Randwick International of Education and Linguistics Science (RIELS) Journal
Vol. 5, No. 4, December 2024 | Page 1284-1301 |
https://www.randwickresearch.com/index.php/rielsj

Differentiated E-Module Based on Problem-Based Learning: Natural Science Subject

DOI: *https://doi.org/10.47175/rielsj.v5i4.1090*

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ABSTRACT

Finding out whether PBL-based differentiated e-modules are feasible, practical, and effective are the three main objectives of this project. This study uses the ADDIE paradigm (Analysis, Design, Develop, Implement, and Evaluate) in conjunction with the Research and Development (R&D) technique. Thirty seventh-grade earth and solar system students served as the study's subjects. In addition to phases of individual trials, small group trials, and field trials, this study included validation tests conducted by professionals in media, instructional design, and materials. The study's findings revealed: In the Very Feasible category, Material Experts scored 85.09, while Learning Design Experts scored 92.87. Extremely feasible Experts in Media Design scored 89.44 in the category of Very Feasible. Field trials scored 87.29 in the Very Feasible category, small group trials scored 87.30, and individual trials scored 87.27 in the Very Feasible category. At a significance threshold of α = 0.05, the computation yielded tcount = 4.256 and ttable = 1.67, indicating that tcount > ttable. These findings indicate that, at a significance level of 5%, there is a substantial difference between the learning outcomes of the students in the experimental and control classes, with H0 being rejected and Ha being accepted. According to the efficacy test's computation, According to the data, students who get instruction using PBL-based differentiated E-modules achieve better learning outcomes than those who receive printed books (81.25% > 73.33%). Therefore, it can be said that the Science on Earth and Solar System class VII PBL-based differentiated E-modules at SMP N 43 Medan are superior to using printed books.

KEYWORDS

E-Module; differentiation; Problem Based Learning; natural sciences

INTRODUCTION

The concept of learning in the era of information technology development leads to changes in student behavior and abilities (Dari & Sudatha, 2022; Kurniawan et al., 2019). Changes in behavior and learning experiences as a result of the development of the learning concept formulated above tend to occur in the 21st century learning paradigm, which now demands skills that lead to 4C competencies. The 4C competencies in question include competencies such as communication, collaboration, critical thinking, and creativity (Arditama & Lestari, 2020; Odebiyi & Odebiyi, 2021). The primary focus of efforts to guarantee the caliber of students with the necessary abilities in the twenty-first century is education and abilities to learn, innovate, use technology, choose information media, think appropriately, and determine appropriate sources of information (Husain & Kaharu, 2021;

Wulandari, 2023). This needs to be supported by learning designs and resources that are in accordance with the current paradigm and educational transformation.

In an attempt to fulfill the vision of Indonesian education toward a sovereign, independent, and individualized advanced Indonesia through the creation of Pancasila students, the Sekolah Penggerak program is one of the implementations of the Merdeka Belajar policy (Desianti, L. C., & Rahayuningsih, 2022; Rahayu et al., 2022). The present independent curriculum is implemented in large part by Sekolah Penggerak (Gunawan & Suniasih, 2022). Differentiated learning, a teaching strategy that accommodates students' needs and learning styles in the classroom, is one of the paradigms created in the autonomous curriculum. The foundation of diversified learning must be the fulfillment of students' learning needs and the way in which teachers address these demands by attending to their students' needs. (Handiyani & Muhtar, 2022; Suwartiningsih, 2021).

Junior high and senior high school are the secondary school levels where differentiated learning has been implemented. By meeting each student's unique learning needs, differentiated learning may be implemented in all learning environments and enhance student learning results (Wahyuni, 2022; Setiyo, 2022).

The idea that every person has unique interests, abilities, and capabilities is emphasized by differentiated learning in the execution of the independent curriculum. As such, teachers must be able to coordinate and collaborate these differences using the appropriate method (Naibaho, 2023). If the elements that contribute to success can be optimized, the autonomous curriculum can be successfully used in driving schools. A shift in how teachers and students approach learning is one of the elements propelling the successful adoption of the autonomous curriculum.

Based on a survey conducted on science teachers at SMP N 43 Medan, the results showed that teachers only occasionally use learning media when teaching science material, with a percentage of 45%. Furthermore, only 54% of teachers employ learning materials in the form of photos or graphics, and only 20% of them use computers. According to the survey, most teachers utilize Google as a source or learning tool, but they also frequently employ IT-based media. According to a survey conducted on seventh-grade science students, 93% of them reported using learning media with e-modules, which is also very likely. The use of digital learning resources is also still highly expected, namely 87%. It can be concluded that the lack of teacher creativity in designing their own learning media that will be used in teaching and the need for learning media as an alternative media that will be used by teachers in teaching. According to the findings of observations and interviews conducted with the science teachers of class VII at SMP N 43 Medan, pupils typically exhibit passive learning styles by failing to answer questions or provide explanations of the content. Furthermore, teachers primarily focus on learning goals and hardly use the problem-based learning model to foster students' scientific literacy and critical thinking abilities. In the meantime, the lecture model, discussion, and taking notes on the teacher's reads are the learning strategies employed. Data from the learning results of SMP N 43 Medan's class VII pupils in the second semester of 2022–2023 support this. 65% of all students have failed to meet the current minimal passing requirement (KKM), with 70 serving as the passing mark in schools.

Based on these problems, teachers must always innovate in the teaching process and need to create a learning environment that is appropriate to the classroom environment, one of which is by implementing differentiated learning. Differentiated learning can Give pupils enough room to be independent, creative, and proactive based on their skills, interests, and physical and mental growth. All students' requirements in science can be met through personalized instruction based on their learning profiles or areas of interest. By

focusing on the differentiation of content, method, and product, differentiated learning assists educators in identifying and creating instruction that is consistent with the nature of science (Wahyuni, 2022: 124). Learning media is a physical support facility for delivering learning materials. Learning media is a means of communication that carries messages from the source of the message to the recipient of the message to support the learning process (Hapsari & Wulandari, 2020). Hartono, quoted by Hapsari and Wulandari (2020), explains that learning media makes teaching more interesting to students. The meaning of the lesson material will be clearer, so it will be easier for students to understand. Learning media also makes the teaching method more varied, not just verbal communication through words spoken by the teacher, so that students do not get bored and teachers do not run out of energy. So Learning media can be viewed as a tool to assist educators in delivering instructional information. In essence, differentiated learning sees each student as unique and dynamic, so schools need to have a plan for it that includes: (1) evaluating the current curriculum to see what strengths and weaknesses students have; (2) creating school plans and strategies that align with the curriculum and learning methods that can be used to meet student needs; (3) outlining how teachers can support students in meeting their needs; and (4) periodically reviewing and evaluating the success of school plans (Marlina et al. 2019: 3). Maryam quoted by Faiz et al. (2022), in differentiated learning there are at least 3 types, including: (1) content differentiation; (2) process differentiation; and (3) product differentiation. Science modules are needed as an alternative to overcome the limitations of learning time due to the complexity of the material (Aryawan et al., 2018a; Hastari et al., 2019). In addition, module development is expected to be able to help students improve their learning outcomes. Judging from the appearance, the available teaching materials in conventional form are considered less interesting, and the information provided is static, which is one of the weaknesses in printed teaching resources. Teaching materials in the form of e-modules because they can be presented more attractively, more efficiently, and more effectively than conventional teaching materials (Diantari, 2018; Logan et al., 2021). The development of e-modules can be a solution for teachers because they can add several types of content in them that can be adjusted to the concept of differentiated learning (Hamid & Alberida, 2021). E-module is a type of teaching material that uses electronic devices that are equipped with text, images, and videos (Dewi & Lestari, 2020). Currently, text, images, videos, and animations are very supportive of learning. In addition, Herawati & Muhtadi (2018) also argue that e-modules include simulations and digital resources that are suitable for educational usage. In addition, interactive e-modules can also be accessed anywhere and can only be accessed online or offline (Wulandari et al., 2021).

With the advantages of e-modules for differentiated learning, they are able to provide several types of content, meaning that they are in accordance with what is needed in creating learning that adapts to the interests, talents, and learning styles of different students (Sidiq, 2020; Nopiani, 2021). This e-module adapts to differentiated learning based on student needs by considering the heterogeneity of competencies, learning styles, and the speed of students in understanding learning materials. The creation of e-modules for differentiated learning in order to add references for teachers in facilitating different learning styles of children (Pratama et al., 2021; Aspriyani & Suzana, 2020). The formulation of the problems in this study includes: (1) How is the feasibility of PBL-based differentiated e-modules in the developed science subjects?; (2) How is the practicality of PBL-based differentiated e-modules in the science subjects that have been developed? (3) How successful are PBL-based differentiated e-modules in science subjects at enhancing student learning outcomes?

RESEARCH METHODS

This study employs a research and development approach (R&D), more commonly referred to as an R&D study, in which educational product development and validation are part of the process. This research approach is used to create specific goods and evaluate their viability and efficacy.

The ADDIE development model is the one that served as the study's reference. The product developed in this study is a differentiated E-module based on PBL Merdeka Curriculum chapter 7 discussing the Earth and the Solar System.

The subjects in this study were 7 class VII students in semester II. Class VII students of SMP N 43 Medan. The object of this study is the development of a differentiated E-module based on PBL for the subject of science. The development procedure is the stages regarding the steps taken by researchers in conducting their research.

The results of this validation are used as a basis for making improvements and refinements to the product objectively. The following is a grid of validation sheets by media experts, which can be seen in Table 1.

Table 1. Grid of Validation Sheets for Media Experts

Aspect	Component	Indicator
Content	Competence	Suitability with core competencies and basic competencies; Clarity of learning indicators; Clarity of learning objectives; Provision of motivation
	Presentation of Material	Systematic presentation of material; Accuracy of learning sequence; Accuracy of procedures; Clarity of instructions for use
	Exercise	Providing exercises for understanding concepts; Providing students with opportunities to practice on their own
	Summary	Provision of summaries for each material
	Test	Clarity of instructions for doing the test; Test quality and assessment quality; Balance of material with test questions
	Bibliography	Suitability with science; Recency/Timeliness of features; Current references
Presentation and Display	Material Content	Student involvement and role in learning activities; Suitability of material with student situations; Adequacy of material to achieve learning indicators; Completeness of material to achieve learning objectives; Breadth of material; Depth and completeness of material; Presentation techniques and Providing other sources for learning
	Example	The accuracy of examples to clarify the content; Adequacy of examples given; Presenting concrete examples from everyday life
	Visualization	The suitability of images to clarify the content; The suitability of the display to clarify the content
Language and Read-ability	Language Clarity	Sentences are easy to understand and do not cause double meanings; Language uses standard language; The language used is communicative; Suitability to the development of students; Readability; Ability to motivate; Coherence and sequence of thought flow; Suitability with Indonesian language rules; Use of terms and symbols/emblems
PBL-Based Learning	Orientation to the problem	Observing, there are images of current life facts for orientation to the problem
	Organizing students	Investigating, there are instructions for activities that students must do. to apply to organizing students
	Guidance for	Processing, there are instructions and directions for compiling

Aspect	Component	Indicator
	investigation	reports to apply through guidance for investigation.
	Developing and presenting work	Processing, a link is provided to download templates and collect assignments to apply through developing and presenting work
	Analyzing the problem-solving process	Processing, the results of student assignments that have been collected are analyzed for the problem-solving process to apply and analyze the problem-solving process..
	Problem solving	In order to assess the problem-solving process, a link is supplied to gather student learning outcomes.

To ascertain whether the way the content is presented is appropriate for the cognitive growth of the pupils, validation by subject matter experts is required. This tool takes the shape of a rating scale-equipped questionnaire. Table 2 displays a grid of validation sheets created by media specialists.

Table 2. Grid of Validation Sheets by Learning Design Experts

Aspect	Component	Indicator
Content	Learning approach	Places a strong emphasis on education; highlights the connection between science, technology, and life; appropriateness of the learning activities in relation to the used approach; encourages pupils to participate in active learning
	Truth of the concept	Conceptual appropriateness in relation to expert conceptions; accuracy of material organization for each discussion
	Depth of the concept	Depth of the material according to students' abilities
	Suitability of the concept	Concept's compatibility with the material's classification and modifications; appropriateness of the material for the experimental activity; The information provided reflects the evolution of the times.
Presentation	Learning activities	Participation of students in educational activities student-centered; appropriate for learning traits; Capacity to use case studies, practice questions, and visuals to pique students' interest
	Experimental activities	Give firsthand experience; Students are encouraged to draw conclusions about concepts, laws, or facts they have acquired through the tasks they complete. It is simple to carry out practical exercises and experiments.
	Implementation	The primary content is in line with the time allotted at school; The connection between educational activities
	Assessment	The primary content is pertinent to the time allotted at school; The connection between educational exercises
Appearance	Content	Correctness and suitability of the pictures with the content; display of text, tables, pictures, and attachments with citations and sources cited; harmony between the text and the pictures; Glossary clarity
	Visualization	Accuracy of color selection in images; Clear printing of images and writing; Appearance can encourage students' interest in reading
Linguistics	Clarity of sentences	Sentences are easy to understand and do not cause double meanings; Language uses standard language; The language used is communicative

Table 3. Graphic Design Expert Validation Sheet Grid E Module

Aspect	Component	Indicator
Software Engineering	Usability	Simple to use; The learning usage guide is straightforward to read and comprehend. The buttons that are provided for navigation are simple to use and clear.
	Compatibility	Performs well on a computer
		Performs nicely when using a smartphone.
	Maintainability	Is easily manageable
	Reliable	Can operate well; does not impair the functionality of smartphones or computers
	Reusable	Can be utilized again to create more visual communication learning e-modules.
Visual commu-nication	Communicative and Creativity	The sample photographs are presented in a simple and understandable manner. The way the educational materials are presented is organized and methodical; The e-module has a straightforward and appealing design.
	Visual	A consistent interface design; high-quality images displayed; learning-supporting images The font size is readable and appropriate for the screen size; The media's choice and arrangement of colors
Learning design	Evaluation faci-lity capability	The quiz function is simple to use; The quiz function has received feedback. Clear displays of student work results are included.

The percentage of each statement on this student trial questionnaire will thereafter be calculated for analysis. Regarding the questionnaire related to the student trial of the product's feasibility, it can be seen in table 4 below:

Table 4. Student Trial Instrument Grid

Aspect	Indicator
Appearance	The text or writing on this e-module is easy to read; The images presented are clear or not blurry; The images presented in the e-module are appropriate; There is a description on each image presented in this e-module; The images presented in the e-module are interesting; The images presented in the e-module are in accordance with the material
Presentation of Material	Illustrates a subject with examples; provides problem-related question examples; The way the content is presented in this e-module motivates me to talk to my friends about it; The e-module's content is logical, and it's easy to follow the learning activities step-by-step. This e-module has no statements that have two meanings; This e-module's sample questions are consistent with the content.
Benefits	Can readily comprehend the content when using this e-module; feel that this e-module makes learning easy; eager to use this electronic module; Each material's initial problems might serve as a source of learning incentive.

Table 5 below shows the questions pertaining to the PBL-based differentiated E-Module's practicality:

Table 5. Practicality Test Instrument Grid

Aspect	Indicator	Description
Accessibility	The PBL-based differentiated E-Module's ease of use	Simple to use, offers versatility, and facilitates navigation.
Benefits	Effectiveness in utilizing differentiated E-modules based on PBL	saves time when preparing for learning: The complete set of PBL-based differentiated E-modules learning resources is accessible.
	Differentiated e-modules based on PBL are simple to use and enhance learning objectives.	Video-based learning resources pique students' interest and offer an engaging educational experience. Students can improve their problem-solving abilities and practice answering practice questions more easily thanks to the available practice questions.
Presentation	PBL-based differentiated e-modules make it simpler for pupils to comprehend new information.	Offers consumers interactive features; The language is simple to comprehend; It is simple to read the variety of font sizes and types.

Table 6 shows that there were forty-five questions in this study.

Table 6. Grade VII Science Question Indicators Earth and the Solar System

No.	Sub Indicators
1.	Solar System: Covers the Eight Planets in the Solar System, Other Celestial Bodies,
2.	Earth and its Satellites: Covers the Movement of Earth in the Solar System, the Moon as Earth's Satellite, Earth's Satellites Other Than the Moon
3.	Getting to Know the Sun Closer: Covers the Characteristics of the Sun, Solar Eclipses, the Role of the Sun in Human Life

Product feasibility testing is carried out to gather data on the viability of the designed learning device product through restricted trials, individual trial evaluations, and small group evaluations, as well as the findings of a questionnaire assessment given to learning specialists (materials, media, and learning design). Using the Likert Scale and the formula and criteria listed in table 7, the product development criteria will be transformed into values:

Table 7. Expert Validation Questionnaire Assessment Qualification Criteria and Student Responses to E-Modules

Value	Criteria	Percentage (%)
A	Very Feasible/Practical	81-100
B	Feasible/Practical	61-80
C	Quite Feasible/Practical	41-60
D	Less Feasible/Practical	21-40
E	Very Less Feasible/Practical	0-20

(Source: Sugiyono, 2016: 134-136; Latifah et al. (2016: 46))

To ascertain the efficacy of the PBL-based differentiated E-Module with the outcomes of the Solar System material test for class VII students, a posttest data collection technique was used in both the control and experimental classrooms. Additionally, the efficacy of the data produced by the test will be examined.

A normality and homogeneity test must be performed before a t-test effectiveness test may be conducted according to certain guidelines. Finding out if respondent data has a normal distribution or not is the goal of the normality test. To determine if the variance of two or more distributions is the same, the homogeneity test is employed. Once both are satisfied, the research data can be subjected to an independent sample t-test.

Data Analysis of Effectiveness of Differentiated E-Modules Based on PBL
Normality Test
Determining the average value is done using the formula:

$$\bar{x} = \frac{\sum f_i \; x_i}{\sum f_i}$$

Calculating the standard deviation (s) is done using the formula:

$$s = \sqrt{\frac{n\sum x_i^{\,2} - \left(\sum x_i\right)^2}{n(n-1)}}$$

This test aims to see whether the sample is normally distributed or not. The test used is liliefors with the following steps:

a. Arrange student scores from the lowest to the highest score
b. Find the standard score using the formula: $z_i = \frac{x_i - \bar{x}}{s}$
   with $\bar{x}$ = Average value of standard deviation
c. For each standard number, use a standard normal distribution list, then calculate the probability $F(z_i) = P(z \leq z_i)$
d. Calculate the proportion of $z_1, z_2, \ldots, z_n$ which is smaller than or equal to zi. If the proportion is expressed as S(zi), namely:
   $S(z_i) = \frac{banyaknya\ z_1, z_2, \ldots\ldots z_n\ \ yang \leq z_i}{n}$
e. Calculate the difference $F(z_i) - S(z_i)$ then determine the absolute price
   Take the largest price among the absolute prices or also called Lhitung. Then compare Lhitung with the Ltabel price ($\alpha = 0{,}05$).

With testing criteria:

1) If L0 < L then the sample is normally distributed
2) If L0> L then the sample is not normally distributed

Homogeneity Test

The purpose of the homogeneity test of variance is to determine whether the sample data has homogeneous variance or not. The homogeneity test of variance uses the F test, with the following hypotheses:

$H_0 : \sigma_1^{\,2} = \sigma_2^{\,2}$ both populations have the same variance.

$H_a : \sigma_1^{\,2} \neq \sigma_2^{\,2}$ both populations have different variances.

To test the hypothesis above, the following formula is used:

$$F_{hit} = \frac{\text{var}\, ians\ terbesar}{\text{var}\, ians\ terkecil}$$

The testing criteria are:
Fhit < Ftab1/2 α(v1, v2), H0 is accepted
Fhit> Ftab1/2 α(v1, v2), H0 is rejected
With the provisions:

real level α = 0,05

v1 = n1-1 and n1 = largest variance size

v2 = n2- 1 and n2 = smallest variance size

Data processing indicates that both samples have homogeneous variance if Fcount < Ftable, which means that H0 is accepted. It can be inferred that the two samples do not have homogenous variance if data processing reveals that Fcount > Ftable, rejecting H0 and accepting Ha.

Using the paired sample t-test, this analysis method assesses how well e-modules enhance student learning achievement. The normality and homogeneity tests as well as the balancing of the average must be performed before the paired t-test, which will be used to assess the efficacy of this PBL-based E-module. The precondition test employs the homogeneity test using the Bartlett technique and the normality test using the Lilliefors method.

Comparative descriptive analysis for testing hypotheses The experimental group and the control group are the two samples compared in this study, and the pretest and posttest results are compared. The purpose of the data analysis is to quantify learning achievement by examining learning outcome data. use the T-test for two independent samples.

If the average learning outcomes of the experimental class and the control class differ significantly, then learning is considered successful. The average difference test or t-test (independent sample t-test) is used to examine this hypothesis. The test of the difference between two population means is used to calculate the t-test (Sudjana, 2010).

The hypothesis of the effectiveness test to be tested is as follows:

Ho : $\mu_1 = \mu_2$

Ha : $\mu_1 > \mu_2$

Description:

μ_1 : Average student learning outcomes using PBL-based E-Modules for science subjects

μ_2 : Average student learning outcomes without using PBL-based E-Modules for science subjects

Ho : The PBL-based E-Modules developed are not effective for improving science subjects for students.

Ha : The PBL-based E-Modules developed are effective for improving science subjects for students.

For hypothesis testing, the two-tailed test formula is used:

$$t_{count} = \frac{\bar{x}_1 - \bar{x}_2}{S\sqrt{\frac{1}{n_1} + \frac{1}{n_2}}}$$

Where S is the root of the combined variance calculated using the formula::

$$S^2 = \frac{(n_1-1)S_1{}^2 + (n_2-1)S_2{}^2}{n_1 + n_2 - 2} \text{ where } S = \sqrt{s^2}$$

Description:

$\bar{x}_1$: Average score of the experimental class

$\bar{x}_2$: Average score of the control class

n_1 : Number of samples of the experimental class

n_2 : Number of samples of the control class

$S_1{}^2$: Variance in the experimental class

$S_2{}^2$: Variance in the control class

S : Combined variance

t : Calculation price with db = n1 + n2 – 2

The testing criteria are Ha is accepted if tcount < ttable and Ho is rejected if tcount > ttable obtained from the t distribution list with dk = (n – 1) and α level = 5%. This testing criterion uses the t test to determine whether the observed differences in the data are significant. By comparing the t count and t table values based on the degrees of freedom and the selected level of significance, the researcher can decide whether the null hypothesis should be accepted or rejected. The null hypothesis is accepted if the t count is greater than the t table with an alpha significance level of 5%. This is an important step in statistical analysis to ensure the accuracy and validity of the conclusions drawn from the data.

Researchers can compare the effectiveness achieved with the ideal effectiveness, which can be expressed as follows, to determine the effectiveness value of the product being developed, claims Sugiyono (2019: 415–418):

$$x = \frac{effectiveness\ score\ obtained}{ideal\ effectiveness\ score}\ x\ 100\%$$

Table 8 below displays the effectiveness assessment:

Table 8. E Module Effectiveness Assessment Criteria

Value	Percentage of Achievement	Criteria
4	76 – 100%	Very Effective
3	56 – 75%	Effective
2	40 – 55%	Quite Effective
1	0 – 39%	Not Effective

(Source: Sugiyono, 2019)

RESULTS AND DISCUSSION

The validation results from the two respondents were in the form of assessment scores for aspects of the PBL-based differentiated E-Module in terms of learning materials with an assessment scale of 1-4.

Table 9. Results of Material Expert Assessment

Assessment Aspect	Component	Mean	Percentage	Criteria
Content Feasibility	Competence	3,5	87,5	Very Feasible
	Motivation	3	75	Feasible
	Material Presentation	3,63	90,63	Very Feasible
	Exercise	3,5	87,5	Very Feasible
	Summary	3,5	87,5	Very Feasible
	Test	3,33	83,33	Very Feasible
	Bibliography	3,67	91,67	Very Feasible
		3,45	**86,16**	**Very Feasible**
Presentation and Display	Material Content	3,71	92,86	Very Feasible
	Example	3	75	Feasible
	Visualization	3,54	88,54	Very Feasible
		3,42	**85,47**	**Very Feasible**
Language and Readability	Language Clarity	3,5	87,5	Very Feasible
		3,5	**87,5**	**Very Feasible**
PBL-Based Learning	Problem orientation	3,5	87,5	Very Feasible
	Student organization	3	75	Feasible
	Guidance for investigation	3	75	Feasible
	Developing and presenting	3	75	Feasible

Assessment Aspect	Component	Mean	Percentage	Criteria
	work			
	Analyzing the problem-solving process	3,5	87,5	Very Feasible
	Problem solving	3,5	87,5	Very Feasible
		3,25	**81,25**	Very Feasible
	Average	**3,40**	**85,09**	Very Feasible

The validation results from the two respondents were in the form of assessment scores for aspects of the PBL-based differentiated E-Module in terms of learning design with an assessment scale of 1-4.

Table 10. Results of Learning Design Expert Assessment

Assessment Aspect	Component	Mean	Percentage	Criteria
Content Feasibility	Learning approach	3,63	90,63	Very Feasible
	Conceptual truth	3,5	87,5	Very Feasible
	Conceptual depth	3,5	87,5	Very Feasible
	Conceptual suitability	3,67	91,67	Very Feasible
		3,57	**89,32**	Very Feasible
Presentation	Learning activities	3,83	95,83	Very Feasible
	Experimental activities	3,5	87,5	Very Feasible
	Implementation	3,5	87,5	Very Feasible
	Assessment	3,5	87,5	Very Feasible
		3,58	**89,58**	Very Feasible
Appearance	Content	3,88	96,88	Very Feasible
	Visualization	3,83	95,83	Very Feasible
		3,85	**96,35**	Very Feasible
Language	Sentence clarity	3,83	95,83	Very Feasible
		3,85	**96,22**	Very Feasible
	Average	**3,71**	**92,87**	Very Feasible

The validation results from the two respondents were in the form of assessment scores for aspects of the PBL-based differentiated E-Module in terms of learning media with an assessment scale of 1-4.

Table 11. Results of Graphic Design Expert Assessment

Aspect	Component	Mean	Percentage	Criteria
Software Engineering	Usability	3,5	87,5	Very Feasible
	Compatibility	3,75	93,75	Very Feasible
	Maintainability	4	100	Very Feasible
	Reliable	3,75	93,75	Very Feasible
	Reusable	3	75	Feasible
		3,6	**90**	Very Feasible
Visual communication	Communicative and Creativity	3,67	91,67	Very Feasible
	Visual	3,6	90	Very Feasible
		3,63	**90,83**	Very Feasible
Learning design	Evaluation facility capability	3,5	87,5	Very Feasible
		3,5	**87,5**	Very Feasible
	Average	**3,58**	**89,44**	Very Feasible

Assessment from field trials the main thing is about: appearance, presentation of material, and benefits. Table 12 below displays the findings of the evaluation of the students' primary field trial:

Table 12. Results of the Assessment of the Main Field Trial of Students

Aspect	Component	Mean	Percentage	Criteria
Appearance	Text or writing is easy to read	3,58	89,42	Very Feasible
	Images are clear or not blurry	3,69	92,31	Very Feasible
	Images are presented accordingly	3,27	81,73	Very Feasible
	Images are presented appropriately	3,73	93,27	Very Feasible
	Image captions are available.	3,27	81,73	Very Feasible
	E-module images are interesting	3,73	93,27	Very Feasible
	Average	**3,54**	**88,62**	Very Feasible
Material Presentation	Explains a concept	3,58	89,42	Very Feasible
	Questions are related to the problem	3,73	93,27	Very Feasible
	Encourages me to discuss	3,58	89,42	Very Feasible
	The e-module material is coherent	3,42	85,58	Very Feasible
	Step-by-step learning activities	3,31	82,69	Very Feasible
	No double meaning sentences	3,69	92,31	Very Feasible
	Example questions are in accordance with the material.	3,31	82,69	Very Feasible
	Average	**3,52**	**87,66**	Very Feasible
Benefits	Learn the content with ease	3,31	82,69	Very Feasible
	E-modules make learning easier	3,42	85,58	Very Feasible
	Wanting to use-modules	3,58	89,42	Very Feasible
	Encourage learning	3,38	84,62	Very Feasible
	Average	**3,42**	**85,58**	Very Feasible
	Total Average	**3,49**	**87,29**	Very Feasible

Thirty students participated in the PBL-based differentiated E-Module's practicality experiment. The results of a practical study on students' use of PBL-based differentiated E-modules as learning resources are shown in table 15.

Table 13. Results of Practicality Assessment from Students

No.	Item	Mean	Percentage	Criteria
1.	The material in the E-Module is easy to understand	3,6	90	Very Practical
2.	The activities in the E-Module are clear and easy to understand	3,53	88,33	Very Practical
3.	The activities in the E-Module motivate students to communicate, interact and work together with others	3,47	86,67	Very Practical
4.	The learning instructions in the E-Module are easy to understand	3,67	91,67	Very Practical
5.	The sentences used in the E-Module are clear to understand	3,57	89,17	Very Practical
6.	The appearance of the E-Module is attractive	3,63	90,83	Very Practical
7.	The images in the E-Module are clear and make it easier to understand the material	3,60	90,00	Very Practical
8.	The E-Module helps students to learn concepts in everyday life	3,50	87,50	Very Practical
9.	The questions in the E-Module are easy to	3,57	89,17	Very Practical

No.	Item	Mean	Percentage	Criteria
10.	understand and clear By implementing this E-Module helps you in carrying out the learning process	3,43	85,83	Very Practical
	Average	**3,56**	**88,92**	Very Practical

Table 14. Summary of Product Feasibility Results

Validation / Trial	Results Percentage	Criteria
Material Expert	85,09	Very Feasible
Learning Design Expert	92,87	Very Feasible
Graphic Design/Media Expert	89,44	Very Feasible
Individual Trial	87,27	Very Feasible
Small Group Trial	87.30	Very Feasible
Field Trial	87,29	Very Feasible
Average	**88,39**	Very Feasible

Hypothesis Testing

The t-test formula was used to test hypotheses in this investigation. To ascertain whether learning outcomes in courses taught with interactive multimedia-based learning materials (experimental class) and learning outcomes taught with printed books (control class) differed significantly, the t-test was used. At a significance threshold of α = 0.05, the computation yielded tcount = 4.256 and ttable = 1.67, indicating that tcount > ttable. These findings indicate that, at a significance level of 5%, there is a substantial difference between the learning outcomes of the students in the experimental and control classes, with H0 being rejected and Ha being accepted. As a result, students who are taught through interactive multimedia-based learning materials get different learning outcomes than those who are taught through printed books.

Table 15. Summary of Hypothesis Test Calculation

Average Post Test Value		t_{count}	t_{table}	Conclusion
Using Differentiated E-Modules Based on BPL	Using Textbooks	4,256	1,67	There is a significant difference
80,5	**68,3**			

The following computations were performed in order to evaluate the efficacy of the PBL-based differentiated E-Modules for the Earth and Solar System content that was created:

$$X = \frac{number\ of\ students\ who\ completed}{total\ number\ of\ students}\ x\ 100\%$$

$$= \frac{26}{32}\ x\ 100\%$$

$$= 81{,}25\%$$

The effectiveness value of printed books can be seen as follows:

$$X = \frac{number\ of\ students\ who\ completed}{total\ number\ of\ students}\ x\ 100\%$$

$$= \frac{22}{30}\ x\ 100\%$$

$$= 73{,}33\%$$

Learning outcomes for students taught with PBL-based differentiated E-modules are higher than those of students taught with PBL-based differentiated E-modules, according

to the findings of the effectiveness test calculated on both. students (81.25% > 73.33%) who have printed books. The differentiated E-Module based on PBL Science on the Earth and Solar System material in class VII of SMP N 43 Medan is therefore superior to using printed books, it can be inferred.

Discussion

Following individual, small-group, and student field/main trials, the E-Module was validated and tested by all experts, including material experts, learning design experts, and media experts. The results showed that the product was highly appropriate for use as learning media for class VII students at SMP N 43 Medan.

According to Sudjana (2005), a suitable e-module must be in line with the learning objectives to be achieved. Furthermore, according to Alimah (2013), the contents of the e-module must be accurate, up-to-date, and in accordance with the facts. The language used must be clear, easy to understand, and in accordance with good and correct Indonesian language rules. According to Mayer (2009), a proper e-module must be interesting and interactive so that it can motivate students to learn. This can be achieved by using various media formats such as images, video, audio, animation, and simulation. The E-Module with the Flipbook platform meets various specified E-Module criteria, so One could argue that it is appropriate for use in the educational process. The present national curriculum served as the basis for the construction of this e-module, namely the Independent Curriculum. In addition, in accordance with Alimah et al. (2013) view, the contents of this e-module are accurate, up-to-date, and in accordance with the facts, using clear language, easy to understand, and in accordance with good and correct Indonesian language rules. In terms of attractiveness and interactivity, this e-module utilizes various media formats, such as images, videos, audio, and text, as suggested by Mayer (2009), so that Students may be inspired to learn by it.

E-Design - Interactive and interesting modules not only make the material easier to understand but also increase student engagement in the learning process. In addition, the neat and easy-to-navigate design, as well as clear and easy-to-understand instructions for use, make this e-module convenient and easy to use by students. Compatibility with various electronic devices without the need for special software or applications also makes it practical, cost-effective, and time-saving, supporting better learning effectiveness. This is in line with the research of Sa'diyah (2021) in his research, which stated that the digital flipbook-based e-module is very suitable for use in learning with an average value of 82% and is more effective than conventional media. Furthermore, research conducted by Hayati et al. (2015) also showed that the Flipbook-based E-Module was "very feasible," with an average percentage of 95.87% with very good interpretation.

According to this study, both teachers and students thought highly of the differentiated E-Module learning materials based on PBL Science content about the Earth and Solar System. Additionally, students submitted evaluations that met the very good criteria with an average score percentage of 94.90%, while teachers provided assessments that met the very good criteria with an average score percentage of 90.20 percent. This medium is highly practical to employ to enhance student learning outcomes because it was built with accessibility, utility, and presentation in mind. This outcome is supported with theories regarding the usefulness of learning media. Arikunto (2019) asserts that a tool's practicality is correlated with its usability, evaluation in terms of planning, execution, interpretation/conclusion of findings, and preservation. According to Milala (2022), practicality also refers to how simple it is for teachers and students to use learning

materials, which enhances creativity and makes the process of learning more relevant, engaging, enjoyable, and practical. Based on the findings of the aforementioned research, it can be said that the media High levels of practicality may be found in this diversified E-module learning about the Earth and Solar System that was produced using a PBL approach. Teachers and students may easily use this learning tool, which makes learning engaging, enjoyable, and meaningful. It also offers pertinent advantages and promotes learning readiness. The results of this study are also consistent with earlier hypotheses and investigations that support the media's usefulness.

Flipbooks and e-modules complement each other effectively in the classroom since they are both portable and practical, accessible through Android and mobile devices, and have tiny file sizes. According to their demands for independent learning, this enables students to access materials at any time and from any location (Muzijah et al., 2020). Additionally, students find learning to be more engaging and enjoyable when e-modules are used in conjunction with Flipbook platforms. The e-modules' videos and pictures aid in students' comprehension of the subject matter, making learning less tedious. Additionally, the developed e-module was deemed appropriate for use as an alternate learning resource in early childhood education, according to Indraswari and Shynta (2017).

The flipbook e-module learning methodology, according to Birgili et al. (2021), asks students to study the content at home before attending class. Learning is genuinely more student-centered in the classroom, where students have the chance to actively participate in the educational process. As a result, the flipbook-based e-modules created in this study are useful for enhancing early childhood literacy and speaking abilities in pupils. Flipbook learning works well for the entire school, not just one, two, or more topics. This is particularly helpful for the new educational paradigm that is currently in place.

CONCLUSION

The following conclusions can be made in light of the problem formulation, goals, findings, and discussion of the study on the creation of PBL-based differentiated E-modules that have already been described:

1. The PBL-based differentiated E-Modules product has met the requirements and is suitable for use as a learning medium for the Earth and Solar System material.
2. The PBL-based differentiated E-Modules product has met the requirements and is practical for use as a learning medium for the Earth and Solar System material.
3. The effectiveness of the PBL-based differentiated e-modules developed is considered more effective than printed books. The results of the hypothesis test prove that there is a significant difference between the learning outcomes of students taught using e-modules and the learning outcomes of students taught using printed books on the Earth and Solar System material.

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