

DEVELOPMENT OF SCIENCE E-MODULES THROUGH HOTS-ORIENTED PjBL APPROACH TO IMPROVE STUDENT LEARNING OUTCOMES ON HUMAN RESPIRATORY SYSTEM MATERIAL

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Abstract: This study aims to develop a Science e-module through a PjBL approach oriented to HOTS to improve the learning outcomes of grade VIII students on the respiratory system material. The research method used is Research and Development (R&D) with the ADDIE model, which consists of Analyze, Design, Development, Implementation, and Evaluation. This research was conducted in grade VIII at SMP Negeri 1 Mimika Timur with a sample of 32 students. The data instruments used in this research were feasibility sheets for validators, science teacher response questionnaires, student response questionnaires, as well as pretest and posttest questions. The results of the study show that: (1) The feasibility of the developed Science e-module obtained a percentage of 95%, teacher response 99%, student response 89%, and the overall average feasibility of the e-module based on validator assessment was 95% with the category "feasible to be used as teaching material". (2) The Science e-module is effective in improving students' learning outcomes with an average n-Gain test score of 0.71 in the high category. The conclusion is that the Science e-module with a PjBL approach oriented to HOTS is feasible and effective in improving students' learning outcomes on the human respiratory system material.

Keywords: Science E-Module; Project Based Learning; Higher Order Thinking Skills; Human Respiratory System.

1. INTRODUCTION

The National Education System Article 1 paragraph (1) states that education is a planned and conscious effort to create a learning environment and learning process to achieve learning goals. The current curriculum development requires teachers to use creativity in learning concepts in the classroom which are expected to build an authentic learning experience, so that students are trained in solving daily problems (Ministry of Education and Culture, 2022).

National Education functions to improve skills and form a respectable character and culture of the nation to educate people's lives. The education system is closely related to the learning process. National education is in line with the demands of 21st century skills, where all humans are required to master forms of skills, including critical thinking skills and problem-solving from various problems that are increasing (R&D of the Ministry of Education and Culture, 2013).

Education is an important foundation for the development of quality individuals, especially in the era of technological advancement in the 21st century which increasingly demands the readiness of future generations as agents of change. So that in learning, students are required to have 4C skills, namely: Critical thinking and Problem Solving, Communication, Collaboration, and Creativity and Innovation.

According to Tiurlina Siregar (2021), the 21st century is a time when there are major changes in all aspects of life, habits and new ways. The rapid development of technology is proof of progress in the world of education that is able to change the order and habits in various fields. The learning process is supported by learning media that is in accordance with the development of the industrial revolution 4.0.

The development of e-modules can encourage the achievement of learning outcomes (CP) in the independent curriculum, considering that one of the benefits of e-modules is that students can learn independently. This is in accordance with the independent curriculum where the preparation of CP in the independent curriculum provides opportunities for students to learn according to their level of achievement, speed and learning style of students (Ministry of Education and Culture, 2022).

With the use of e-modules, students can measure the level of mastery of the material discussed in each unit of module explained by the teacher. The development of teaching materials packaged in the form of digital or electronic modules (e-modules) can be a solution to the problems experienced by students of SMP Negeri 1 Mimika Timur grade VIII. E-modules are independent learning materials that are systematically compiled to achieve learning goals in an electronic format so as to make users more interactive.

The development of e-modules with a HOTS-oriented PjBL approach with CP's focus on the ability to analyze the relationship between organ structures in organ systems and their functions as well as abnormalities or disorders in the organ system, expects students to be able to manage various information that provides benefits about organ systems and organ health. One of the learning approaches that focuses on skill development is PjBL and is expected to improve learning outcomes for students. Thus, in an effort to overcome educational challenges in the era of technological advancement in the 21st century that requires skills in daily life, this study aims to apply the Project Based Learning (PjBL) approach in schools.

PjBL is a technique that provides innovation, the role of the teacher in this method

is as a facilitator who provides facilities to students when asking questions about theory and motivates students to be active in teaching. Learning is carried out by assigning projects that must be completed by students so as to produce products resulting from learning activities. PjBL is a learning model that makes students as subjects or learning centers, emphasizing the learning process that has a final result in the form of a product. This means that students are given the freedom to determine their own learning activities, work on learning projects collaboratively until results in the form of a product are obtained (Damayanti L., et al., 2023).

The steps of PjBL learning are by determining the project, in this case determining the theme/topic of the project, stringing the steps of activities in completing the project from beginning to end, compiling a project implementation schedule with teacher assistance, completing the project with teacher monitoring, preparing reports/presentations or publication of project results (product forms), and evaluating the process and project results. In terms of the implementation of HOTS-oriented PjBL learning, students have high-level thinking skills by having levels of C4 to C6, namely in the form of analysis, evaluation and creation skills (Ariyana., et al., 2018)

Learning outcomes can be measured by the average test results given. The learning outcomes of grade VIII students of SMP Negeri 1 East Mimika for the 2024/2025 school year in the respiratory system material are quite low where the results of the formative scores of students have not met the KKTP, which is around 55%, this is due to the lack of student learning support facilities at school and the use of learning approaches that are still conventional so that they can have a big impact on student learning outcomes.

This research is important to answer challenges in the world of education, especially in improving the quality of science learning at the junior high school level that through the development of innovative, effective, efficient and technology-based learning media and with the right learning approach can improve student learning outcomes.

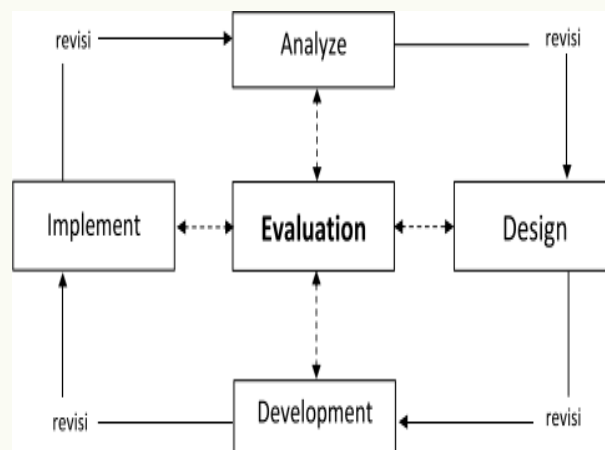
A number of researchers have previously been carried out to find solutions for learning activities and appropriate learning resources to support students in improving learning outcomes. Weni Desmaliza ., et al., 2025" Development of PjBL Learning E-modules on plant and photosynthetic materials for Grade IV Elementary School " The results of the study show that e-modules with the Project Based Learning (PjBL) approach can improve student learning outcomes and understanding as well as encourage critical, collaborative and creative thinking skills through project-based learning.

Based on this background, this study aims to: (1) develop a science e-module through a HOTS-oriented PjBL approach on decent respiratory system material, and (2) analyze the effectiveness of e-modules on improving the learning outcomes of grade VIII students of SMP Negeri 1 Mimika Timur.

2. RESEARCH METHODS

This research uses Research and Development (R&D) with the ADDIE model: Analysis, Design, Development, Implement, Evaluation. Research and Development is a research method used to produce new product designs, test the feasibility of existing products, and develop and create new products (Sugiono, 2019). This is in line with the opinion (Tegeh, 2014) that the R&D research and development method is a series of processes or the development model chosen in this study is the ADDIE development model. This model is structured programmatically with systematic sequences of activities in an effort to solve learning problems related to learning resources that are in accordance with learning characteristics. The steps of the ADDIE development model can be seen in Figure 1.

Figure 1. Step-by-step chart of ADDIE development model (Tegeh, 2014)



Based on Figure 1, it can be seen the steps to implement development using the ADDIE model. This development model begins with the analyze stage. At this stage, the researcher conducts a process of curriculum review, student evaluation, concept assessment, determination of learning objectives, and student needs. Curriculum review means analyzing the curriculum applied at SMP Negeri 1 Mimika Timur by paying attention to the CP and ATP used by science subjects for grade VIII in odd semesters. After understanding the curriculum that is applied, the potential that will be achieved in the learning process is

then identified. Student analysis is carried out to examine the characteristics of students at SMP Negeri 1 Mimika Timur which includes the background of students' abilities and level of understanding.

At the design stage, the researcher begins to compile an e-module that is developed based on the results of the analysis that has been carried out previously. The researcher designs the instruments that will be used from the e-module, validation questionnaires, teacher responses, and student responses. Furthermore, the instruments that have been prepared will be validated to obtain a valid assessment instrument, which will be validated by material experts to design learning modules, in this case quality e-module results.

The next stage of development is product realization, where the e-module to be developed follows a predetermined design where the researcher develops an e-module with the PjBL approach on respiratory system materials in humans and continues the implementation stage, where the researcher conducts product trials.

Structural analysis of design, development, implementation and evaluation (Tegeh, 2014). The product produced from research and development is in the form of a teaching material module book/e-module. In this study, respiratory system materials are selected with a development approach using small-scale and large-scale trial classes. Experimental design is used in field tests and one-on-one trials, small group trials and experimental class trials using limited classes.

The subjects in this study involved three lecturers from FKIP Cenderawasih University as validators and three science teachers from SMP Negeri Timika and grade VIII students of SMP Negeri 1 Mimika Timur. The research time was carried out during January-February 2026 in 3 meetings. The research sample is part of the number and characteristics possessed by the population, namely class VIIIA with a total of 32 people and other class VIII as a limited/comparative class. This study uses purposive sampling. The research instruments used are the e-module feasibility validation instrument sheet by the validator, in this case supervisors and examiner lecturers, teacher response sheets (peer teachers of science subjects), student responses (carried out by 9 students in class VIIID) and evaluation instruments/questions. The results of the e-module validation will be tested on a small scale and on a large scale. Small scale is carried out in classes where the number of students is smaller than in large scale. Small scale trials in class VIIIB which are smaller in number compared to research classes are in class VIIIA of SMP Negeri 1 Mimika Timur with a larger number of students. Large-scale class trials are tested with one group pre-test and

post-test involving all students.

O1 x O2

Description:

O1 = Classes before participating in learning with e-modules (pre-test)

X = Provision of science e-modules with a HOTS-oriented PjBL approach

O2 = Classes after participating in learning with e-modules (post-test)

The research variables in this study are the independent variable (X), namely learning science of respiratory system materials with a HOTS-oriented PjBL approach, and the bound variable, namely learning outcomes with science e-modules.

The data collection techniques in the research are e-module feasibility assessments, the results of student learning outcome assessments. Aspects and instruments can be seen Table 1.

Table 1. Aspects of observation and data collection instruments

Yes	Observation Aspect	Data Collection Instruments
1	E-module eligibility	Validation questionnaire sheet
2	Learning Outcomes	Final test questions in the cognitive realm

Source: Arikunto Suharsimi, 2013

The technique of analyzing e-module feasibility data was developed by the researcher using percentage descriptive analysis. The overall value of the e-module is calculated by the formula:

$$P = \frac{\eta}{N} \times 100\%$$

Description:

P = Percentage of score obtained

η = Total average score of the assessment aspect

N = The maximum number of scores of the assessment aspect

Assessment criteria for average scores and percentages. The eligibility categories can be seen in Table 2.

Table 2. Eligibility criteria for e-modules

Eligibility Percentage	Categories	Remarks
81 % - 100 %	Highly feasible	Okay, no revision needed
61 % - 80 %	Worthy	Good needs revision
41 % - 60 %	Quite feasible	Pretty good, revision and review of the content of the material
0 % - 40 %	Not eligible	Not good, total revision and reassessment of the content of the material

Source: Arikunto, 2013

The percentage of the results of the response of teachers and students to the e-module, calculated using the following formula and the questionnaire result criteria can be seen in Table 3:

$$P = \frac{f}{N} \times 100\%$$

Description:

P = Percentage of the vote

f = Total selected score

N = Maximum number of scores

Table 3. Criteria for the results of the questionnaire of teacher and student responses to the E-module

Percentage	Criteria
81 % - 100 %	Excellent
61 % - 80 %	Good
41 % - 60 %	Enough
21 % - 40 %	Not Good
0 % - 20 %	Not Good

Source: Ridwan, 2013

Analysis of test instruments with validity and realism tests. Measure the validity of questions using the Pearson Product Moment formula:

$$r_{xy} = \frac{n \sum XY - \sum X \sum Y}{\sqrt{[n \sum X^2 - (\sum X)^2][n \sum Y^2 - (\sum Y)^2]}}$$

Description:

rx_y/count = Correlation coefficient of the score of the question item with the total score

X = Total score of item/item

Y = Total score

n = Number of respondents

The validity of the calculation was obtained in consultation with the r of the Product Moment table. The question is said to be valid if the r calculation of the table has a significant level of 5% (0.05). To test the validity and reliability of the mastery of the concept, the researcher used SPSS (Static Product and Service Solutions) software 22.

The assessment of student learning outcomes is the data of pre-test and post-test results from the experimental class and the control class, then the normalized n-Gain value (n-Gain) is calculated. The learning outcome is calculated as normalized n-Gain by Hake with the formula:

$$n\text{-Gain} = \frac{\text{Posttest Score} - \text{Pretest Score}}{\text{Maximum Score} - \text{Pretest}}$$

The interpretation of n-Gain according to Hake can be seen in the following Table 4:

Table 4. Categories of N-Gain score acquisition

G Value	Category n-Gain
$g > 0.7$	Height
$0.3 \leq g \leq 0.7$	Medium
$g < 0.3$	Low

Source: Hake, 1999

3. RESULTS AND DISCUSSION

This research produced a product in the form of a science E-module with a HOTS-oriented PjBL approach for respiratory system material in human grade VIII junior high school.

Stages of Analysis

Curriculum analysis, student analysis, concepts, tasks and objectives of learning to be achieved. Curriculum analysis is carried out so that researchers can identify problems faced by educators in the teaching and learning process. This stage is discussed with fellow science teachers regarding the acquisition of student formative score results. Student analysis is carried out to find out the characteristics of students at SMP Negeri 1 Mimika Timur and will be used as the basis for compiling e-modules.

Design Stage

This stage is to design product adjustments with the HOTS-oriented PjBL learning model which is integrated into the development of e-modules. In this stage, the researcher analyzes TP, topics and formulates IKTP, determines the learning models and methods to be used and prepares the overall e-module framework in the preparation and design of the e-module.

Depeloment Stage (Development)

In this stage, a respiratory system material e-module will be developed with a PjBL approach for grade VIII at SMP Negeri 1 Mimika Timur which is based on the results of expert validation and product revision. This e-module is designed interactively using the Heyzine Flipbooks application to improve mastery of concepts and collaboration skills. This e-module is comprehensively arranged consisting of several main parts:

- a. Introduction: Cover, foreword, table of contents, list of images/tables/links, concept map, and instructions for use.
- b. Core Section: Introduction, Learning Objectives, Learning Objectives Achievement Indicators (IKTP), content of materials, learning videos, and Student Worksheets (MFIs).
- c. Evaluation & Closing Section: Pre-test and post-test questions, answer keys, glossary, bibliography, and author biodata.

Implementation Stage

This stage is carried out when the e-module is declared suitable for use judging from the results of the validator assessment, teacher response and student response and has passed the product revision stage. The implementation stage aims to determine the level of validity/feasibility of the e-module that has been developed. The following is a recapitulation of the assessment of student responses after the application of the e-module with the PjBL approach of respiratory system materials in humans which can be seen in

Table 5.

Table 5. Student response results

Yes	Description	Remarks
1	Number of pupils	32 people
2	Average student response results	89%
3	Criteria	Highly feasible

Based on Table 5, it is known that the level of student response to the e-module is known and it is concluded that the e-module developed has a good level of practicality/feasibility. This result is in line with research conducted by Tiurlina Siregar (2026) that using the e-module of the IPAS Project in learning significantly through PjBL is effective and can improve student learning outcomes.

E-Module Eligibility

The results of the e-module feasibility analysis that have been validated by material experts, media experts as well as the responses of teachers and students are presented in Figure 4.

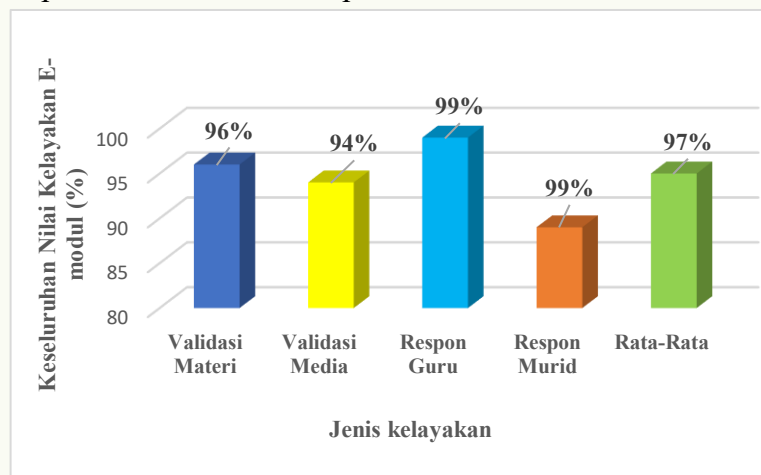


Figure 4. Bar chart of the n-Gain average of learning outcomes.

Based on Figure 4, it is known that the results of material validation are 96% (very feasible), media validation is 94%, teacher response is 99% (very good) and student response to the e-module developed is 99% (very good), so that overall the percentage of e-module feasibility value obtained is obtained at 97% which is in the category of very feasible to be used as teaching material in science learning on human respiratory system materials to improve student learning outcomes.

Improved Learning Outcomes

Student learning outcomes were obtained by analyzing pre-test and post-test scores. The results of student learning outcomes research were obtained by analyzing using n-Gain in the form of pre-test and post-test scores. Learning outcomes on human respiratory system material as evidenced by the results of the n-Gain test can be seen in Table 6 below:

Table 6. Results of the n-Gain test of average learning outcomes

Meetings	Average Score		n-Gain	Categories
	Pre-test	Post-test		
Meeting Module 1	43,44	81,58	0,68	Medium
Meeting Module 2	35,94	79,38	0,69	Medium
Meeting Module 3	40,06	84,88	0,76	Height
Average	39,81	81,94	0,71	Height

The results of the n-Gain test are the average learning outcomes of students in the diagram shown in Figure 5 below:

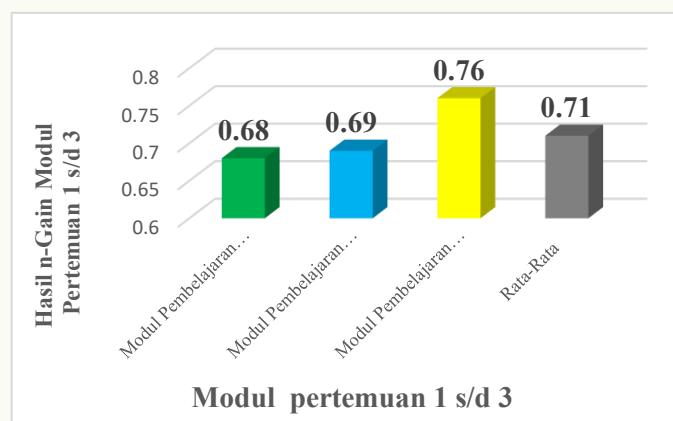


Figure 5. Bar chart of n-Gain average learning outcomes.

Based on Table 6, the n-Gain result of meeting module 1 was 0.68 with the medium category, and meeting 2 with an average value of 0.69 with the medium category, and meeting module 3 resulted in n-Gain 0.76 with the high category. The results showed that each meeting increased This proves that the use of science e-modules of respiratory system material in humans can improve student learning outcomes by seeing the tendency to increase n-Gain. This improvement shows that in the learning process students using e-modules can be said to be very effective in achieving learning goals. This is supported by previous research conducted by Putu L, Wayan & Citra (2023) which stated that Project-Based Learning E-Modules for Social Science Learning to Improve Student Learning

Outcomes.

4. CONCLUSIONS AND SUGGESTIONS

CONCLUSION

The E-Module of Science Human Respiratory System Material through the HOTS-oriented PjBL approach developed through the ADDIE model with a high category and the validation of the feasibility of the e-module of 97% was stated to be very feasible for use in learning at SMP Negeri 1 Mimika Timur, and was effective in improving student learning outcomes with an average n-Gain test of 0.71 in the high category.

ADVICE

The Human Respiratory System Materials Science e-module with a HOTS-oriented PjBL approach that is relevant to daily life can be developed as one of the learning resources that are tailored to the needs of students.

5. THANKS

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