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Development of E-Module-Based PjBL to Develop Computational Thinking Skills Integrategration with CCR Implementation in Science Education

Efrika Marsya Ulfa[1*], Sri Wahyuni[2*], Zainur Rasyid Ridlo[3]
[1,2,3] Universitas Jember, Jember, Indonesia

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ABSTRACT

Objective: *This research aims to describe the Validity, Practicality and effectiveness of E-Module.* ***Methods:*** *The research conducted using the type of development research using the ADDIE model was carried out at MTs Negeri 1 Jember.* ***Result:*** *This research develop E-Modul based PjBL. Validity obtained a percentage of 94% and belongs to the category of very valid. The practicality of obtaining a percentage of 97% is included in the excellent category. Effectiveness analysis based on the results of pretest and posttest calculations obtained an N-gain value of 0.57 which is included in the moderate category. The result of student response was 89.7% which was included in the very positive category. So, it can be concluded, the project-based E-Module based on learning business materials and simple machine is effective and can be used in science learning in junior high schools.*

INTRODUCTION

Students are required to apply science skills in everyday life so that they can solve problems and make reasoned decisions (Shin et al., 2021). According to Pisani (2018), Indonesian students still have weak science skills. Based on data from the Programme for International Student Assessment (PISA) in 2018 from 79 countries, Indonesian students are in the category of science performance ability of Indonesian students at level 71 (Andreas, 2018). The ability to solve this problem can be improved by the application of computational thinking skills. This ability can help students solve a problem (Hunsaker, 2020). The definition of Computational Thinking according to Wing is that Computational Thinking is a frame of mind to break down difficult problems into more concise and solvable (decomposition) using a set of policies to find solutions (algorithms) and using concise data (abstract) to be used on similar problems (generalizations) (Yadav et al., 2017). Computational Thinking Skill is also in line with various aspects of 21st-century competencies such as critical thinking, creativity and problem-solving (Binkley et al., 2012). Ridlo (2020) explained that Computational Thinking Skill consists of 5 indicators, namely decomposition, pattern recognition, abstraction, algorithms, and evaluation. Table 1 below shows the element of Computational Thinking Skill related to the indicators that are used in the implementation of the Project-Based learning model.

Table 1. Element, Definition, and Indicator of Computational Thinking Skill

Element	Definition	Indicator
Abstraction	The skill to decide what information about an entity/object to keep and what to ignore (Wing, 2010).	The student's skill is to identify important relevant ideas for solving the problem.
Generalization	The skill to formulate a solution in generic terms so that it can be applied to different problems (Selby, 2014)	The student's skill is trained to recognize the same or different patterns or details in problem-solving to find solutions.
Decomposition	The skill to break a complex problem into smaller parts that are easier to understand and solve (National Research Council, 2010)	The student skill of trained to break down problems into simpler things and that they are easy to solve.
Algorithms	The process to devise a step-by-step set of operations/actions of how to go about solving a problem (Selby, 2014)	The student's skill to find the right steps to solve a problem is given by creating a simple computer program.
a. Sequencing	The process to put actions in the correct sequence (Selby, 2014)	
b. Flow of control	The order in which instructions/actions are executed (Selby, 2014)	
Debugging	The skilled process to identify, remove, and fix errors (Selby, 2014)	The student's skill can find, identify and repair error syntax from computer programming.

Developing Computational Thinking Skills in science subjects can be based on the principles of 21st-century learning which emphasizes student-centred learning or Student Center Learning (Trilling, 2012). During the learning process, computational thinking skills teaching materials for students, namely E-Modules. E-Module is one of the teaching materials that can be used to support technology-based learning, and train students to learn independently, actively and also creatively whether assisted by teachers or not (Aryawan et al., 2018). Project-based learning is one of the teaching methodologies used in E-Modules. A project-based learning model that derives from the design outcomes and has a specific objective or outcome to create learning materials is referred to as project-based learning (Tiurlina, 2016). The stages of the project-based learning learning process are as follows: (1) asking questions about the phenomena around you, (2) designing the project completion stage, (3) compiling the project implementation time, (4) analyzing and gathering using math, information, or computational thinking, (5) presenting the final project results, and (6) evaluating the process and final results (Muskania & Wilujeng, 2017).

Project-Based Learning can be applied with the help of various learning media in improving students' Computational Thinking Skills is Google collaboration. The Google Collaboration platform or called Collab is a free service for learning programming that combines the features of jupyter notebooks and is hosted by google (Nelson & Hoover, 2020). Google Collaboration is a free service that can be accessed on gadgets without

installing other applications using the help of a google account to do coding python-based programming languages (Alhajir et al., 2021)

Activities on the E-Module can be carried out flexibly, and accessible anytime and anywhere. The process of implementing electronic learning can be applied using the The research of Ridlo et al (2020) that CCR has a positive impact on increasing student response in the assessment process, this is because CCR provides facilities for the online assessment process in real-time. The design of this E-Module contains practice material that can be adjusted to computational thinking skill indicators to develop students' computational thinking skills. Project Based Learning-based E-Modules are used in junior high school science subjects in the first semester to learn about simple business and machine materials learned by students in class VIII of junior high schools / MTs. Research this time has the aim of describing the Validity, Practicality and effectiveness of Project Based Learning-Based E-Modules to develop Cloud Classroom Integrated Computational Thinking Skills (CCR) in junior high school student.

RESEARCH METHOD

General Background

The research conducted is research and development research using the ADDIE model. A variable is a characteristic of research in which the data will be measured (Marpaung, 2021). This research aims to develop a product that is an E-Modul-based PjBl for developing computational Thinking Skill Middle school students in a science subject. This research has two variables which are E-Module - Based PjBL and Computational Thinking Skills.

Sample / Participants / Group

This research was conducted at MTs Negeri 1 Jember. The subjects in this study were students of class VIII A MTs Negeri 1 Jember for the academic year 2022/2023. The product is an Electronic Module (E-Modul) implementation at the class of VIII A MTs Negeri 1 Jember. The product validates by media and content experts which are one lecturer in the Science Education department Teacher and Training Education and two teachers at MTs Negeri 1 Jember.

Instrument and Procedures

The research conducted is development research using the ADDIE model which has five stages, analyze, design, develop, implement, and evaluate shown in Figure 1. Stages ADDIE model.

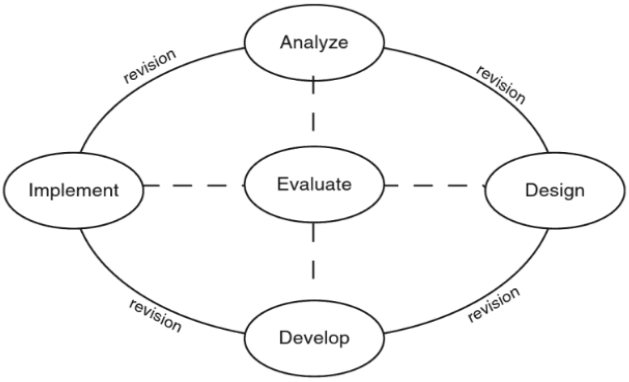

Figure 1. Stages ADDIE Model

The five steps of the ADDIE Model are analyze, design, develop, implement, and evaluate. Stages are shown by a straight line, while an optional stage is shown by a dashed line. The stages being examined initially seek to identify or study E-Modul for development. Researchers look at the curriculum utilized in MTs Negeri 1 Jember and how it is customized, as well as the learning resources and media that are used by the students in this class. The second stage, design, tries to create a final product, a teaching strategy, and an assessment question. This stage develops the third stage, which aims to produce an E-Module-based PjBL up till the researcher conducts a validity test. Implementation at VIII A represents the fourth stage at VIII A MTs Negeri 1 Jember learning. In an implementation, the researcher used a one-group pretest and posttest design to observe and measure the sample before and after the treatment of a variable. Last, Evaluate to aims evaluation for the product and improvement to the given advice from media and content expert.

Data Analysis

Data analysis techniques in the form of the validation analysis, practicality, and efficiency. The validity of this study was assessed by three validators, namely, three experts selected, this assessment includes content and material aspects, presentation aspects, and language aspects. Calculating the average value of the validator using the following formula (Nesri & Kristanto, 2020)

$$V = \frac{T_{sv}}{T_{sm}} \; x \; 100\%$$

Information:

V : Percentage of validation

T_{sv} : Score result validation

T_{sm}: Score maximum

This practicality test analysis can be measured through observation of the results of learning implementation. The test results of the implementation of this learning can be calculated through the following formula (Sudjana, 2005):

$$P = \frac{f}{N} \, x \, 100 \, \%$$

Information :

P = Percentage learning outcomes

f = Score result

N = Score maximum

This efficacy analysis is based on student feedback following participation in learning utilizing a Project Based Learning-based E-Module and the results of the Computational Thinking ability exam. The N-gain Test was used to conduct an effectiveness analysis based on the outcomes of the students' Computational Thinking Skill test, specifically as follows (Hake, 2002):

$$N - Gain = \frac{x_{post} - x_{pre}}{x_{max} - x_{pre}}$$

Information :

N-Gain : Average score gain

x_{post} : Average score *posttest*

x_{pre} : Average score *pretest*

x_{max} : Score maximum

Analysis of Student Response Data using a questionnaire of student responses to the use of Project Based Learning E-Modules. Based on the responses that have been filled in by students, it can be entered into the following formula (Rasyid et al, 2016):

$$RS = \frac{A}{B} \, x \, 100 \, \%$$

Information:

RS = percentage student response

A = Voted from student

B = Total amount

The Material (Work And Simple Machine)

A force used to move an object is called work. the more work was put in. Therefore, an object had to make more effort to move farther. We can infer from the theory that the amount of work (W) is governed by the amount of force and displacement (F and s) applied to the item. The following formula illustrates the calculation process:

$$W = F \, x \, \Delta s$$

Information:

W = Work (Joule)

F = Force (Newton)

Δs = Distance (Meters)

Percentage of work greatly influenced by the distance of force. Work directly propotional with force and distance. The relation between work (W) and Force (F) and distance (Δs) can identify in figure 2 below

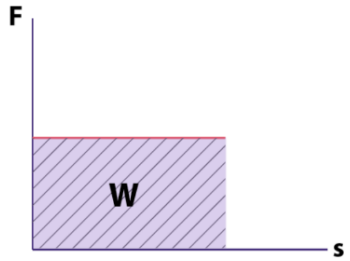

Figure 2. Relation between Work, Force and Distance

Energy is the ability to make an work. The amount of effort on a moving body is equal to the change in kinetic energy (E_p) and the amount of effort that falls vertically as a change in potential energy (E_k). The rate of energy or power is the amount of energy used in every second.

$$P = \frac{W}{t} = \frac{\Delta E_k}{t} = \frac{\Delta E_p}{t}$$

Information :

P = Power (watt)

W = Work (joule)

t = *Time* (second)

ΔE_k = Kinetic Energy (Joule)

ΔE_p = Potential Energy (Joule)

A simple machine is a tool for making labor and business easier. There are four types of simple machine namely: pulleys, shafted wheels, inclined planes and levers. A pulley is a straightforward machine consisting of grooved wheels attached to a rope that is used to facilitate work since they can change the direction of force when dragging or lifting something. A wheel that may revolve together is referred to as a shafted wheel. An inclined plane is a flat surface that has been positioned at an angle to lessen the effect of gravity and make object movement easier. By doubling the power force and shifting the force's axis, leverage can help business.

RESULTS AND DISCUSSION

Analyze which at this stage aims to analyze or initial identification needed in the development of E-Modules. This development began with observation activities by researchers to collect information from the intended school. In MTs Negeri 1 Jember, there is still a little learning process using E-Modules. Computational Thinking Skills of students at MTs Negeri 1 Jember in the science learning curriculum of MTs Negeri 1 Jember have taught little computational thinking skills, but there is still a need for

interesting teaching materials to develop computational thinking skills or computational thinking skills of students. From the results of the interview with the Science Teacher, it is marked that the process of solving Computational Thinking problems is still low either with the help of a computer or not. The results of the analysis and interviews were used as the basis for developing E-Modules on Business and Simple Machine materials. This E- Module is prepared by the Computational Thinking Skill indicators so that it can develop Computational Thinking Skills in junior high school students.

Design stage, it resulted in an E-Module and lesson plan design created through Microsoft Word 2013. The lesson plan or Learning Process Plan designed here refers to project-based learning syntax or Project Based Learning. The lesson plan that will be made includes core competencies, basic competencies, learning objectives, learning steps and assessments. The product results that have been designed in Microsoft Word 2013 are then uploaded in PDF form and shared by barcode and URL link to students. The initial basic introduction of Computational Thinking to the students was named Computational Thinking Corner showed in Figure 3. In this Computational Thinking Corner section, students are invited to understand the basics of simple programming to be applied in assigned projects. In product development, researchers also use the help of Google Collaboratory shown in Figure 4 as a learning medium to support the development of students' Computational Thinking Skills. Google Collaboratory learning media is used for students to make problem assessments from existing projects in the developed E-Module. Furthermore, students can click https://unej.id/emodulusahadanpesawatsederhana to access E-Modul. the E-Module created will be integrated by CCR or Cloud Classroom shown in Figure 5 which is used as a place for students to collect answers from existing project work.

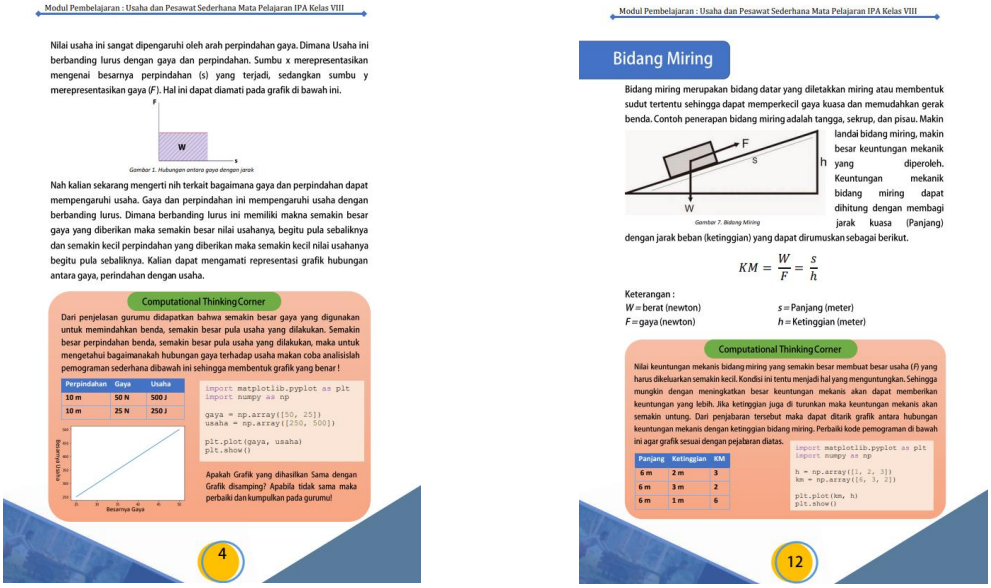

Figure 3. Computational Thinking Corner in E-Module

Figure 4. Google Collaboratory View

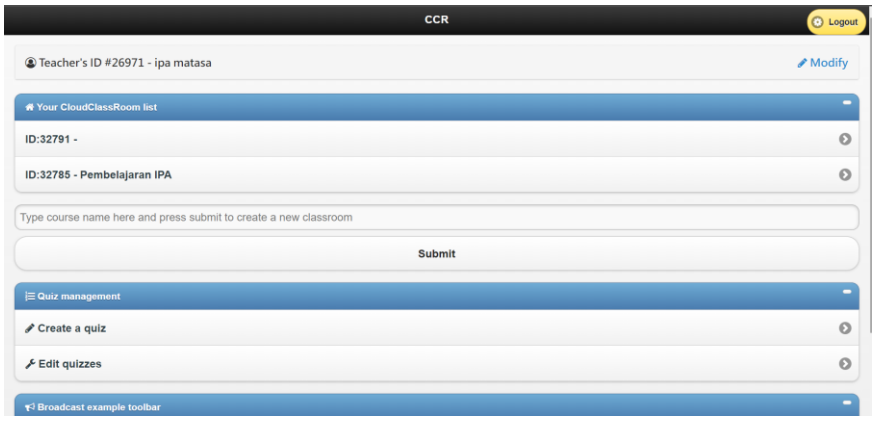

Figure 5. Cloud ClassRoom (CCR) View

Develop stage in the form of E-Modules that have been compiled, validation is then carried out by validators. The acquisition of this validation number is then processed and analyzed through the calculation of the average total percentage value of each aspect that is grouped and then analyzed according to the validity category for the results you can observe in Table 2.

Table 2. Analysis E-Module Validity

No.	Aspect of Interval	Score Assessment (%)			Percentage (%)	Criteria
		Validator 1	Validator 2	Validator 3		
1.	Substance	75	100	100	92	Very Valid
2.	Material	88	92	92	90	Very Valid
3.	Presentation	95	95	95	95	Very Valid
4.	Language	95	100	90	95	Very Valid
5.	Graphics	88	100	100	96	Very Valid
	Average Value Percentage	89	97	95	94	Very Valid

Based on the data from the validation results of the three validators, an average percentage value of 94% was obtained and was included in the category of very valid validity. In addition, researchers also evaluate the content and design aspects of the product to improve the quality of the E-Module that has been produced. This evaluation is derived from suggestions and comments by validators. This is used as a basis for making improvements so that when the E-Module is used, it can become a better product. Project-based learning-based E-Modules received an average score of 88.61% in research by Nisrina et al. (2021), signifying excellent in all respects. If the average calculation result is more than 85%, it is considered to be extremely useable and excellent in every way. This is also corroborated by research by Irman & Waskito (2020), which found that the E-Module contains a validation value of 88% and is legitimate and appropriate for usage in the learning process. The validity analysis's findings fit into a category that is very practical, demonstrating that project-based learning-based E-Modules can be used for learning. On the other hand, project-based learning-based E-Modules require modification based on ideas and remarks from validators, such as cover and formula writing. Implement stage, a trial of the E-Module product was carried out which had been declared valid in learning activities at MTs Negeri 1 Jember. The subjects of the development trial were 30 students of class VIII A MTs Negeri 1 Jember. The results of this development test were obtained from data on the implementation of learning using E-Modules on business materials and simple machine obtained based on observations from three observers during the learning activity the results can observe in Table 3.

Table 3. Analysis of learning outcomes

Learning Activities	Learning Activities -						Percentage (%)	Criteria
	1	2	3	4	5	6		
Introduction	96	98	95	98	97	98	97	Excellent
Discussion	95	94	98	97	98	99	97	Excellent
Concluding	98	98	96	100	96	100	98	Excellent
Average	97	97	96	99	97	99	97	Excellent

The following is a picture explaining the implementation of learning adjusted from the results in Table 3 and Figure 6.

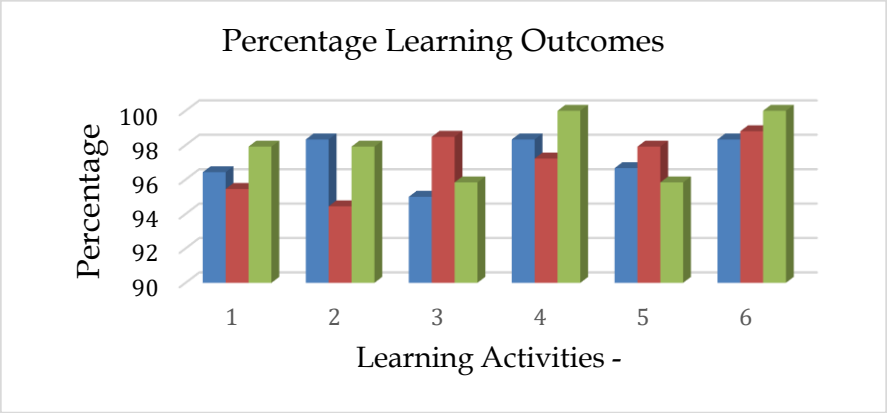

Figure 6. Percentage Learning Outcomes

This practicality assessment was completed by an observation implementation sheet conducted by three observers consisting of one science teacher of MTs Negeri 1 Jember and two student friends to make observations while learning activities were taking place. The observed activities start from the introduction, core, and closing activities. This activity was carried out in as many as six offline meetings for class VIII A MTs Negeri 1 Jember students. Based on the results of the analysis of learning implementation data in preliminary activities, a percentage of 97% was obtained which was included in the excellent criteria, core activities received a percentage of 97% which was included in the excellent criteria and closing activities received a percentage of 98% which was included in the excellent criteria. So the total number of learning activities got a score of 97% with an excellent category.

The practicality value analysis's findings are based on the degree to which learning activities follow the applicable curriculum, how effectively they are implemented using E-Modules, how actively they are used in instruction, how to engage students, and how they are interacted with (Marhaman et al., 2022). The teaching materials are thought to be useful, namely those that help boost students' motivation for learning and facilitate the learning process for teachers (Jayanti, 2017). Mahyuni et al. (2017) assert that because a product can support the learning process utilizing project-based learning-based E-Modules, teaching materials with a high percentage of practicality value can be used in the learning process.

In the implementation of learning activities using project-based learning-based E-Modules, there are several obstacles. These obstacles are (1) The time for implementing learning using E-Modules is limited; (2) Some students still have difficulty operating Cloud Classroom (CCR); (3) Students do not understand the operation of Google Collaboratory. However, some of the existing obstacles can be overcome by solutions, namely (1) Giving instructions to students to learn E-Modules before learning; (2) Describing how Cloud Classroom (CCR) operates; (3) Describing the operation of Google

Collaboratory and displays screenshots of the stages of operation. The following the result of student calculation in manual and google collaboratory shown in Figure 7.

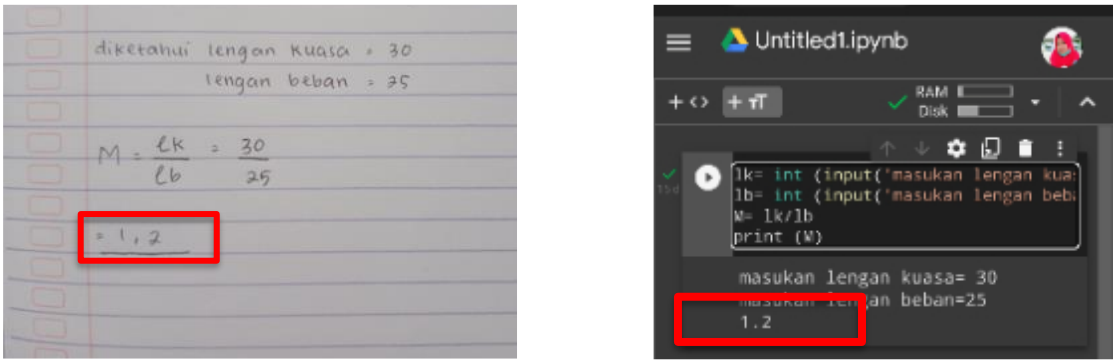

Figure 7. Result of student calculation in manual and google collaboratory

Evaluate stage, it is carried out to develop students' Computational Thinking Skills after learning using E-Modules so that the effectiveness of E-Modules can be known on business materials and simple machine. The effectiveness of the E-Module developed can be seen from the results of the pretest analysis and posttest Computational Thinking Skill. Tests are given to develop students' Computational Thinking Skills before and after learning using project-based learning-based E-Modules. The following is the average of students' pretest scores and post-test scores shown in Figure 8.

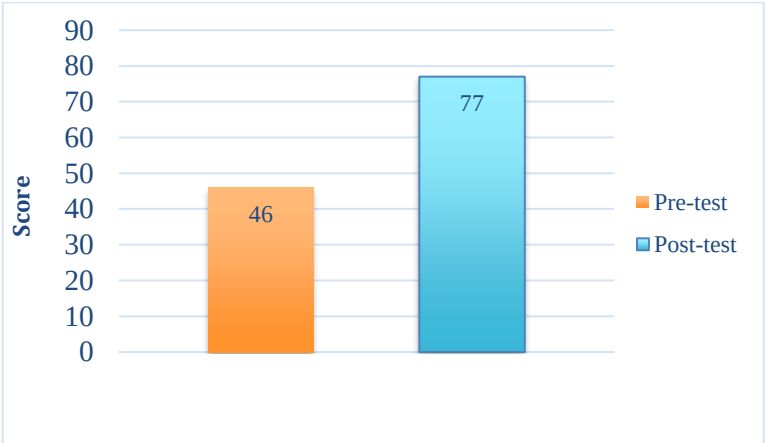

Figure 8. Result from Pretest and Posttest

Based on Figure 8. it shows that before being treated, namely the implementation of learning using project-based learning-based E-Modules, the average student score was 46. Meanwhile, after being given treatment, namely the implementation of learning using project-based learning-based E-Modules, the average student score was 77. The effectiveness of the E-Module of magnitude value is measured using the N-gain formula. The results of the N-Gain calculation can be seen in Table 4.

Table 4. Analysis of learning outcomes

Component	VIII A Class		*N-Gain*	Criteria
	Pretest	Postest		
Number of Students	30	30	0,57	Moderate
Lowest	18	66		
Highest	65	92		
Average	46	77		

Table 3 shows the N-Gain value of 0.57 is included in the moderate category it can show an increase in Computational Thinking Skills in class VIII A MTs Negeri 1 Jember students after participating in learning. The test was given to see the extent to which project-based learning-based E-Modules can develop students' Computational Thinking Skills in the form of pretests and posttests carried out by students using the help of a learning management system, namely CloudClassRoom (CCR). In addition, student response questionnaires are also carried out using CloudClassRoom (CCR) so that archives of student response scores can be stored online on CloudClassRoom (CCR). The use of CloudClassRoom (CCR) requires a google account to be able to enter the platform and requires a CloudClassRoom ID shared by researchers during learning. The effectiveness of project-based learning-based E-Modules is also seen in the students' responses to the E-Module. The calculation of the effectiveness of project-based learning-based E-Modules is also reviewed based on the results of student response questionnaires. This response questionnaire is given after the learning process using a project-based learning-based E-Module which consists of three aspects, namely design, presentation and use are described through 8 questions. The score interval that students can fill in is 1-4 with 1 indicating a statement of disapproval, 2 indicating a statement of disapproval, 3 indicating a statement of the sufficient agreement and 4 indicating a statement of agreement. The following are the results of the analysis of student responses shown in Table 5.

Table 5. Analysis of student response questionnaire

	Aspect	Percentage (%)	Category
1.	Design	94,4	Very Positive
2.	Presentation	86,6	Very Positive
3.	Utilization	86,2	Very Positive
Average student response		89,7	Very Positive

Table 5 shows 89.7% of the student replies after using project-based learning-based E-Modules, according to the analysis, fell into the category of favorable responses. On the basis of the findings of the calculation analysis, it can be concluded that project-based learning-based E-Modules for the development of computational thinking skills on business materials and basic airplanes are useful for use in the educational process. According to research by Cahyani et al. (2020) the results of the student response questionnaire showed a percentage of 80.15%, which is in the very good category, after

learning utilizing project-based learning-based E-Modules. Students can participate more actively in the teaching and learning process by working on projects with the help of this useful project-based learning-based e-module (Laili et al., 2019).

CONCLUSION

Fundamental finding: The results of the analysis of the assessment of project-based learning-based E-Module development products to develop Computational Thinking Skills for junior high school students were obtained, namely the validity of the E-Module was included in the very valid category. So the project-based E-Module learning business materials and simple planes are valid and can be used in science learning in junior high schools. The practicality of the E-Module obtained a percentage of the implementation of all meetings excellent category. Thus, the E-Module is project-based learning business materials and simple machine practical and can be used in science learning in junior high schools. Effectiveness analysis based on the results of pretest and posttest calculations obtained an N-gain value in the moderate category so that it can show an increase in Computational Thinking Skill ability after use, E-Module based on project-based learning business materials and simple machine. **Implication:** Based on the results of the student response questionnaire analysis, shows that the average student response result in the very positive category. So, it can be concluded, the project-based E-Module based on learning business materials and simple machine is effective and can be used in science learning in junior high schools. **Limited:** Based on the research that has been done, students' N-gain scores are in the moderate category. **Future research:** Research is needed on better modules so that students' N-gain is in the high category.

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***Efrika Marsya Ulfa (Corresponding Author)**
Science Education, Department of Teacher and Training Education
Universitas Jember, Jember
Jl. Kalimantan Tegalboto No.37, Kabupaten Jember, Jawa Timur, 68121, Indonesia
Email: 190210104087@mail.unej.ac.id

Dr. Sri Wahyuni, M.Pd.
Science Education, Department of Teacher and Training Education
Universitas Jember, Jember
Jl. Kalimantan Tegalboto No.37, Kabupaten Jember, Jawa Timur, 68121, Indonesia
Email: sriwahyuni.fkip@unej.ac.id

Zainur Rasyid Ridlo, M.Pd.
Science Education, Department of Teacher and Training Education
Universitas Jember, Jember
Jl. Kalimantan Tegalboto No.37, Kabupaten Jember, Jawa Timur, 68121, Indonesia
Email: zainur.fkip@unej.ac.id