



E-Module Based on Project-Based Learning Integrated Deep Learning Framework and Contextual to Improve Creative Thinking Skills

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Abstract. This study aims to: (1) develop a PjBL-based e-module to improve students' creative thinking abilities in the course on educational media technology; and (2) assess the e-module's viability, usefulness, efficacy, and originality. The ADDIE model was used to design this research and development (R&D) project, which comprises Analysis, design, development, implementation, and evaluation are the first five steps. This research was carried out in the sixth semester of the Department of Mechanical Engineering Education's course on educational media technology at Unimed's Faculty of Engineering. Small groups, field groups, individual trial groups, and validation groups are the research's subjects. Furthermore, specialists in instructional design, learning media, learning resources, and visual design, the PjBL-based E-Module product is the outcome of the research. According to the findings, (1) the PjBL-based E-module is practicable and satisfies the requirements; (2) the E-module based on PjBL is useful and satisfies the requirements; and (3) The findings of the hypothesis test showed that students who were taught using the e-module had different learning outcomes from individuals who were instructed using printed texts. Students that are taught using the PjBL-based E-Module had improved learning results. Greater than 73.33% in comparison to printed books (81.25%). As a result, the PjBL-based e-module integrated with DLFC in educational media technology is better than printed books.

Keywords: E-Modules, Project Based Learning, Integrated Deep Learning Framework and Contextual, Creative Thinking Skills

1 Introduction

Web and mobile applications are examples of technologically based educational applications [1]. Therefore, to adjust technology to the evolving demands of society, the government must be responsive. In this case, technological advances have influenced the use of digital applications in learning [2]. The ability to master digital technology along with the progress of the times is very important. Chan and Zhang [3] There are variations in the quality of education throughout Indonesia as digital technology is a reflection of that nation's educational system. Everyone involved in the learning process has been changed by this technological revolution.

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To meet these needs, PjBL-based e-module media emerged. E-modules are learning media in the form of electronic modules [4]. E-modules are learning materials that can be accessed digitally, such as text, images, videos, or interactively, and can be accessed via mobile devices. The combination of sophisticated mobile technology with the interactive format of e-modules provides opportunities to improve students' learning experiences in the Educational Media Technology (TMP) course.

E-modules are digital multimedia learning and are not printed with a systematic layout with various features developed by the module layout guidelines. E-modules are structured with an independent learning approach and use problem-solving methods to achieve learning objectives. In addition, the curriculum and learning units are adjusted to the level and method of module development. The advancement of technology called "e-module" allows printed modules to function as electronic modules. Although people can use or create printed module features, the digital features of e-modules make them the same as printed modules [5].

Imansari and Sunaryantiningsih [6] stated that e-modules can display text, images, animations, and videos in an attractive package for the learning process via computers or other digital devices while not causing boredom in learning. This shows that e-modules can be the right alternative for an attractive learning model with images and videos. According to Suyatna, Maulina, Rakhmawati, and Khasanah [7], interactive books improve student learning outcomes more than printed books.

The Educational Media Technology course at the university is very important for various educational revolutions, especially the twenty-first-century educational revolution and, in particular, the 4.0 educational revolution. At this stage, the role of the teacher no longer plays a major role in the learning process. Instead, the role of the teacher changes to focus on students, with the teacher only helping to prepare learning resources and media to meet students' learning needs [8].

Students studying educational media technology often face problems related to courses and technology elements. Some of the problems include: (1) limited access and technological capabilities; (2) mastery of different technologies; (3) lack of motivation for learning materials or approaches; (4) difficulty adapting to new learning models; (5) lack of active involvement; (6) challenges to collaborate and communicate; (7) lack of understanding of the concept of educational media technology; and (8) difficulty in managing information. As a result, the learning process must achieve goals by CP and CPMK.

The learning process requires increasing human resources with problem-solving, communication, collaboration, critical thinking, and creative skills [9]. In universities, learning models are always the basis of learning in class and tutorials.

PjBL is a learning model that allows students to actively participate in making projects and utilize their potential to solve problems [10]. Project-based learning can encourage and direct students to be creative and make products that are under their fields of expertise. The results of research conducted by Silva et al. [11] showed that project-based learning affects students' engineering practice learning outcomes. In addition, research conducted by Khotimah et al. [12] found that the application of project-based learning models increased creative thinking and scientific literacy. This

shows that project-based learning can have a positive impact on student learning outcomes.

The learning process is seen as a systematic procedure to accomplish learning objectives since it includes several interconnected components, including teachers, students, instructional materials, and associated settings. Technology is involved in the learning process, which is a cognitive process to acquire knowledge. It is possible to use technology as an additional tool in the educational process [13]. Deep and contextual learning framework, also known as Deep and Contextual Learning Framework, combines several essential elements to create a relevant and meaningful student learning experience in the Educational Media Technology course.

Deep Learning Framework and Contextual (DLFC) has several main components in the learning framework, including: (1) determining specific, measurable, achievable, relevant, and time-limited (SMART) learning objectives so that students have a clear understanding of what they want to achieve; (2) aligning learning with real-world contexts to provide relevance and practical application of learning materials; (3) integrating the PjBL approach in projects or assignments that reflect real-world tasks, require critical thinking, and allow for the development of practical skills; (4) Providing opportunities to actively engage in learning through conversation, discussion, experimentation, or practical activities; (5) encouraging collaboration and communication between students, providing opportunities to share ideas, support each other, and build social skills; (6) encouraging students to reflect on their learning experiences, identify what they have learned, and how they can improve their own understanding; and (7) integrating Educational Media Technology to enhance the learning experience by providing access to richer and more interactive resources.

Some of the benefits of DLFC are as follows: (1) Accuracy Enhancement: DLFC can improve the accuracy of deep learning models by considering relevant contextual information; (2) Relevance Enhancement: DLFC models can produce results that are more relevant to specific situations and contexts; (3) Adaptability Enhancement: DLFC models can more easily adapt to changing environments and conditions; and (4) Interpretability Enhancement: DLFC can help improve interpenetration and understanding between individuals DLFC is a very useful method to improve the effectiveness and relevance of deep learning models. DLFC can produce models that are more intelligent, adaptive, and useful in various applications by combining the power of deep learning with contextual understanding.

One must have the ability to think creatively to always find new ways to achieve goals. One of the indicators of creative thinking skills is flexibility, flexibility, creativity, and elaboration. Flexibility produces many ideas and concepts, questions, and solutions that are put forward smoothly; creativity produces new ideas and concepts in different ways and combinations; and originality produces new ideas and concepts.

The learning outcomes of FT UNIMED from the Educational Media Technology course in S1 Mechanical Engineering are as follows: (1) students can understand and be proficient in using the principles, procedures, and educational media technology to evaluate the learning process and outcomes; (2) students can understand, master, and analyze the procedures and learning outcomes of educational media technology; and

(3) students can evaluate the learning process and outcomes with educational media technology.

The following are the research issues: How can an e-module based on DLFC-integrated PjBL be developed to enhance creative thinking skills in the course on educational media technology? (2) How feasible is it to use the e-module based on DLFC-integrated PjBL? (3) How practical is it to use? (4) How can the e-module based on DLFC-integrated PjBL effectively improve results? (5) How is the ability of creative thinking skills?

2. Research Methodology

This study was developed using the ADDIE paradigm for research and development (R&D) objectives. Analysis, design, development, implementation, and evaluation are the steps in the model development process. This study was carried out during the sixth semester of the Department of Education's course on Educational Media Technology. Unimed's Faculty of Engineering, Mechanical Engineering Education, 2024–2025 academic year. This research included instructors and students in field trials, small group trials, individual trials, and validation groups. Furthermore, specialists in instructional design, learning media, learning materials, and graphic design the subject of this investigation is PjBL-based electronic modules.

The development process employed in this study is a process that must be adhered to or completed during the creation and manufacturing of goods. The development stage in this study is separated into four phases. The investigator switched to the Borg and Gall product development stage from the Dick and Carey instructional development stage. The Needs analysis comes first, followed by product design, validation, and assessment, and finally, the ultimate product is the last stage. Using this method, researchers acquired validation data for e-modules from a group of specialists (lecturers) in the evaluation of the viability of the questionnaire and e-module.

C1 (remembering) is one of the multiple-choice questions in the learning outcome text format. C2 (knowledge), C3 (use), C4 (analysis), C5 (assessment), and C6 (creation). Before the employment of this instrument, First, a trial is used to assess quality. The validity and reliability of the instrument serve as indicators of its quality in describing the variables that will be tested, the questions' degree of difficulty, and the discriminating capability of the inquiries.

Table 1. Post Test Indicators and Question Grid

Indicator	Question Grid
Able to explain the basic concepts of educational technology and its applications in the context of engineering education	- Basic Concepts of Educational Technology - Development of educational technology - Theory of learning educational technology - Principles of learning design
Able to select and use appropriate software to develop learning materials	- Educational Software - Types of software - Selection and use of appropriate software

Able to develop various types of interesting and effective digital learning materials	- Development of Digital Learning Materials - Digital learning text materials - Digital learning movies, - Digital learning animations - Digital learning pictures - Simulated digital learning - Digital educational games
Capable of incorporating technology into the classroom learning process	- Technology-Based Learning Design - Learning design models - Development of online learning modules
Able to evaluate the effectiveness of learning using technology	- Technology-Based Learning Evaluation - Evaluation instruments - Data analysis
Able to integrate technology into the learning process in the classroom	- Implementation of Technology in Learning - Integration of technology in the curriculum - Digital classroom management
Capable of keeping up with the most recent advancements in educational technology and its possible uses	- Educational Technology Trends - Artificial intelligence - Virtual reality - Augmented reality

- 1) According to the rules in table 2 below, the questionnaire evaluation results scores acquired from experts (media and materials) and student replies in the form of quantitative data are converted into categories.

Table 2. Questionnaire Assessment Scale Guidelines

Category	Score
Very good	4
Good	3
Poor	2
Very Poor	1

- 2) Calculate the average score of the instruments using the following formula:

$$M = \frac{\sum X}{N}$$

Description:

M = Average score

$\sum X$ = Total Score

N = Assessor count

- 3) Converting the average score from a qualitative value to a quantitative value using the subsequent evaluation criteria.

Table 3. Scoring Assessment Criteria

Score	Range Score	Category
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4	$X \geq 3,0$	Very Feasible
3	$3,0 > X \geq 2,5$	Feasible
2	$2,5 > X \geq 2,0$	Less Feasible
1	$X < 2,0$	Not Feasible

The following formula may be used to determine the validation and practicality test results:

$$Percentage = \frac{\Sigma \text{ score per item}}{\Sigma \text{ score maximal}} \times 100\%$$

Following expert validation, the outcomes are modified to meet the requirements listed in table 9 below:

Table 4. Conversion of Validity Levels

Level of Achievement (%)	Category	Description
81 – 100	Very Valid	No need to revise
61 – 80	Valid	No need to revise
41 – 60	Quite Valid	Revised
21 – 40	Less Valid	Revised
0 – 20	Not Valid	Revised

The effectiveness test results may be used the following formula:

$$Percentage = \frac{\Sigma \text{ number of competent students}}{\Sigma \text{ total student}} \times 100\%$$

7) Converting learning outcome test data with learning outcome effectiveness guideline table.

Table 5. Effectiveness Table

Percentage of Total Completion (%)	Effectiveness
$X > 80$	Very Good
$60 < X \leq 80$	Good
$40 < X \leq 60$	Enough
$20 < X \leq 40$	Less
$X \leq 20$	Very Less

Utilizing the T-Test for Analysis Independent two-sample t-tests or independent sample t-tests are used in the test. If the average of one sample group differs from that of another, the t-test is employed. Two prerequisites must be fulfilled before using the t-test to analyze data: the normality test and the homogeneity test.

3. Results and Discussion

3.1 Research Results

Multiple levels of expert validation and product trials are conducted for PjBL-based E-Modules, including validation by graphic design experts, learning design experts, and material experts.

Researchers can decide if the created material is appropriate for use in the educational process based on the outcomes of the feasibility test. This is shown as follows in Table 6.

Table 6. Summary of Product Feasibility Results

Validation/Trial	Mean	Result Percentage	Criteria
Material Expert	3,58	89,48	Very Eligible
Learning Design Expert	3,58	89,53	Very Eligible
Graphic/Media Design Expert	3,48	87,02	Very Eligible
Small Group Trial	3,60	89,92	Very Eligible
Average	3,56	88,99	Very Eligible

It is concluded that the E-Modules product is useful for the learning process and satisfies the requirements based on the findings of the practicality of utilizing PjBL-based E-Modules integrated with DLFC in Educational Media Technology. This is shown as follows in Table 7.

Table 7. Summary of Practicality Results of Products

Practicality	Mean	Result Percentage	Criteria
Practicality by Students	3,53	88,19	Very Practical
Practicality by Lecturers	3,56	88,89	Very Practical
Average	3,53	88,19	Very Practical

The lowest score was 65, and the best score was 93, according to the learning outcomes of students who were instructed utilizing PjBL-based E-Module learning materials. The standard deviation was 5.83, the mode was 74.9, the median was 73.1, and the average was 80.6. The ratio of absolute frequency, or the number of students with a learning outcome score, to relative frequency, or the number of percent of learning outcome scores, was used to view the student's score in an interval class. Using interactive multimedia-based learning resources, Table 8 offers a thorough overview of the learning goals.

Table 8. Frequency Distribution of Learning Outcomes of Experimental Class Students

Class	Class Interval	Absolute Frequency	Relative Frequency
1	66-70	2	6,25%
2	71-75	5	15,63%

3	76-80	9	28,13%
4	81-85	9	28,13%
5	86-90	5	15,63%
6	91-95	2	6,25%
Total		32	100%

2) Information on the Learning Outcomes of Students Taught Using Printed Books

The lowest score was 51, and the best score was 82, according to the learning outcomes of students who were instructed utilizing printed history instruction books. The standard deviation was 7.41, the median score was 59.1, and the average score was 59.1. was 68.3, with 73 being the mode. A thorough overview of the learning goals is given in Table 9 using books in print.

Table 9. Frequency Distribution of Student Learning Outcomes in the Control Class

Class	Class Interval	Absolute Frequency	Relative Frequenc
1	51-56	3	10,00%
2	57-62	5	16,67%
3	63-68	7	23,33%
4	69-74	7	23,33%
5	75-80	6	20,00%
6	81-86	2	6,67%
Total		30	100%

The hypothesis of the research is tested using the t-test formula. The t-test is used to see if there is a discernible difference between the learning outcomes of the control class, which utilizes printed books, and the experimental class, which uses multimedia-based learning tools. At a significance level of $\alpha = 0.05$, the computation results indicate that the t count is bigger than the t table, with t count = 4.54 and t table = 1.67. The findings show a significant difference in student learning outcomes between the experimental and control groups at the 5% significance level, with Ha being accepted and H0 being rejected. Because of this, students who use interactive multimedia-based learning resources get different learning outcomes than those who use printed books.

Table 10. Summary of Hypothesis Test Calculations

Average Post Test Score		tcount	ttable	Conclusion
Using PjBL-based E-Modules	Using Textbooks	4,54	1,67	There is a significant difference
81,5	66,8			

In order to evaluate the efficacy of the constructed PjBL-based E-Module, the following computations were performed:

$$\begin{aligned}
 X &= (\text{number of students who completed})/(\text{total number of students}) \times 100\% \\
 &= 26/32 \times 100\%
 \end{aligned}$$

$$= 81,25\%$$

The following illustrates the efficacy value of printed books:

$$\begin{aligned} X &= (\text{number of students who completed})/(\text{total number of students}) \times 100\% \\ &= 22/30 \times 100\% \\ &= 73,33\% \end{aligned}$$

Learning results were better for pupils taught using PjBL-based e-modules than for those taught with printed books, according to the results of the effectiveness test on both ($81.25\% > 73.33\%$). Consequently, it may be said that PjBL-based e-modules are better than those that rely on physical books.

3.2 Discussion

PjBL-based E-Modules integrated with DLFC on Educational Media Technology were validated and tested by all experts, including media experts, lesson design experts, and material experts. Individual trials with small student groups also revealed that the product was very feasible to use as a learning medium.

According to learning objectives, a good e-module must be created [14]. Furthermore, the e-module's information needs to be precise, up-to-date, and pertinent, according to Alimah [15]. The language used ought to be understandable, straightforward, and compliant with proper and appropriate Indonesian grammar. A good e-module should be engaging and interactive, since this should pique students' interest in learning, according to Mayer [16]. This may be accomplished with a variety of media forms, including pictures, videos, music, animations, and simulations. The Flipbook platform satisfies different requirements; thus the e-module may be used in the educational process.

According to Sa'diyah's research [17], the digital flipbook-based e-module is more effective than traditional media and is extremely viable to use in learning, with an average value of 82%. Furthermore, a study conducted by Hayati, Setyo, and Handoko [18] discovered that the Flipbook-based E-Module is "very feasible" with a 95.87% average percentage and excellent interpretation.

Teachers and students in this study gave favourable evaluations to the e-module learning materials based on DLFC-integrated PjBL on Educational Media Technology. Teachers' average percentage of 90.20% and students' average percentage of 94.90% indicate that their assessments were extremely good. When creating this medium, the following factors were considered.

The practicality of understanding media theory backs up these findings. In terms of preparation, usage, interpretation, and result storage, practicality is associated with the ease of use of assessment instruments, according to Arikunto [19]. Practicality, according to Milala [20], also relates to how simple it is for instructors and students to use educational materials. Learning is made more relevant, engaging, enjoyable, and practical by the PjBL-based E-Module learning media combined with DLFC in the created educational media technology. It may be inferred from the study's findings that the produced instructional media technology is very practical. Both teachers and students find this learning tool to be user-friendly. They offer pertinent advantages

and make learning engaging, enjoyable, and meaningful. They also assist pupils in getting ready for class. Furthermore, the results of this investigation align with earlier hypotheses and research that bolster the usefulness of this educational tool. To decide whether to continue with the PjBL-based E-Module integrated with DLFC in Educational Media Technology because it has proven useful or to discontinue it because it is ineffective, an efficacy test was conducted. Comparing the learning outcomes of students who used the E-Module with those who utilized traditional media was how this test was conducted. The data analysis revealed a considerable difference between the two groups' learning outcomes.

Flipbooks and e-modules were successful in the learning process because they were portable and useful, and they could be accessed through Android phones. To satisfy their demands for autonomous study, this enables students to access materials at any time and from any location [21]. Additionally, using DLFC in educational media technology in conjunction with PjBL-based e-modules makes learning more engaging and enjoyable for students. The e-modules' videos and visuals aid in students' comprehension of the subject matter, making learning engaging.

In the digital era, reading habits, resource availability, and material tastes are all rapidly changing, claim Gonca Cumaoglu, Esra Sacici, and Kerem Torun [22]. Changes in reading habits have affected the usage of related technology, archiving, and resource accessibility. Thus, e-books can be seen as useful in the classroom. Additionally, according to Indraswari and Shynta Putri [23], e-modules created from the development's outcomes are seen to be viable as substitute resources for early childhood education.

The flipbook e-module learning paradigm essentially invites students to study the content at home before class, according to Birgili, Seggie, and Oğuz [24]. Learning in the classroom is more student-centered, which gives students more chances to actively engage in the process. Consequently, this study's flipbook-based e-module is successful in raising kids' early reading and speaking abilities. Flipbook learning works well not only for one or two topics but for the entire school. This is quite beneficial for the modern educational paradigm.

According to Arsyad [25], including educational media in the teaching and learning process has several benefits. The first is that educational materials may help make information and messages more understandable, which will facilitate and improve learning results. The second is the ability of learning media to focus and focus students' attention, which helps them become more motivated to study, interact more directly with their surroundings, and raise their chances of learning even more.

4. Conclusions

The following conclusions may be made in light of the problem formulation, goals, findings, and discussion of the aforementioned study on the creation of PjBL-based e-modules: (4) The results of the hypothesis test demonstrate that the learning outcomes of students who received instruction via e-modules and those who received instruction via printed books differed considerably. (1) e-modules based on PjBL have met the requirements and are suitable for use as teaching resources; (2) e-modules based on

PjBL have met the standards and are beneficial for use as teaching resources; and (3) the built e-modules are thought to be more effective than printed books.

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