Integrating E-learning and Project-Based Learning to Enhance Higher Order Thinking Skills in Indonesian Polytechnic Students

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Abstract. This research explores the integration of E-learning and Project-Based Learning (PBL) to enhance Higher Order Thinking Skills (HOTS) among polytechnic students in Indonesia. Utilizing a mixed-methods approach, the Research and Development (R&D) methodology, and the 4D model, an educational intervention was developed and validated. The intervention, designed to support collaborative learning and resource sharing, proved effective in enhancing students' ability to navigate complex problems and think critically. The study reveals the potential of digital platforms combined with PBL in fostering critical and collaborative skills necessary for the Fourth Industrial Revolution. The intervention was well-received and effective, achieving a high practicality score of 81%, suggesting its potential for broader application. The research recommends further exploration of comprehensive strategies and technological implications in diverse educational contexts

Keywords: Project-Based Learning (PBL), Higher Order Thinking Skills (HOTS), Polytechnic Education.

1 Introduction

The Indonesian education system is undergoing significant reforms to better prepare students for the demands of the Fourth Industrial Revolution (4IR). The government has prioritized human capital development, focusing on enhancing the quality of local human resources through vocational and technical training centers aligned with industry needs [1]. This context provides a fertile ground for implementing innovative teaching methods such as Project-Based Learning (PBL) to foster Higher Order Thinking Skills (HOTS) among polytechnic students. HOTS are critical for students to navigate complex problems and think critically. Research indicates that strategies like Collaborative Strategic Reading (CSR) can enhance HOTS among students [2]. This is particularly relevant for vocational and technical education, where students must apply theoretical knowledge to practical scenarios.

PBL has gained traction in Indonesia as an effective educational approach. It allows students to engage in group projects, promoting independent learning and practical application of knowledge. Studies have shown that PBL can significantly improve classroom dynamics and is well-received by both students and teachers [3], [4], [5]. However, some challenges remain, which need to be addressed to optimize its implementation. The integration of e-learning and blended learning approaches has shown promise in improving learning outcomes. Utilizing mobile and desktop applications can cater to the diverse needs of students, making learning more accessible and engaging [6]. These technologies can support the implementation of PBL

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by providing platforms for collaboration and resource sharing. Despite the growing adoption of Project-Based Learning in Indonesian polytechnics, there is a lack of comprehensive research on the integration of E-learning with PBL particularly in reading skills, are still very limited. Project-Based Learning (PBL) is an innovative educational approach that emphasizes active student engagement through the creation of projects. This method not only evaluates student performance but also enhances cognitive development. PBL requires students to independently create projects, fostering a sense of autonomy and active participation in their learning journey. This approach is particularly effective in subjects like buffer chemistry, which involve abstract concepts that benefit from visual and practical learning aids.

Project-Based Learning (PBL) is an innovative educational approach that emphasizes active student engagement through the creation of projects. This method not only evaluates student performance but also enhances cognitive development. PBL requires students to independently create projects, fostering a sense of autonomy and active participation in their learning journey. This approach is particularly effective for complex subjects, as it involves practical applications that benefit from visual and interactive learning aids.

Project-Based Learning (PBL) possesses the potential to provide students with engaging and meaningful learning experiences. By engaging in practical projects, Multimedia Engineering students gain a deeper understanding of the subject matter and enhance their capacity for information retention. The hands-on nature of PBL encourages students to think creatively and collaboratively, which are essential skills in both academic and professional settings. Through PBL, Multimedia Engineering students learn to integrate various media elements, design interactive experiences, and work effectively in teams, all of which are crucial for their future careers in the fast-paced and ever-evolving field of multimedia technology[5].

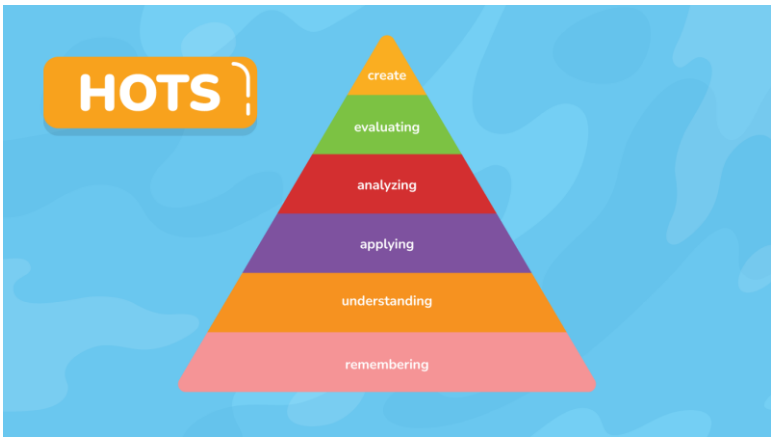

Fig. 1. HOTS also known as Bloom Taxonomy

Given the importance of HOTS in navigating complex problems and thinking critically, how eLearning and PBL is integrate and explore effective strategies for enhancing these skills in English language education are needed to be addresses. So, this paper investigates how integrating E-learning with Project-Based Learning can enhance Higher Order Thinking Skills among Indonesian Polytechnic students. This study employs a mixed-methods approach, combining quantitative assessments of HOTS with qualitative analyses of student experiences in E-learning and PBL environments. The study may highlight the potential technological

implications of integrating E-learning and PBL, emphasizing the role of digital platforms and applications in supporting collaborative learning and resource sharing in polytechnic education.

2 Methodology

This research necessitates a systematic approach to address the core challenges, which encompass the construction of the repository and the evaluation of user responses. Information systems, particularly those deployed in educational settings, often employ the waterfall methodology. However, for this study, the researcher chose the Research and Development (R&D) methodology to systematically create, test, and refine an educational intervention that integrates E-learning with Project-Based Learning (PBL). The R&D approach is particularly suited for this study because it allows for a structured process to develop innovative educational models, ensuring that the final product is both effective and practical for real-world application. By following the R&D methodology, the researcher can rigorously evaluate the impact of the intervention on students' Higher Order Thinking Skills (HOTS) and make data-driven improvements to optimize its effectiveness. The development model employed to create the e-learning platform is the 4D model[7], [8].

Moreover, the method can be articulated regarding organizational matters as follows:

1. Define Phase
   The Define phase is the initial step where the research problem is identified, and a comprehensive literature review is conducted to establish the theoretical framework and objectives of the study. This phase is crucial for understanding the current state of knowledge and identifying gaps that the research aims to address.
2. Design Phase
   In the Design phase, the researcher determines the sample size and develops detailed lesson plans and instructional materials tailored for the experimental group. This step ensures that the intervention is well-structured and aligned with the study's objectives[9].
3. Develop Phase
   The Develop phase involves the actual creation and refinement of the educational product. This phase includes expert evaluation and pilot testing to ensure the intervention's appropriateness and accuracy[10].
4. Disseminate Phase
   The Disseminate phase involves the implementation and evaluation of the developed e-learning intervention. This phase aims to assess the practicality and effectiveness of the intervention among the target audience.

By following these phases, the study ensures a rigorous and systematic approach to developing and validating an effective educational intervention. The cohort for this investigation comprised the entirety of the student body enrolled in the Teknologi Rekayasa Multimedia program at Politeknik Negeri Media Kreatif especially in fifth semester’s students. The validation process engaged three faculty members, focusing on both construct and content validation, facilitated through the deployment of a meticulously designed validation questionnaire. This instrument was specifically crafted to ascertain the e-learning content's validity pertaining to the buffer solution material that was developed.

Subsequent to the validation phase, the educational product underwent a series of revisions by the researcher, predicated on the feedback received, until it reached a threshold of validity.

Upon achieving this benchmark, the e-learning solution was subjected to a practicality trial among students of the Politeknik to gauge its applicability and effectiveness in an authentic educational setting.

This process aligns with the Research and Development (R&D) methodology delineated in the study "Integrating E-learning and Project-Based Learning to Enhance Higher Order Thinking Skills in Indonesian Polytechnic Students," ensuring a rigorous approach to the development and refinement of the educational intervention.

2.1 Validity

The validity process for this research is using Aiken's V:

$$V = \frac{(N\ x\ M) - S}{N\ x\ (k-1)} \quad (1)$$

Description:

N is the number of experts/judges.
M is the maximum scale value
S is the sum of the ratings given by all experts/judges for a particular item.
k is the number of scale points

Table 1. Score Based on Formula

Interval	Judges
0.00 - 0.20	Poor Agreement
0.21 - 0.40	Fair Agreement
0.41 - 0.60	Moderate Agreement
0.61 - 0.80	Good Agreement
0.81 - 1.00	Excellent Agreement

2.2 Practically

By employing the Likert scale, the study meticulously quantifies the degree to which the integration of e-learning with project-based learning is perceived as applicable to the real-world scenarios and challenges faced by the students. The resulting data, derived from this ordinal scale, provide a robust foundation for analyzing the extent to which the educational innovation aligns with the cognitive and practical demands of polytechnic education. The research uses the following formula:

$$P = \frac{f}{n}\ x\ 100\% \quad (2)$$

Description:

P is Pre-qualify final value
f is value acquired
n is max number

The evaluation of the research was conducted using a Likert scale, as illustrated in the following table:

Table 2. Likert Scale of Practicality

Interval	Category
$80\% < x \leq 100\%$	Very Effective
$60\% < x \leq 80\%$	Somewhat Effective
$40\% < x \leq 60\%$	Neutral
$20\% < x \leq 40\%$	Somewhat Ineffective
$0\% < x \leq 20\%$	Ineffective

3 Result and Discussion

Based on the research that has been done, result of 4D development model will be explain as follow.

3.1 Define Phase

From define phase, researcher run an identification of existing issue, and also conduct literature review of the previous research. Then function analysis were run. The result of the analysis can be shown as below:

Table 3. Hardware Requirement

No	Hardware Requirements	Software Requirements
1	CPU with Core i3 minimum	VPS with 1 CPU Core minimum
2	RAM 4GB minimum	Perl Package
3	Diskspace 40GB minimum	Ubuntu 10.4
4		Putty/SSH
5		LAMP Stack
6		Network 1Gbps

3.2 Design Phase

Design phase start with designing the solution for Project Based Learning in eLearning, and not forget to add HOTS for the project. The developed e-learning module comprises several components, including covers, user instructions, lesson plans, competency achievement indicators, evaluation sheets, and profiles of the developers. The development for eLearning also uses multimedia software, like Microsoft word, Power Point and Youtube. All developments can be seen as shown in **Fig. 2**. and **Fig. 3.**

Fig. 2. PBL Guidelines

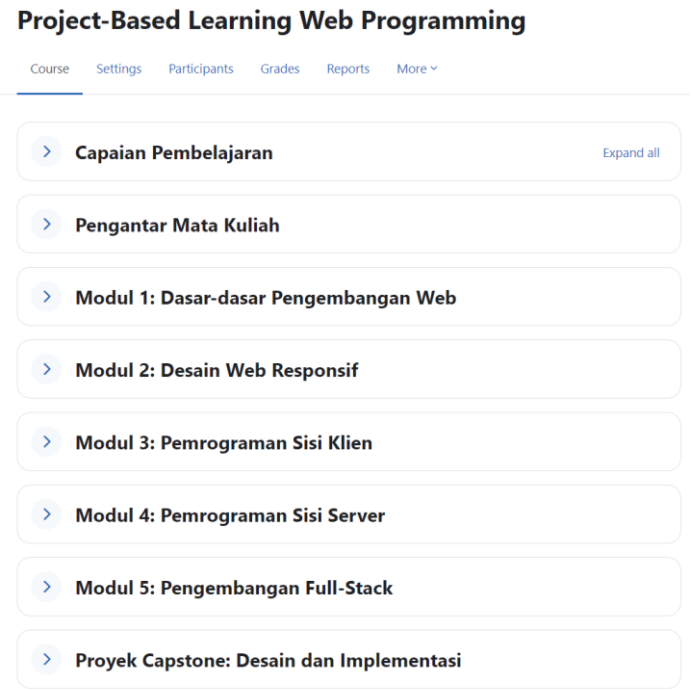

Fig. 3. Designing Course

3.3 Development Phase

Validity Test. Development Phase start with validity test first, so all the designing phase before need to validThe validity test was conducted by three validators who are faculty members at Politeknik Negeri Media Kreatif. Validity test were two parts, first part was content validation and the second part were constructing validation. The results of the validity test are presented in **Fig. 4.** and **Fig. 5**. below:

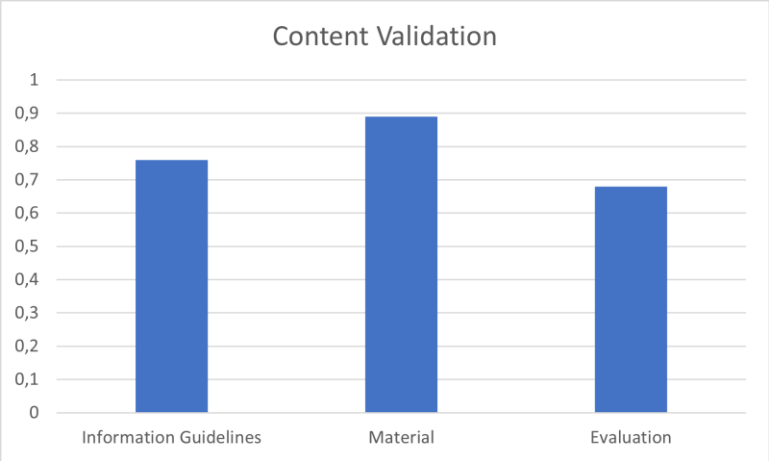

Fig. 4. Content Validation by Validator

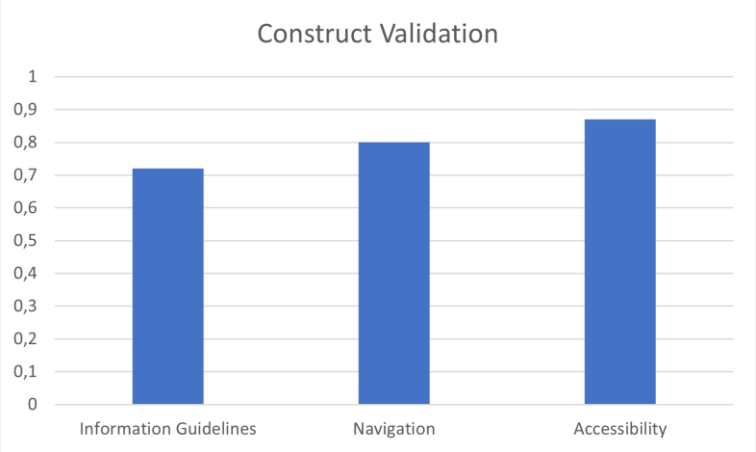

Fig. 5. Construct Validation by Validator

The Content Validation table, with scores ranging from 0.68 to 0.89, reveals the robustness of the e-learning material, with the content and guidelines showing substantial reliability, though the evaluation methods indicate a need for refinement to better gauge and enhance student learning. Meanwhile, the Construct Validation table, with values between 0.72 and 0.87, underscores the platform's user-centric design; it highlights a commendable level of accessibility, ensuring that learners from various backgrounds can engage with the material without hindrance, and a navigation system that facilitates ease of use, although the information guidelines suggest a slight margin for improvement to optimize user guidance. Together, these tables provide a quantitative lens through which the platform's content quality and structural design can be scrutinized and perfected. The validated e-learning content will be revised in accordance with the suggestions and comments provided by the validators.

Revision. Revision that the researches did were in information guidelines, minor revision in navigation and adding more subject material. After that then the researches sent it back to validator. This stage will stop after validator declared valid for the eLearning.

Practically Test. Practically test involved by the all students in Teknologi Rekayasa Multimedia that using questinaire. Based on the test, its reveal that practically test value was 81% which in very Practical category. Whit this value, student judge the eLearning give them advantaged to push their skill in project-based learning especially high order thinking skill project.

4 Conclusion

The study investigates the integration of E-learning and Project-Based Learning (PBL) to enhance Higher Order Thinking Skills (HOTS) among Indonesian Polytechnic students. Utilizing the Research and Development (R&D) approach, the study systematically developed and validated an educational intervention with the 4D model. The analysis indicates that both content and construct validations show substantial reliability and user-centric design, although some areas require refinement. Practically, the intervention achieved a high practicality score of 81%, suggesting it is well-received and effective in enhancing students' skills. The research underscores the potential of integrating digital platforms with PBL to foster critical and collaborative skills necessary for the Fourth Industrial Revolution, recommending further exploration of comprehensive strategies and technological implications in diverse educational contexts.

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