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## DEVELOPMENT OF PROJECT BASED LEARNING ELECTRONICS MODULE ON INTERNET OF THINGS (IOT) MATERIAL WITH NODEMCU ESP32

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### Abstract

Based on observation sheets and interviews with Jambi University physics education students, it is known that there is no teaching material that can provide an overview to students about making Internet of Things (IoT) projects with NodeMCU ESP32 so that students still find it difficult in making Internet of Things (IoT) material projects with NodeMCU ESP32. This study aims to develop a project-based electronics module (Project Based Learning) on Internet of Things (IoT) material with NodeMCU ESP32. The method used is research (Research and Development) with the ADDIE model, including the analysis, design, and development stages. Module validation data is collected through a questionnaire sheet filled in by material validation and media validation. The results of material validation show that the module has a feasibility of 92% with a very feasible category, while the results of media validation show a feasibility of 90.16% with a very feasible category. Module trials were conducted on 27 Jambi University Physics Education students, which showed student perceptions of the module of 83.03% in the very good category. Based on these results, this module is considered feasible and effective as an alternative teaching material in learning electronics, especially on Internet of Things (IoT) material with NodeMCU ESP32 in university.

### Keywords:

Module, Electronics, Internet of Things (IoT), NodeMCU ESP32, Project Based Learning

## INTRODUCTION

Research needs to be done carefully, critically, factually, objectively, and scientifically in order to find answers or address issues. This explains why research in education is so crucial (Mappasere, 2019). The weak learning process is one of the problems that plague our education system. Students are not encouraged to develop critical thinking skills during the learning process (Junaedi, 2019).

The learning process is very important to be carried out properly in higher education. Education in higher education must provide opportunities for students to develop and actualize their abilities (Mariati, 2021). Learning is the process of gaining knowledge, skills, or attitudes via interaction with information and experiences.

The independent curriculum is a curriculum that offers a variety of extracurricular learning opportunities. The content will be optimized to provide ample opportunities for students to explore concepts and strengthen their competencies. Instructors are free to choose various teaching strategies to adapt the curriculum to the interests and learning needs of each student (Khoirurrijal et al., 2022). One of the top priorities in the autonomous curriculum that provides engaging and pertinent learning is the application of Project Based Learning (PjBL).

Project Based Learning (PjBL) is a methodological approach to education that teaches students information and skills by having them explore and explore real and challenging topics and carefully designed tasks and products (Widiyatmoko & Pamelasari, 2017). The learning process in higher education can motivate students to help other students in completing the project.

In higher education, especially in the Physics Education study program at Jambi University, there is an electronics course that applies project-based learning as a learning model that supports learning the Internet of Things (IoT) with NodeMCU ESP32. NodeMCU is an open source

Internet of Things (IoT) platform written in the Lua computer language (Amri, 2018). The NodeMCU used is NodeMCU ESP32, ESP32 contains a number of I / O pins, allowing it to be built into control or monitoring applications. The ESP32 can host applications or delegate all WiFi network tasks to other applications, thus freeing up processor resources. The ESP32 is used in the Internet of Things (IoT), which enables monitoring and control of wireless networks. It gives users access to secure remote control mechanisms (Harpad et al., 2022).

Based on observation sheets and interviews with Jambi University physics education students, it is known that there is no teaching material that can provide an overview to students about making Internet of Things (IoT) projects with NodeMCU ESP32 so that students still find it difficult in making Internet of Things (IoT) material projects with NodeMCU ESP32.

So that students can use available resources to learn independently, anytime, and anywhere, at their own pace, without the help of teachers or other friends; students can learn in any order they choose; students can increase their independent learning potential; and students can use these materials as guidelines to direct their learning activities, namely module teaching materials (Fajri, 2018). Modules are educational resources that contain content, methods, limits, and evaluation techniques that are developed regularly and imaginatively to meet subject competencies and subcompetencies (Imansari, 2017). Through the use of modules, students can learn according to their ability level and determine their level of achievement during the learning process (Herawati 2018). Due to the availability of modules, students have the opportunity to self-regulate or overcome any shortcomings, errors, or deficiencies they may have (Suastika, 2019).

This study aims to determine the results of making a project-based electronics module based on Internet of Things (IoT) material with NodeMCU ESP32 and student opinions about the module.

## METHODS

The research method used is development research, using ADDIE, consisting of 5 steps, namely analysis, design, development, implementation and evaluation. For more clarity, the stages can be described as follows:



Picture 1. Research stage

(Sumber: Setiadi & Yuvita 2020)

The ADDIE model research carried out only until the development stage (Developmet), because the purpose of this research is only limited to developing and producing a valid module product.

The module validity test is conducted by qualified validators, namely media expert validators and material expert validators. Validators will provide an assessment of the product module along with recommendations and comments using a validation questionnaire form. While the material validation questionnaire sheet assesses the feasibility of information, presentation, and language, the media validation questionnaire sheet assesses the Project Based Learning (PjBL) process on ease of use, integration, balance, shape, color, and design.

This study employed descriptive analysis as its method of data analysis, and it did it by applying the following formula to determine the validation results' percentage value:

$$Persentase = \frac{Skor\ total}{Skor\ maksimal} \times 100\ \% \quad (1)$$

After analyzing the data, the feasibility level of the module product can be seen from the score obtained. The greater the score, the better the feasibility level. The following criteria are used as a reference in the validation of module material and media which can be seen in Table 1.

**Table 1. Module eligibility criteria**

<b>Percentage (%)</b>	<b>Feasibility Level</b>
80 % -100%	Very feasible
60 % - 80 %	Feasible
40 % - 60 %	Fairly feasible
20 % - 40 %	Less feasible
0 % - 20 %	Not feasible

(Ridwan, 2016:18)

After the product is declared feasible, it is continued by distributing perception questionnaire sheets to students to find out student perceptions of the module products that have been developed. The perception questionnaire has positive questions, and the data will be analyzed and interpreted in the criteria in Table 2.

**Table 2. Student Perception Scoring Criteria**

Percentage (%)	Perception Level
80 % -100%	Very good
60 % - 80 %	Good
40 % - 60 %	Fairly good
20 % - 40 %	Less good
0 % - 20 %	Not good

(Sumber: Riduwan, 2016)

## FINDINGS AND DISCUSSION

The final result of this research is a project-based electronics module on the Internet of Things (IoT) using ESP32 NodeMCU. This study only addresses the first three steps of the ADDIE development model of analysis, design, and development. This is due to the fact that the purpose of this study is to create a project-based electronics module on the Internet of Things (IoT) material with an ESP32 NodeMCU.

At the analysis stage, steps are taken to identify and examine the problems that occur in the field. Student needs questionnaires were distributed and interviews with students were used to gather information.. The results obtained from interviews and questionnaire sheets, students need a project-based learning module on Internet of Things (IoT) material with NodeMCU ESP32.

At the design stage, the module product design is carried out. Researchers make the content and material of the Internet of Things (IoT) module with NodeMCU ESP32, supporting images on the material, project exercises and project assignments specifically on Internet of Things (IoT) material with NodeMCU ESP32 and other relevant sources.

After that, it will continue with the development stage, namely developing the module according to the story board made. The storyboard for the developed module consists of eight main components, each with its own design and purpose.

The first part is the front cover, which features several institutional identities such as the University of Jambi (Unja) logo, the Ministry of Education and Culture logo, and the Independent Campus logo. In addition, it displays the module title, the specific material title, and the author's name. The second part is the preface section. This page begins with the heading "Foreword," followed by the content of the preface, and ends with a footer. The third part presents the table of contents. It contains the title "Table of Contents," the organized list of sections and subsections, and a footer for consistency. The fourth part describes the sub-chapter layout of the module's main content. Each section includes a title, the body of the content, and a footer. The fifth part highlights the design for the project activity section of the module. This section consists of the project activity title, detailed instructions or content for the activity, and a footer. The sixth part is the glossary section, which provides a list of key terms and their explanations. It includes the heading "Glossary," the glossary entries, and a footer. The seventh part is the bibliography. This section begins with the title "Bibliography," followed by the reference list, and concludes with a footer. Finally, the eighth part is the back cover. It features an illustration of the ESP32, the material title, and a summary of the module's content.

After developing the module in accordance with the story board, it was continued with material validation and media validation of the module. Material validation was carried out three

times with a material validation questionnaire sheet to assess the feasibility of content, presentation and language. The first material validation shows that the module product falls into the feasible category with a feasibility percentage of 64.33%. This module still needs to be made a little improvement according to the suggestions and comments given by the material validator. The following Table 3 shows the comments and suggestions of material validators.

**Table 3. Material Validator Comments and Suggestions**

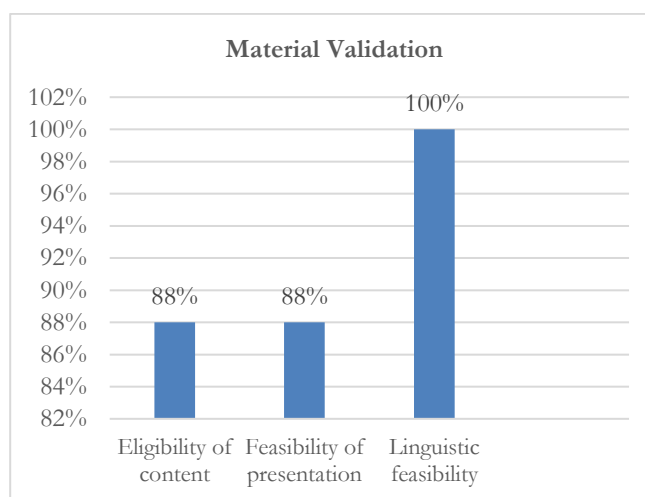
No.	Comments and Suggestions for Improvement
1.	Image reference source added
2.	The writing system is tidied up again
3.	Evaluation questions added
4.	Understand the Steps of PjBL
5.	Differentiate between Training and Project Activities

After making improvements, the module was revalidated by the material validator. The percentage of module feasibility became 78.66% with a feasible category. The material validation results can be seen in Table 4.

**Table 4. Material validation results**

Aspect	Percentage(%)		
	First Validation	Second Validation	Third Validation
Content Suitability	65%	80%	88%
Presentation	68%	76%	88%
Language	60%	80%	100%
Average	64,33%	78,66%	<b>92%</b>
Category	<b>Layak</b>	<b>Feasible</b>	<b>Very Feasible</b>

To clarify the results of the validation of the project-based learning module material on the Internet of Things (IoT) material with NodeMCU ESP32 can be seen in Figure 1.



**Picture 2. Percentage of Material Validation**

Furthermore, media validation is carried out using a validation questionnaire sheet sourced from Arsyad A, (2011) to assess simplicity, integration, balance, shape, color and design of PjBL steps. Simplicity, integration, balance, shape and color are elements that must be considered in the process of making printed teaching materials as learning resources (Nasa'i & Sari, 2023). The results of media validation were carried out twice. The results of the initial media validation showed that the module product had a feasibility percentage of 84.16%, so it was included in the feasible

category. However, based on comments and recommendations from media validators, the module design still needs to be improved. The following Table 5. shows the comments and suggestions of media validators.

**Table 5. Comments and Suggestions for Improvement**

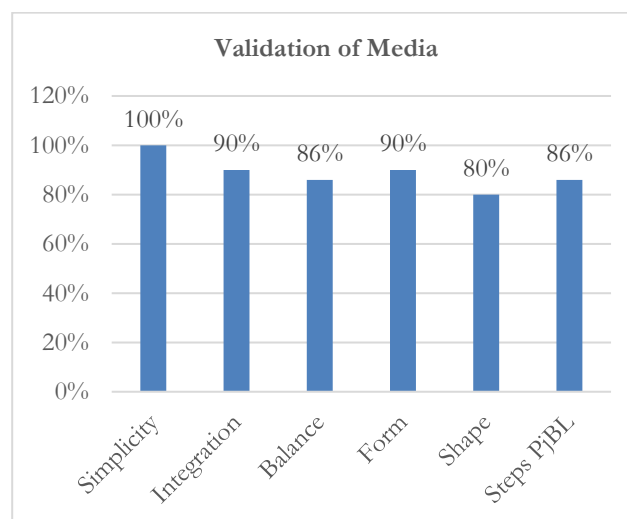
No.	Comments and Suggestions for Improvement
1.	For tools and materials, pictures should be provided and made into a table
2.	There should be a slight variation in pont size, specific titles and subtitles
3.	For work procedures, specific steps should be accompanied by pictures/illustrations
4.	There should be a variety of font colors for titles, subtitles, and other important sections

After making improvements, the module was revalidated by the media validator. The percentage of media feasibility is 90.16% with a very feasible category. The results of media validation can be seen in Table 6.

**Table 6. Media validation results**

Aspect	Percentage (%)	
	First validation	Second validation
Simplicity	100%	100%
Integrity	85%	90%
Balance	80%	86%
Shape	80%	100%
Color	80%	80 %
PjBL	80%	96 %
Rata-rata (%)	84,16%	90,16%
Criteria	Feasible	Very Feasible

To clarify the results of media validation of project-based learning on Internet of Things (IoT) material with NodeMCU ESP32 can be seen in Figure 2.



**Picture 3. Percentage of Media Validation**

As can be observed from the above diagram, the aspects that receive the highest percentages are those for simplicity (100%), integration (90%), balance (86%), shape (90%), color (80%), and PjBL Step (86%). The project-based learning module on Internet of Things (IoT) material using NodeMCU ESP32 is deemed suitable for testing after material and media validation.

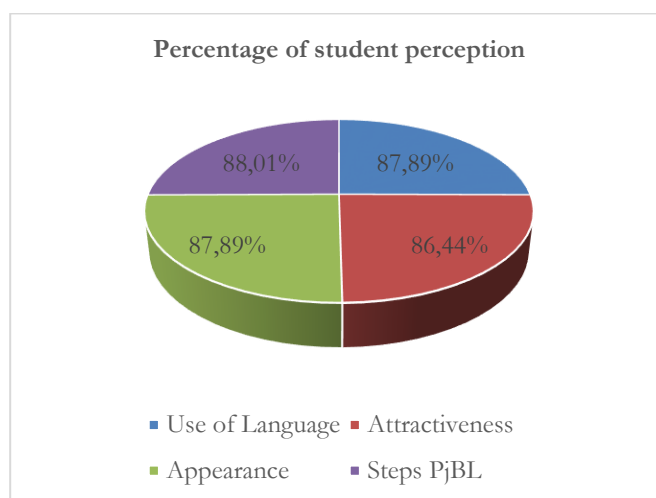
Furthermore, the module was tested on 27 physics education students who had contracted electronics courses using student perception questionnaires sourced from Lestari et al. (2013) to see student perceptions of project-based learning modules on Internet of Things (IoT) material with NodeMCU ESP32 that had been developed. The results of the student perception questionnaire on the module product can be seen in Table 7.

**Table 7. Percentage Results of Student Perception Questionnaires**

No	Assessment Item	Percentage	Category
<b>Language Usage</b>			
1.	The module uses Indonesian language that is correct, simple and communicative	92,59%	Very good
2.	The module uses sentences that are easy to read and understand	84,44%	Very good
3.	Information in the module is presented clearly	86,66%	Very good
	<b>Percentage</b>	<b>87,89%</b>	
<b>Homepage</b>			
4.	Cover display and arrangement of learning activities learning activities in the module are interesting	91,11%	Very good
5.	The module presents images, colors and fonts with an attractive appearance	89,62%	Very good
6.	The information contained in the module is explained in full	86,66%	
	<b>Percentage</b>	<b>89,13%</b>	Very good
<b>Attractiveness</b>			
7.	Modules help learners get interested in Learning	86,66%	Very good
8.	Modules can facilitate learners to learn independently	85,18%	Very good
9.	Modules help learners acquire Information	88,88%	Very good
10.	The module can provide an overview in making micro projects of analog systems and digital systems	86,66%	Very good
11.	The project in the module is interesting to do	85,92%	Very good
12.	Project exercises in the module are in accordance with the material and provide basic knowledge to students in making analog system and digital system projects.	85,92%	
13.	The video presented on the barcode is interesting and makes it easy to create project exercises.	85,92%	Very good
	<b>Percentage</b>	<b>86,44%</b>	Very good
<b>Steps PJBL (<i>Project Based Learning</i>)</b>			
14.	The procedure for presenting the problem or fundamental question in the project is appropriate and easy to understand.	89,62%	Very good
15.	The procedure for preparing a project plan is appropriate and easy to understand.	88,14%	Very good
16.	The procedure for creating a project schedule is appropriate and easy to understand.	88,14%	Very good
17.	The procedure for monitoring student project activity and progress in the module is appropriate and easy to understand.	88,14%	Very good

18.	The project evaluation procedure in the module is appropriate and easy to understand.	87,40%	Very good
19.	The reflection procedure on the learning experience in the module is appropriate and easy to understand.	86,66%	Very good
<b>Percentage</b>		<b>88,01%</b>	Very good
<b>Average Percentage of Student Perception Questionnaire</b>		<b>83,03%</b>	<b>Very good</b>

Based on Table 8, the average percentage of student perception questionnaire is 83.03% and categorized as very good. To clarify the results of the student perception questionnaire on the project-based learning module on Internet of Things (IoT) material with NodeMCU ESP32 can be seen in Figure 3.



Picture 4. Percentage of student perception questionnaire results

The diagram above illustrates that the percentage of aspects of language use (87.89%), appearance (87.89%), attractiveness (86.44%), and PjBL Steps (88.01%) are as follows. Thus, it can be said that the Internet of Things (IoT) project-based learning module with NodeMCU ESP32 is interesting to use as an alternative teaching resource when creating an Internet of Things (IoT) project with NodeMCU ESP32. This is in line with research conducted by Novianto et al., (2018) that through learning using project-based modules, students are increasingly interested in learning. Curiosity increases, honesty, learning discipline, creative ideas in learning increase and the hard work shown in the learning process also increases.

## CONCLUSION

Project-based learning modules on Internet of Things (IoT) material with NodeMCU ESP32 obtained an average feasibility of material expert validation findings of 92% with a very feasible category, according to the results of research and discussion. In addition, the results of media expert validation with an average percentage of 90.16% are classified as very practical. The results of the project-based learning module on Internet of Things (IoT) material with NodeMCU ESP32 obtained an overall score of 83.03% with a very good category based on student perception questionnaires.

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