 2. Media expert validation graph

3. Student Response

Student responses are intended to determine the level of e-module feasibility developed for real classes. This user response is carried out to determine students' opinions after using the e-module. The aspects assessed by students are based on aspects of content feasibility, language, presentation, and graphics.

Table 3Student responses

No	Aspect	Score obtained	Maximum score	Percentage (%)
1	Content Eligibility	919	1080	85%
2	Linguistics	762	900	85%
3	Presentation	606	720	84%
4	Graphics	616	720	86%
Amount		**2903**	**3420**	**85%**

Based on the results of the assessment of the interactive e-module by SMKN 2 students, this module obtained a high percentage of eligibility in various aspects, namely 85% for content eligibility, 85% for language, 84% for presentation, and 86% for graphics. Overall, the total percentage obtained was 85%. Based on the existing qualifications, this percentage is included in the "Very Eligible" category. The following is a presentation of the material expert assessment data in the form of a diagram:

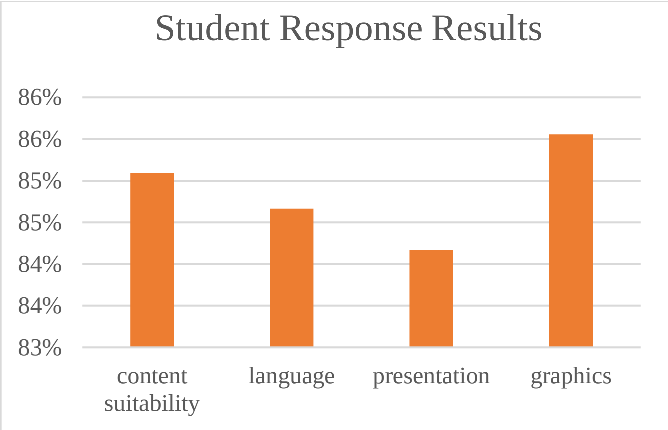

Figure 3Student response graph

B. DISCUSSION

The results of this study were analyzed in depth to provide a comprehensive picture of the quality of the interactive E-modules developed and how they are used in a learning environment.

1. Subject Matter Expert Validation

Validation from material experts focuses on four main aspects, namely the appropriateness of content, language, presentation, and graphics. Based on the table presented, a total score of 72 out of 95 was obtained with an overall appropriateness percentage of 76%. This shows that overall this module falls into the "appropriate" category. Validation from material experts is in line with research (Hidayat 2020) . The highest percentage was achieved in the language aspect of 84%, which shows that the use of language in the module is very good and in accordance with applicable language rules. The language used makes it easier for students to understand the material.

In terms of content suitability, the percentage obtained was 77%. This shows that although the material presented is quite relevant and in accordance with learning objectives, there is still room for improvement to be more in line with the curriculum and students' needs. The presentation aspect received a percentage of 80%, which shows that the structure and flow of material delivery are quite good. However, the graphic aspect only received a score of 60%, which is the lowest percentage. This indicates that the visual appearance of the module still needs improvement, especially in terms of graphic design which can affect students' appeal and understanding of the material.

In conclusion, although this module is considered adequate, there are still several aspects that need to be improved, especially in the graphic aspect, so that the module is more attractive and makes it easier for students to understand the material presented.

2. Media Expert Validation

The assessment from media experts focuses on technical aspects, such as format, organization, appeal, font shape and size, space (white space), and consistency. Based on the media expert validation table, the total score obtained was 79 out of 90, with an overall feasibility percentage of 88%. This percentage places the module in the "very feasible" category, which indicates that in general the module is very good in terms of appearance and material arrangement. This validation from media experts is in line with research by Fitkirana & Kurniawan (2023) and Hidayat (2020) with the results of media expert validation showing "very feasible".

The format and use of space (white space) aspects received a perfect score with a percentage of 100%, indicating that the module format is very neat and efficient. The proper use of white space makes the module look cleaner and easier to read. The organization aspect received a percentage of 87%, indicating that the arrangement of the material is quite systematic and structured, although there is still room for improvement in content management to make it clearer.

Attractiveness, font shape and size, and consistency each received a percentage of 80%. This shows that although the module is visually appealing and consistent in appearance, there are still some things that can be improved, such as choosing a more readable font or improving the visuals to make it more attractive to students. Overall, validation from media experts shows that the module is very feasible to use, with some minor adjustments that can further improve the quality of the display and comfort of using the module.

3. Student Response

Student assessment is an important aspect to determine the extent to which the interactive module developed is able to meet the needs and expectations of users. Based on the student response table, the total score obtained was 2903 out of 3420 with an overall percentage of 85%. This percentage shows that the module is in the "very feasible" category according to student perception.

The aspects of content and language suitability each received a percentage of 85%. This shows that students feel that the material presented in the module is relevant and in accordance with what they need in the learning process. The use of clear and easy-to-understand language is also one of the advantages of this module, which makes it easier for students to follow the learning independently.

The presentation aspect received a percentage of 84%, which means that the module is quite good in terms of structure and how to deliver the material. Students feel that the learning flow offered by the module is quite logical and easy to follow. However, like the assessment from experts, students also gave high marks to the graphic aspect with a percentage of 86%. An attractive visual display that is easy for students to understand is one of the factors that encourages student involvement in the learning process.

Overall, the responses of the students showed that this interactive module is very suitable for use in the learning process. However, to achieve more optimal results, improvements in the presentation and appropriateness of the content still need to be considered so that the material is more structured and in accordance with the needs of students in the field.

IV. CONCLUSIONS

Based on the research data and discussion of this research, the following conclusions can be drawn :

1. The interactive e-module of Manufacturing Engineering Drawing developed using the 4-D model is an interactive e-module based on the Edukati LMS designed using the Project Based Learning (PjBL) learning model.
2. The level of suitability of the interactive e-module was assessed based on validation by (1) Material experts at 76% with the category "suitable", (2) Media experts at 88% with the category "very suitable", (3) Student responses at 85% with the category "very suitable".

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