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Nama Jurnal : *Journal of Learning for Development*

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Judul Artikel yang direview: *Development of Ubiquitous Project-Based Learning (U-PjBL) Model to Improve Critical Thinking Skills of Elementary School Students*

Bulan, Tahun Artikel yang direview : Mei 2024 (1st *Round*)

[JL4D] Journal of Learning for Development - Review Request
2 messages

Dr Tony John Mays via eJournal of Learning for Development <noreply@jl4d.org>
Reply-To: Dr Tony John Mays <tmays@col.org>
To: Sri Wahyuni <wahyunis@edu.uir.ac.id>

Sat, May 4, 2024 at 12:21 AM

Dear Sri Wahyuni:

I believe that you would serve as an excellent reviewer of the manuscript, "Development of Ubiquitous Project-Based Learning (U-PjBL) Model to Improve Critical Thinking Skills of Elementary School Students," which has been submitted to Journal of Learning for Development . The submission's abstract is inserted below, and I hope that you will be able to undertake this important task for us.

Review guidelines are available here: Review guidelines JL4D v2.pdf

Also, if you have not done so recently, please update your reviewer profile to let us know if your research interests or affiliation have changed.

The review is due 2024-05-31 but we would appreciate it if you could confirm your ability to complete it by this deadline no later than 2024-05-24 to avoid any delays in the review process.

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If you are having any problems accessing the journal web site, please do not hesitate to contact us for assistance.

Thank you for considering this request and a reminder to confirm your ability to complete the review.

Please note that JL4D does not issue Certificates for Reviews. However, we acknowledge all reviewers for the previous year in the Editorial of the March issue.

Dr Tony John Mays
Commonwealth of Learning
Phone 1-604-775-8235
tmays@col.org

"Development of Ubiquitous Project-Based Learning (U-PjBL) Model to Improve Critical Thinking Skills of Elementary School Students"

Abstract

The integration of technology with a learning model that considers the characteristics of students is exemplified in Ubiquitous Project-based Learning (U-PjBL). The model is designed to facilitate independent learning, empowering students to learn without any restriction. Therefore, this study aimed to 1) develop U-PjBL model to improve critical thinking skills of Elementary School students, 2) determine the validity of the developed model, and 3) determine the effectiveness. Research and Development (R&D) approach was adopted with ADDIE (Analysis, Design, Development, Implementation, and Evaluation). model. The result showed that U-PjBL model was a project-based learning model supported by technology. U-PjBL consisted of five learning phases, namely starting with essential questions, exploration of project planning, and schedule, Exploration of Alternative Solutions, Project Execution, and Communication. U-PjBL model was suitable for use in learning. Furthermore, the implementation results in learning also showed that U-PjBL model could improve critical thinking skills of students compared to non U-PjBL.

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Sri Wahyuni <wahyunis@edu.uir.ac.id>
To: reviews@webofscience.com

Mon, May 6, 2024 at 3:53 PM

Sri Wahyuni
Universitas Islam Riau, Pekanbaru, Indonesia
[Quoted text hidden]

Review:Development of Ubiquitous Project-Based Learning (U-PjBL) Model to Improve Critical Thinking Skills of Elementary School Students

| 1. Request | 2. Guidelines | 3. Download & Review | 4. Completion |

Request for Review

You have been selected as a potential reviewer of the following submission. Below is an overview of the submission, as well as the timeline for this review. We hope that you are able to participate.

Article Title

Development of Ubiquitous Project-Based Learning (U-PjBL) Model to Improve Critical Thinking Skills of Elementary School Students

Abstract

The integration of technology with a learning model that considers the characteristics of students is exemplified in Ubiquitous Project-based Learning (U-PjBL). The model is designed to facilitate independent learning, empowering students to learn without any restriction. Therefore, this study aimed to 1) develop U-PjBL model to improve critical thinking skills of Elementary School students, 2) determine the validity of the developed model, and 3) determine the effectiveness. Research and Development (R&D) approach was adopted with ADDIE (Analysis, Design, Development, Implementation, and Evaluation). model. The result showed that U-PjBL model was a project-based learning model supported by technology. U-PjBL consisted of five learning phases, namely starting with essential questions, exploration of project planning, and schedule, Exploration of Alternative Solutions, Project Execution, and Communication. U-PjBL model was suitable for use in learning. Furthermore, the implementation results in learning also showed that U-PjBL model could improve critical thinking skills of students compared to non U-PjBL.

Review Type

Anonymous Reviewer/Anonymous Author

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Review Schedule

| 2024-05-03 | 2024-05-24 | 2024-05-31 |
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Review:Development of Ubiquitous Project-Based Learning (U-PjBL) Model to Improve Critical Thinking Skills of Elementary School Students

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Manuscript Review Radio

Manuscript Title: *

Development of Ubiquitous Project-Based Learning (U-Pjbl) Model to Improve Critical Thinking Skills of Elementary School Students in Indon

Manuscript #:

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The article is related to the field of learning for development.

◉ Yes
○ Somewhat
○ No

The article is complete, clear and well-organized.

○ Yes
◉ No
○ Somewhat

The significance of the problem is clearly articulated.

○ Yes
◉ No
○ Somewhat

The applicability and interest to the field (relevance beyond case presented) is clearly articulated.

○ Yes
◉ No
○ Somewhat

The article makes an original contribution to the field of learning for development, broadly defined.

○ Yes
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○ Somewhat

The problem is clearly described within a theoretical framework (where appropriate).

○ Yes
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The literature review demonstrates a clear relationship between the problem and learning for development and other relevant literature.

○ Yes
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The research design and methodology are appropriate for the study.

○ Yes
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The discussion of the results is accurate and useful.

○ Yes
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○ Somewhat

The article uses sound argument and analysis.

○ Yes
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The conclusion describes implications for practitioners in learning for development practice.

○ Yes
● No
○ Somewhat

The article uses an acceptable standard of English.

○ Yes
○ No
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Based on my assessment of the above criteria, my recommendation for this manuscript is:

○ Accept
● Accept with revisions
○ Reject

Comments to Author

ABSTRACT:
1. The abstract should begin with a general overview to demonstrate the urgency of this study and followed by the research objective.
2. It's better to write in alphabetical order and mention the varied relevant keywords.

INTRODUCTION:

ABSTRACT:
1. The abstract should begin with a general overview to demonstrate the urgency of this study and followed by the research objective.
2. It's better to write in alphabetical order and mention the varied relevant keywords.

INTRODUCTION:
3. You should show "the connecting dots" between project-based learning and the primary education stage, supported by relevant theories or studies.
4. It is better to support or cite the previous relevant studies for every statement mentioned in this part.

LITERATURE REVIEW:
5. In this part, it is better to put the rubric of state of the art of syntax from several project-based learning contexts.

DISCUSSION:
6. This part should be elaborated based on the findings.

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Participants   Edit

Prof Santosh Panda (santosh_panda)

Sri Wahyuni (sriwahyunialfian)

Messages

Note	From
Dear Editor, I hereby attach the notes for the previous article that I reviewed. ABSTRACT: 1. The abstract should begin with a general overview to demonstrate the urgency of this study and followed by the research objective. 2. It's better to write in alphabetical order and mention the varied relevant keywords. INTRODUCTION: 3. You should show "the connecting dots" between project-based learning and the primary education stage, supported by relevant theories or studies. 4. It is better to support or cite the previous relevant studies for every statement mentioned in this part. LITERATURE REVIEW: 5. In this part, it is better to put the rubric of state of the art of syntax from several project-based learning contexts. DISCUSSION: 6. This part should be elaborated based on the findings. Thank you for giving me a chance to contribute to your journal. best regards, Sri Wahyuni	sriwahyunialfian 2024-05-06 01:46 AM

Add Message

Review: Dev...   g Skills of
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1. **Request**

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○ Yes
◉ No
○ Somewhat

Development of Ubiquitous Project-Based Learning (U-Pjbl) Model to Improve Critical Thinking Skills of Elementary School Students in Indonesia

Abstract: This study aimed to develop a Ubiquitous Project-based Learning (U-PjBL) model to enhance the critical thinking skills of elementary school students. The Borg and Gall Study method and Development model were adopted and validation testing was conducted to validate U-PjBL. The validation instrument referred to the characteristics of the learning model, including supporting theory aspects, syntax, reaction principles, social and support systems, as well as instructional and accompanying impact. Furthermore, the reliability of the U-PjBL model validation instrument was based on interobserver agreement obtained from the statistical analysis percentage. A t-test was used to examine and scrutinize the trial results generated by the model. Based on expert validation, U-PjBL was consistent with the characteristics of the learning model. Therefore, the developed U-PjBL model falls into the highly valid category. This means that the model can be used in learning activities. The trial results also showed that the developed U-PjBL model can improve the critical thinking skills of students.

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Introduction

Education is the fundamental foundation in shaping the future of individuals and development of society. In the primary education stage, development of innovative learning approaches becomes more urgent to ensure the holistic growth of students (Serdyukov, 2017). One of the approaches that has been increasingly emphasized in recent years is "Project-Based Learning" (PjBL) (Le Thi Kim Thu, 2018). This approach provides students with unique opportunities to develop conceptual understanding, problem-solving skills, and collaborative skills through hands-on experiences in practical-oriented projects (Jaenudin et al., 2020).

The implementation of PjBL in Elementary School presents challenges even though it has proven effective at various educational levels. Students at this level, having grown accustomed to interacting with technological devices, exhibit traits, such as self-directed learning, independence, and a strong inclination to select what and how to learn (Iftode, 2020;Ahadin et al., 2023). While regarded as digital natives, these students frequently lack the skills required for proficiently planning and developing knowledge. Teachers also need to strengthen critical thinking skills and modify teaching approaches to maximize student engagement, thereby requiring a learning model that can support the characteristics of students. This situation necessitates the use of PjBL model designed to accommodate development characteristics of elementary school students.

An important aspect of designing PjBL model is the integration with technology (Chayomchai, 2020). According to a previous study, the rapid development of information and communication technology has transformed the educational landscape (Alam, 2020). Therefore, it is crucial to incorporate the concept of "ubiquitous learning" or even learning in the design. By leveraging

technology and online resources, students can learn without any restrictions from the physical limitations of the classroom space (Martin et al., 2013).

PjBL model aims to create a learning environment that accommodates the diverse learning styles of Elementary School students and integrates user-friendly technology to support learning. This background led to development of Ubiquitous Project-Based Learning (U-PjBL) model suitable for the characteristics of Elementary School students. The model considers development characteristics, provides appropriate support, and uses technology to improve learning efficiency. Therefore, this study described the process of developing U-PjBL model to help improve critical thinking of Elementary School students.

Literature Review

Ubiquitous Learning

Ubiquitous Learning (U-Learning) is an approach that integrates information and communication technology (ICT), creating an accessible learning environment without any restriction. U-Learning is also a paradigm in a ubiquitous computing environment, enabling learning with the appropriate content at the designated place and time in the right way (Pizarro, 2021). It allows students to study, requiring the skill to access various learning resources on multiple devices. These learning resources should be capable of presenting learning situations and facilitating the progress of students on various devices (Suartama et al., 2021; Wang et al., 2017).

The main characteristics of U-Learning are permanency, accessibility, immediacy, interactivity, and situating of instructional activities (Ogata & Yano, 2004). (1) Permanency: Students will not lose the work unless intentionally deleted and the learning process is continuously recorded every day. (2) Accessibility: The learning process is self-directed, allowing students to access all the data, videos, and documents. All information is provided according to the request of students. (3) Immediacy: Students

can obtain information speedily in any location, allowing for prompt solutions to problems. (4) Interactivity: Students interact synchronously or asynchronously with teachers or peers. (5) Situating of instructional activities: Problems presented in learning are real-life issues occurring in the community. Therefore, learning can seamlessly become a part of students' lives, presenting problems and the necessary knowledge naturally and authentically.

U-Learning environment improves context-awareness and seamless learning experiences. It has four criteria, namely context awareness, interactivity, personalization, and flexibility (Virtanen et al., 2018). Context awareness is the skill of a system, device, or application to identify, understand, and respond to the situation or context of the surrounding environment. The context-aware learning environment can be built using Learning Management Systems with various approaches and functions. In information technology, it refers to the active recognition of the system or application and understanding of the context or environmental situation. Interactivity is the level of user engagement to interact, communicate, and participate in a system, application, or environment. It includes all forms of user engagement in various activities, from simple to highly complex. Interactivity includes two-way responses between the user and the system or environment, creating a more engaging experience than merely being a passive observer. Personalization is a strategy that customizes experiences or content according to individual preferences, characteristics, or needs. The objective is to provide a more relevant, efficient, and satisfying experience for the user. Meanwhile, flexibility is the adapting skill of individuals to situations according to the needs. In this context, students have the opportunity to learn, based on the schedules, learning goals, or educational needs.

Project-Based Learning (PjBL)

PjBL is an inquiry-based collaborative teaching approach where students integrate, apply, and build knowledge during joint work to create solutions to complex problems (Guo et al., 2020; Yunus et al., 2022). This approach has six advantages, including driving questions, focusing on learning objectives, participating in educational activities, collaborating among students, using technology scaffolding, and creating tangible artifacts (Krajcik & Shin, 2014). The most important of these indicators is the creation of artifacts that solve authentic problems, thereby distinguishing PjBL from other student-centered learning models.

The main benefits of PjBL include the opportunities for students to engage deeply in the scientific world(Larkin, 2016). These include asking fundamental questions and participating in scientific study, allowing the building and application of knowledge to discover solutions. Scientific practices have been proven to contribute to student engagement during learning (Lavonen et al., 2017). At the same time, PjBL allows students to see and appreciate the relationship between scientific practices and the real world, the importance of learning, conducting investigations, and the openness of the issues investigated (Hasni et al., 2016).

PjBL incorporates four key ideas to optimize learning effectiveness, where students actively build the understanding and work collaboratively in an authentic learning environment equipped with cognitive tools(Terrón-López et al., 2015; Krajcik & Shin, 2014). Compared to traditional teaching, the approach has produced better academic achievements (Chen & Yang, 2019). According to the result of a previous study, it is shown to improve critical thinking skills (Sasson et al., 2018). PjBL also contributes to developing the intrapersonal and interpersonal competencies of students (Kaldi et al., 2011).

Some of the approaches to implementing a project include structured, top-down, and bottom-up (Kozinski, 2018). The structured approach is reliable for implementing a project and it includes

division into several modules, each containing tasks to be performed. Each step of the project activities is described clearly, thereby students can carry out the project effectively and achieve the planned goals. The steps of PjBL are 1) Identification of a project, 2) Defining a plan, 3) Fixing a time frame and processing, 4) Providing guidance and monitoring a project, and 5) Outcome of a project [20]. Below is Figure 1 showing the steps of PjBL.
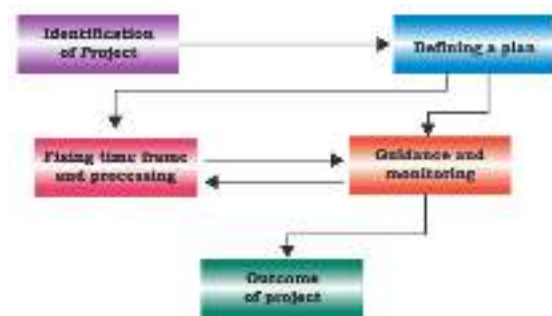

Figure 1. Steps of Project-Based Learning Model (Kozinski, 2018)

The first step is the identification of a project, where students are motivated to explore various sources in a real-life environment. The second step is defining a plan, allowing students to form groups, with one person as the leader and others as members. All members are promoted to participate in the project activities. Through discussion, the group leader and members determine the respective roles, and decisions are also made on the strategy and tools needed for the project. The third step is fixing the time frame and processing, where students establish a structured schedule for project implementation. In this situation, students need to understand the importance of a schedule for project completion. The fourth step is providing guidance and monitoring a project, where the group leader and teachers monitor the project implementation process and guide the investigation of various sources. The fifth

step is the outcome of a project, where students identify the impact of the product, and the results can be revised based on peer or user feedback.

Critical Thinking

Critical thinking skills are required of every student to solve problems in life. It is the skill to think rationally when solving problems or making decisions (Poce et al., 2019). Critical thinking is synonymous with high-level thinking because it recognizes that not all information read can be accepted as verified knowledge. Therefore, it necessitates thorough reevaluation before being considered as truth (Nugraha et al., 2017).

Critical thinking is the skill of thinking evaluatively in analyzing the gap between reality and truth, designing problem-solving steps, and daily life implementation according to applicable norms (Rachmadtullah, 2015; Apriandi et al., 2023). It can be developed through problem-oriented learning that challenges students to apply skills, such as analyzing, arguing, classifying, proving, and drawing conclusions. In addition, critical thinking skills include the process of identifying and analyzing information sources, showing prior knowledge, making connections, and drawing conclusions. Some of the characteristics include 1) reasoning and guessing, 2) viewing situations from various perspectives and dimensions, 3) being open to change and innovation, 4) seeing thoughts without prejudice, 5) having an open mind, 6) analytical thinking, and 7) paying attention to details (Rochmad et al., 2018).

Methods

Development of U-PjBL model refers to the design of the Borg and Gall study and development model. It broadly consists of three steps, namely the preliminary study, product development, and testing. In development study of U-PjBL, the Borg and Gall development step is modified according to the

objectives, needs, and field conditions. The process is carried out in two steps, namely 1) preliminary study, including field surveys and literature reviews, and 2) product development, such as model preparation and validation.

The preliminary study aims to analyze and describe the problems in the field and conduct a needs analysis to support development of U-PjBL model. It also focuses on a literature review through various study results and then undergoes analysis to serve as a reference in model development. Furthermore, the model development is continued, which takes the form of a model design (prototype). The prototype is U-PjBL model to support learning implementation in Elementary School.

Participants

The r subjects were all participants involved in each stage of the design model. In the introductory stage, it involved 6 learning design experts. Research subjects at the model trial stage involved 1 teacher and 30 elementary school students.

Data Collection and Analysis

The developed model product is subjected to validation testing to validate the learning model. The validation instrument for the model refers to the characteristics of the learning model, including aspects of supporting theory, syntax, social system, reaction principles, and support system, as well as instructional and accompanying impact (Joyce & Weil, 2023). This study focused on testing the validity of U-PjBL learning model and the effectiveness. The validity measured includes the intervention components based on needs and state-of-the-art knowledge. The framework structure reflects the construction of developed product components supported by a particular theory. The effectiveness of the model is measured based on the achievement of critical thinking skills of students.

The validation instrument for U-PjBL model consists of a validity sheet and effectiveness model using critical thinking skill test developed by Saenab, S (Saenab et al., 2021). Six learning experts were included as validators and validation was carried out on U-PjBL model. Subsequently, scores were calculated using the average formula and compared with the validation assessment criteria. The criteria used in validation are shown in Table 1.

Table 1. Criteria for Learning Model Validation Assessment

	Assessment Category	Description
$3,25 < P < 4,00$	Very Valid	Can be used without revision
$2,50 < P < 3,25$	Valid	Can be used with minor revisions
$1,75 < P < 2,50$	Less Valid	Can be used with quite a few revisions
$1,00 < P < 1,75$	Not Valid	Can be used with many revisions

The reliability calculation of U-PjBL model validation sheet instrument is based on interobserver agreement from the statistical analysis of the percentage of agreement (R). It is considered reliable when the percentage is $\geq 75\%$ (Borich George, 1994).

Results and Discussion

Preliminary Study

Based on the survey, it is evident that the learning process in elementary schools has not reached a high-level thinking level. This is due to the low understanding of teachers in conducting learning

activities that can develop the high-level thinking skills of students. The learning process carried out is not consistent with development characteristics of students and has failed to keep pace with technological advancements. Based on observations and interviews with teachers and the school principal, it was found that learning facilities to support online learning are available in the school. However, there is a constraint due to the inability of teachers to use these facilities. This situation necessitates development of a learning model that can enhance high-level thinking skills, specifically critical thinking, and is consistent with technological developments.

Ubiquitous Project-Based Learning (U-PjBL) Model

U-PBL model combined two main learning approaches, namely "Ubiquitous" and "Project-Based" Learning. This model aimed to develop an equitable environment, allowing students to access and participate in real-world context learning projects with time and place flexibility.

U-PBL is a project-based learning model designed to be implemented in various settings, using a variety of data, and accessible on any device. This learning model is designed to accommodate the individual characteristics of students, allowing for lifelong learning. This methodology extends beyond the acquisition of hard skills and technology-based knowledge, but also about developing soft skills. With U-PBL, students are expected to have collaborative skills, critical thinking, creativity, and proficiency in communication.

The key elements of the U-PBL model are as follows:

1. Equal Learning

   This includes the concept that learning is not bound by time, place, or specific media. Students can access learning materials, interact with instructors and peers, and participate in projects from different devices and locations.

2. Real-World Context-Based Projects

    Projects used in U-PBL are designed to reflect real-world situations or relevant problems. These projects provide real and practical contexts for students to apply knowledge.

3. Time and Place Flexibility

    Students have the flexibility to organize learning time according to individual needs. Materials can be accessed and students can lalso participate in projects either asynchronously (not simultaneously) or synchronously (simultaneously) and from different locations.

4. Collaborative Engagement

    U-PBL encourages cooperation and collaboration among students, thereby enabling team work, sharing ideas, and supporting each other in solving complex problems.

5. Comprehensive Skill Development

    Students develop various problem-solving, critical thinking, communication, and collaboration skills. Students also time management, self-direct learning, and designing of projects.

6. Utilization of Technology and Online Resources

    Technology is crucial in U-PBL, allowing students to access information, communicate online, develop digital products, and engage in technology-supported projects.

U-PBL leads to deep, flexible, real-world-relevant learning experiences, thereby enabling students to develop essential skills for future success. This method uses technology to provide greater accessibility and flexibility in learning while maintaining the essence of the Project-Based Learning (PjBL), which is problem-solving and knowledge construction based on projects.
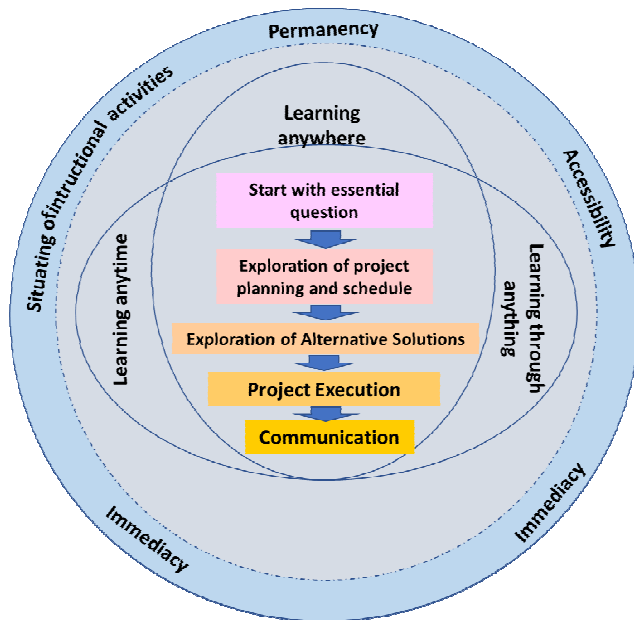
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Figure 2. U-PjBL Model Design

Figure 2 shows that U-PjBL model consists of three aspects, namely the phase of project implementation and U-Learning environment. The project activities consist of 5 phases, namely starting with essential questions, exploration of project planning, and schedule, exploration of alternative solutions, project execution, and communication. Learning activities for the project can be carried out in the environment around students, in an unlimited time, and in conditions that suit the needs of students. This model is expected to improve critical thinking, creativity, communication, and collaboration skills. The syntax and learning activities of U-PjBL model are shown in Table 2.

Table 2. Teacher and Student Activities in U-PjBL Model

Syntax	Teacher Activities	Student Activities
Phase 1 Start with a essential question	1. Teachers initiate the learning process by presenting essential questions. 2. Teachers provide guidance to access available references online and offline.	1. Students answer the questions posed by teachers. 2. Students review available references, both online and offline.
Phase 2 Exploration of project planning and scheduling	1. Teachers guide students in conducting literature reviews. 2. Teachers teach students in project planning. 3. Teachers monitor student discussion process in creating project plans. 4. Teachers guide students in creating a timeline for project completion. 5. Teachers guide students in setting project completion deadlines.	1. Students conduct interviews and literature reviews to create project plans. 2. Students discuss and collaborate in planning project activities. 3. Students collaborate to create a timeline for project completion. 4. Students collaborate to set a project completion deadline
Phase 3 Exploration of Alternative Solutions	1. Teachers guide students in conducting interviews and literature reviews. 2. Teachers guide students in determining the chosen solution.	1. Students conduct interviews and literature reviews to find solutions. 2. Based on literature reviews, students determine the chosen solution.

Phase 4	1. Teachers monitor the project implementation process online/offline.	1. Students work on the project.
		2. Students prepare project presentations.
Project Execution	2. Teachers evaluate the project implementation process.	
Phase 5	1. Teachers monitor the presentation process.	1. Students present the project results.
Communication	2. Teachers and students engage in reflection.	2. Students from different groups provide feedback on the project.
		3. Students engage in reflection.

Validation Results

Based on the expert validation data, U-PjBL model obtained through the validity assessment instrument shows that the validation scores fall into the "highly valid" category. Table 3 shows content validity assessment result of U-PjBL model.

Table 3. Content Validity Assessment Results of U-PjBL Model

U-PjBL Model Components	Validity and reliability of U-PjBL model			
	Mean	Validity	α	Reliability
Supporting Theory	3.67	Very Valid	.777	Reliable
Syntax	3.83	Very Valid	.718	Reliable
Social System	3.83	Very Valid	.718	Reliable
Reaction Principles	3.83	Very Valid	.718	Reliable
Support System	3.50	Very Valid	.792	Reliable
Instructional Impact and Ancillary Impact	4.00	Very Valid	.833	Reliable

The validity scores of U-PjBL model reviewed from the supporting theory showed an average of 3.67. Similarly, the syntax, social system, reaction principles, support system, as well as instructional and ancillary impact, had average values of 3.83, 3.83, 3.83, 3.50, and 4, respectively. All aspects of the validity assessment of U-PjBL model meet the valid criteria. A reliability analysis was conducted, showing that the coefficient scores for each component of the model validation, based on the assessment results of six experts, all fell into the reliable category. This shows that U-PjBL model developed based on the high percentage of agreement components can be used to improve critical thinking skills of students.

Effectiveness of U-PjBL Model

U-PjBL model was implemented in Elementary Schools using an experimental design with two classes, namely experimental and control. The experimental class used U-PjBL model, while the control class used a different model. Table 3 shows the learning outcomes using U-PjBL and non U-PjBL models.

Table 4. Group Statistics

Group Statistics

	Learning Model	N	Mean	Std. Deviation	Std. Error Mean
Critical_thinking	U-PjBL	30	84.8000	7.42503	1.35562
	Non U-PjBL	30	79.8000	7.42503	1.35562

The table above shows that the average score for the class taught using U-PjBL model is 84.8, and 79.8 for non U-PjBL. This shows that critical thinking skills of students taught using U-PjBL model are higher than non-PjBL.

Table 5. Independent Samples Test

The results of the difference test between U-PjBL and non U-PjBL model had a sig value (2-tailed) < 0.05, showing a significant difference in critical thinking skills. Therefore, it can be concluded that U-PjBL model can improve critical thinking skills of students.

Discussion

U-PjBL is a learning model that integrates the project learning process in offline and online learning environments. According to a previous study, learning that integrates offline and online learning environments can improve the understanding and critical thinking skills of students (Haleem et al., 2022). In a case where students encounter real-world situations that require detailed information, online information can be used to supplement the knowledge.

U-PjBL model consists of five phases, namely starting with essential questions, exploration of project planning, and schedule, exploration of alternative solutions, project execution, and communication.. Each learning phase is always supported by both offline and online learning environments. At each phase, students consistently need additional information from online sources, enhancing access to more comprehensive and precise data.

U-PjBL model is supported by the Socio-constructivist, computer-supported collaborative learning (CSCL), and information processing theories. Socio-constructivist learning theory includes

Commented [A5]: This part should be elaborated based on the findings.

interaction among students, as well as between students and teachers with the support of technology (Kadek Suartama et al., 2020). CSCL theory focuses on knowledge construction through collaboration in a social environment by creating a virtual learning community with peers and teachers (Ng & Nicholas, 2007). Similarly, Information Processing theory includes the process of receiving, processing, storing, and retrieving information, and it requires attention, memory, and reasoning. Based on this theory, learning is a process where students process, acquire, and store knowledge in the short-term and long-term memory.

Based on the implementation results, it is evident that critical thinking skills are higher in U-PjBL model compared to non U-PjBL. U-PjBL model trains the investigative skills of students with technology support (Urooj & Shahid Farooq, 2023). It also allows students to determine their solutions to problems, considering certain considerations. This flexibility allows for the exploration of interests in solving problems and creating motivation in the learning process.

Conclusion

In conclusion, U-PjBL model was a project-based learning model supported by technology. Accordingly, it consisted of five learning phases, namely starting with essential questions, exploration of project planning, and schedule. The validation results of the five aspects of the model, namely supporting theory, syntax, social system, reaction principle, support system, learning impact, and accompanying impact, fell into the "very valid" category. The implementation results in learning also showed that U-PjBL model could improve critical thinking skills of students compared to non U-PjBL. Therefore, U-PjBL model could be widely used to improve critical thinking skills of Elementary School students.

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