

## Implementing Project Based Learning in Mathematics Learning Media Course

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### Abstract

In order to describe the implementation of PjBL in the Mathematics Learning Media course as a learning assessment material, a classroom action research (PTK) was conducted. The research subjects were 3rd semester students of Mathematics Education at Alkhairaat University Palu in the academic year 2023/2024. Data were collected through observation, interviews, questionnaires, and documentation, which were then analysed using the Miles & Huberman model. In addition, data triangulation was also carried out to obtain valid and credible data. The results of this study resulted in 7 (seven) evaluation materials, namely the effectiveness of PjBL, challenges of PjBL implementation, students' reactions, students' skills, students' creativity, use of learning media and recommendations for improvement. With these findings, it is hoped that it can be our concern so that we can correct deficiencies and improve the learning process.

**Keywords:** Project Based Learning, Learning Media, Maths.

### Introduction

Mathematics education is one of the critical aspects in building students' intellectual capacity. In the current era of technological and information development, innovative and relevant learning methods are very important to improve students' mathematical skills (Anita, 2017; Zativalen et al., 2022). One promising approach is the use of PjBL in mathematics media courses (Assidik, 2018; Hajerina et al., 2022; Hasjiandito et al., 2014; Ningsih et al., 2022).

Mathematics skills, PjBL and learning media are closely related in the learning process. Mathematical skills are the basis for students to be able to analyse data, create models and solve problems related to the development of learning media. PjBL, as a learning method that emphasises real projects, provides opportunities for students to apply their mathematical skills in relevant contexts. Meanwhile, learning media serve as a tool that can visualise abstract mathematical concepts so that students can understand them more easily.

Project-based learning (PjBL) emphasises an active learning experience where students not only understand mathematical concepts theoretically, but also apply them in real situations through concrete projects (Ginanjari et al., 2021; Mardiyanti et al., 2023;

Zativalen et al., 2022). The implementation of this method in the Mathematics Learning Media course is expected to provide a more in-depth and contextualised learning experience, improve problem-solving skills and increase students' interest in learning (Anita, 2017; Ginanjar et al., 2021; Hajerina et al., 2022; Wulandari, 2016).

There have been many previous studies linking Classroom Action Research (CAI) with PjBL, but these studies link the factors that influence the use of PjBL (Ginanjar et al., 2021), such as learning activities (Mardiyanti et al., 2023; Wariani & Hayon, 2023), creative thinking skills and creativity (Anita, 2017; Rati et al., 2017; Zativalen et al., 2022), learning independence (Anjarsari et al., 2021), Skills (Wulandari, 2016), and interest in learning (Hajerina et al., 2022; Sunita et al., 2019), besides involving online learning (Abidin et al., 2020; Anjarsari et al., 2021), and looking at it in terms of products and learning outcomes (Wariani & Hayon, 2023). While this research looks at the evaluation results of PjBL as conducted by Rahma et al. (2023). It's just that the research was carried out at the junior high school level with various school residents, while this research was carried out at the tertiary level with the research subject of Mathematics Education students in the Mathematics Learning Media course.

Evaluation studies are used to identify effectiveness and challenges that may arise during implementation (Rahma et al., 2023). This evaluation will provide insight into the extent to which project-based learning can improve students' mathematical understanding, the extent to which the learning media used support the learning objectives, and how students respond to this learning method (Adinugraha, 2018; Ningsih et al., 2022). In addition, when evaluating the implementation of PjBL, a number of issues are likely to arise, such as limited resources, facility skills, time constraints, uneven learning outcomes and difficulties in assessment.

By exploring this understanding, we can gain a deeper insight into the potential of project-based learning to improve the quality of mathematics education (Rahma et al., 2023). The results of this evaluative study can make a valuable contribution to the development of learning approaches in mathematics learning media courses and can pave the way for further improvements in innovative and relevant teaching strategies. In addition, evaluation of the implementation of PPA in learning media courses is important to ensure that the learning model used is truly effective in improving student competence, both in theory and in practice. This evaluation can also help to identify necessary improvements, such as in assessment methods, classroom management strategies or the provision of more

supportive resources. The results of the study are expected to provide guidance to lecturers on how to improve the quality of teaching and strengthen the link between theory and practice.

Based on the above description, this research aims to implement project-based learning in mathematics learning media courses as a learning assessment material.

## **Method**

To explain the implementation of project-based learning in the mathematics media course as a learning evaluation material, the researchers used classroom action research (CAR). PTK is used to improve teaching quality, learner participation, increase the use of technology, teacher and learner performance, teacher and learner satisfaction, identify problems in the learning process, improve the learning environment and achieve sustainable learning (Mardiyanti et al., 2023). This research was conducted on mathematics education students in the 3rd semester, academic year 2023/2024, a total of 20 students. The research was conducted from 15 November 2023 to 19 January 2024.

The procedure in this research is carried out in four stages, namely 1) planning, 2) implementation, 3) observation and 4) reflection (Anjarsari et al., 2021; Noge, 2018; Rizqoh, 2022). The research was carried out in 2 cycles, where in the first cycle students were given a project to make a game which was then presented in class. During the second cycle, students were given a project to make a video of the game they had previously made, to be uploaded to the Youtube channel, showing how the game was made and its implementation in learning. In the planning stage, the researcher made a schedule for the implementation of project-based learning activities and prepared materials to be used in learning. In the implementation stage, the researcher divided the students into 4 groups and then gave each group a project to make a mathematics game (self-made) with the theme chosen by each group that is suitable for the game made.

Data collection in this study was done through observation, interviews, questionnaires and documentation. The instrument used in the observation process is an observation sheet prepared based on the steps in PjBL, which is then validated by the lecturer of the Learning Theory and Innovation course. While the questionnaire instrument used is a student response questionnaire sheet consisting of aspects of the practicality and effectiveness of the application of PjBL in following the mathematics learning media course.

Observation was used to see how students presented the products (maths games) they had produced. Interviews were conducted to find out students' responses related to the project of making learning media (maths games). As respondents for the interview activities, 4 students were selected with the following considerations: 1) each respondent represents each study group according to the group formed before, 2) respondents are active in learning activities both individually and in groups, 3) respondents have good communication skills, and 4) respondents do not feel forced or pressured to give information during the interview.

**Table 1.** Respondents for Interview Activities

No.	Initials Name	Group
1.	RA	1
2.	RM	2
3.	SI	3
4.	LI	4

The questionnaire was given to find out the responses of students participating in the Mathematics Learning Media course by implementing PjBL. The given questionnaire aims to measure students' motivation, interest and independence. While documentation is done to record or store documents or research support as additional data.

The data analysis used in this research consists of four stages, based on the Miles & Huberman model, namely data collection, data reduction, data presentation and drawing conclusions (Suciati et al., 2022). In addition to analysing the data using the Miles & Huberman model, data triangulation was also carried out as a step to validate and ensure the credibility of the data.

## **Results and Discussion**

Project-based learning emphasises the application of learners' knowledge and skills through the development of projects or tasks that reflect real-life situations. It involves learners in researching, planning and carrying out projects that have a specific purpose. This type of learning provides opportunities for learners to go deeper into the subject matter, to develop a better understanding and to develop practical skills such as teamwork, problem solving and presentation. During the project-based learning process, teachers act as facilitators, supporting students (learners) in achieving project goals and linking them to

broader learning concepts (Ginanjar et al., 2021; Mardiyanti et al., 2023; Norhikmah et al., 2022; Sunita et al., 2019).

This approach aims to motivate learners, develop creativity and provide meaningful learning experiences (Anita, 2017; Rahma et al., 2023; Zativalen et al., 2022). In this study, the researchers gave the students 2 types of projects. In cycle 1, the project given was in the form of making mathematical games related to the subject matter or mathematical material for primary, junior high or high school, depending on the choice of study groups that had been formed. Once the maths game project has been produced, each group presents its work to its peers in the classroom. As for the second cycle, the project given was to make a video containing the game that had been made before. The content of the video must include the steps of making the game, including tools and materials (if used) and how to implement the game. Once the video was made, it was uploaded to the Youtube channel and each group sent a Youtube link containing the video they had made.

After implementing PjBL in the e-learning course, carry out an evaluation related to the effectiveness and impact of its implementation. Evaluation can help researchers to improve the quality of learning, the skills of lecturers and students, and to create a learning environment that is dynamic, responsive and relevant to the needs of students and lecturers, especially in mathematics learning media courses (Rahma et al., 2023).

Based on the results of data collection during observations, interviews and documentation, a number of evaluation materials related to the implementation of PjBL in mathematics learning media courses were found. The evaluation can be divided into 7 (seven) themes, namely 1) effectiveness of PjBL, 2) challenges of PjBL implementation, 3) students' reactions, 4) students' skills, 5) students' creativity, 6) use of learning media, and 7) recommendations for improvement.

#### *1) Effectiveness of Project Based Learning*

Evaluating the effectiveness of project-based learning means that researchers measure the extent to which project-based learning (PjBL) is effective in improving students' understanding in mathematics learning media courses. The increase in understanding in question is related to the students' understanding in making learning media (mathematics games), the material or subject matter of school mathematics, and the relationship between the two (whether the material used is suitable or not with the game made).

Based on the observations of the implementation of PjBL in the mathematics learning media courses and the interviews with the respondents, it seems that the students not only understand the mathematics learning media they make, but also gain new understanding in relation to other learning media (mathematics games) made by other groups, as well as increase their understanding in relation to the material or subject matter used in their learning media, such as integer operations. The learning media increased and improved the students' understanding of school mathematics material that they had forgotten or even not remembered well, because the material was presented in an interesting and fun way.

The above is in line with Ausubel's view on meaningful learning, Bruner's view on interactive and constructivist learning, and Gagne's view on learning concepts or demonstrated materials (Suciati et al., 2023). These findings are also in line with research conducted by Hajerina et al. (2022) that students can improve their understanding through project-based learning in mathematics learning media courses, especially related to making learning media. Because project-based learning can provide benefits to students in the form of new knowledge and skills, as well as mathematical abilities.

## 2) *Challenges of Project-Based Learning Implementation*

Evaluation in relation to challenges in the implementation of PjBL means that researchers identify challenges or obstacles in mathematics learning media courses using PjBL. The aim of this evaluation is to find out the factors that can affect the effectiveness of the implementation of project-based learning, so that researchers can formulate strategies for improvement so that learning becomes better and more effective.

Based on the results of observation and reflection in each cycle, some observations on challenges and obstacles in implementing project-based learning are presented in Table 2 below:

**Table 2.** Challenges and Obstacles

No.	Cycle	Challenges and Obstacles
1.	Cycle I	<ol style="list-style-type: none"> <li>1. Limited presentation time</li> <li>2. Limited resources</li> <li>3. Pupils' understanding of the rules of the game created by the presenting group</li> <li>4. Readiness of each group in presenting their tasks</li> <li>5. External interference</li> </ol>
2.	Cycle II	<ol style="list-style-type: none"> <li>1. Time constraints</li> <li>2. Limited resources</li> <li>3. The level of understanding of students in understanding the tasks given by lecturers</li> <li>4. Assignments are not as expected by the lecturer</li> <li>5. Multiple video fixes</li> </ol>

In addition to the data obtained through observation and monitoring, the data also came from interviews with 4 respondents who were identified. The following are excerpts from the results of the interviews with the four respondents regarding the challenges and obstacles encountered when creating a maths game project:

Grup I (RA):

*The challenges and obstacles in doing the project in group 1 were related to time constraints, as group 1 was the first to come up to present the assignment given by the lecturer. However, it became a challenge for our team to complete the task on time. Other obstacles were related to external interference and the number of group members working on making maths games.*

Grup II (RM):

*In our group, the problem was the time it took to complete the product, because we had to coordinate the time with the group members, so the maths game task was not optimal. In addition, it was difficult to organise the friends involved in the game because they did not understand the rules that our group had made.*

Grup III (SI):

*The challenges and obstacles experienced by group 3 were finding suitable ideas between materials and games (for the first task) and not knowing how to edit videos (for the second task). In addition, the time constraints of the task.*

Grup IV (LI):

*In the given project, the challenges we faced were related to choosing the right games and materials, because we had to make our own games that were suitable for the materials we chose. In addition, it is related to the time to get together with the team members to work on the assigned tasks.*

The above findings are in line with research by Rahma et al. (2023) that the barriers to implementing project-based learning are related to leadership, unresponsive learners and learner understanding. In addition, the challenges that learners may face in learning are related to the lack of resources, the role of trainers and the assessment of learning outcomes (Ginanjari et al., 2021).

### 3) *Student's Response*

A further evaluation is carried out to see the response of students who take learning media courses with the application of PjBL. The response referred to in this study is related to students' activity, motivation, interest in learning and independence. In this learning, the students actively participated in the lecture as shown by their enthusiasm in participating in the maths game presented by the presenting group. The presenting group also seemed enthusiastic in explaining and commenting on the maths game they presented in class. Based on the results of the questionnaires given by the students, the results show that the students have motivation, interest and learning independence in the high and medium categories. This can also be seen in their involvement in making maths games, in presenting and explaining the games they have made, in participating in the games presented by the presenting group and in making videos that are uploaded to the Youtube channel. Pupils also try to overcome challenges or obstacles that they encounter in their projects, such as making videos and uploading videos to Youtube. When they face difficulties in editing videos, they try to find a way out by watching Youtube or reading references on Google.



**Figure 1.** Student engagement in maths games

The findings above show that PjBL can increase students' activity, independence and interest (Anjarsari et al., 2021; Hajerina et al., 2022; Mardiyanti et al., 2023; Rahma et al., 2023). This is in line with research conducted by Wariani & Hayon (2023) that student activity is in the good category, learning outcomes are in the very satisfactory category and students produce 13 learning media, lesson plans, LKPD and questions relevant to the products produced. In addition, PjBL can also increase students' motivation and involvement in learning (Ginanjari et al., 2021).



#### 4) *Students' Skills*

With the project given in the Learning Media course, the students have demonstrated some mathematical skills according to the researchers' expectations. The skills used by the students in this project-based learning are 1) critical thinking skills, 2) problem solving skills, 3) communication skills, 4) concept understanding skills, 5) collaboration skills, 6) time management skills and 7) technology skills. Students are able to use critical thinking skills, where they are asked to think and create a never-before-made mathematical game (based on the ideas of the students and their groups), adapted to the material chosen by the students themselves. In the area of problem-solving skills, students are required to learn to face and solve problems that arise in the completion of the mathematical game project they have created, including the production of videos in Cycle II.

Furthermore, students need to have communication skills because they need to be able to communicate their ideas effectively to group members and teachers, including when presenting and communicating mathematical ideas. Students need to have concept understanding skills, because when they present the mathematical game they have made, it will certainly be associated with a mathematical concept, according to the material they have chosen. Therefore, the presenting team must have a good understanding of the mathematical concepts they want to convey through mathematical games. In addition, teamwork certainly requires students to have collaborative skills such as cooperation, cohesiveness, sharing of ideas, deliberation to achieve something by consensus. Students are also required to have good time management skills in order to meet the deadlines set when carrying out projects in Cycle I and Cycle II. Students must also have technological skills to help them complete the Cycle II project, namely making videos and uploading them to the Youtube channel.

The above findings are certainly in line with the aims of project-based learning (PjBL), which encourages learners to develop and improve their understanding, critical thinking, teamwork and problem-solving skills (Ginancar et al., 2021; Rahma et al., 2023).

#### 5) *Students' Creativity*

Student creativity in PjBL in mathematics learning media courses can be seen in various ways, such as:

- Creation of innovative maths games

In PjBL, students are given the opportunity to think creatively according to their imagination about what mathematical games they want to make, what tools and materials they want to use, and what steps to take to implement the game according to the chosen material (Cycle I).

- Creating demonstration videos

Pupils' creativity in making videos corresponds to the mathematical games made in Cycle I. It includes tools and materials, how to make them and how to use the games. Where it includes tools and materials, how to make them and how the game is used. To see the creativity of these students, here is a Youtube link that contains a video of the game that the students uploaded:

**Table 3.** Youtube link created by students

No.	Grup	Link
1.	Grup I	<a href="https://youtu.be/xIy4rGXJJzU?si=HzCr-I4H3Sx5kdYK">https://youtu.be/xIy4rGXJJzU?si=HzCr-I4H3Sx5kdYK</a>
2.	Grup II	<a href="https://youtu.be/8AJS5BWsen0?si=fS6NqN7SdFVYjlfH">https://youtu.be/8AJS5BWsen0?si=fS6NqN7SdFVYjlfH</a>
3.	Grup III	<a href="https://youtu.be/Sjq0HaO19g4">https://youtu.be/Sjq0HaO19g4</a>
4.	Grup IV	<a href="https://youtu.be/YKBW2_E0tlc?feature=shared">https://youtu.be/YKBW2_E0tlc?feature=shared</a>

This finding is in line with the purpose of project-based learning, which provides opportunities for learners to develop their creativity (Rahma et al., 2023).

#### 6) *Implementation of Learning Media*

The use of learning media in mathematics learning media courses using PjBL can enrich students' learning experiences and increase the effectiveness of the learning process. This can be seen in the educational games developed, such as the adoption of snakes and ladders games on the concept of whole numbers, domino games on the addition of whole numbers, and so on. In addition to creating games, students then simulated games in the classroom, the simulation of mathematical games certainly attracted students' motivation and involvement in the learning process and provided interactive experiences on the mathematical concepts studied (Cycle I). In addition, the students also used learning videos that showed how to make and use the mathematical games they had created. The video provided instructions to motivate and provide additional insights into learning media that can be associated with mathematical concepts.

Learning media produced by students through project-based learning is in the very satisfactory category (Wariani & Hayon, 2023)

7) *Recommendation for Improvement*

In order to increase the effectiveness of PjBL in learning media courses, the following recommendations for improvement are based on the results of observation and reflection carried out in two cycles, among others:

- Clear learning objectives

It is important for the teacher (educator) to set clear learning objectives related to the project that will be given to the students, so that the students can understand the purpose of the project and how the project will be carried out, such as the selection of appropriate and suitable media and concepts to improve the understanding of mathematical concepts for users, tools and materials, and games that have never been used before.

- Structured project design

When designing a project (maths game), it is important for the teacher (educator) to create a clear structure, including steps to be taken, deadlines and assessment criteria. In order to be able to guide the students in carrying out the project.

- Adequate guidance

Provide appropriate guidance to students during the project completion process. Teachers can provide guidance, feedback and support when students experience difficulties or confusion.

- Well integration of technology

Make effective use of technology in mathematics learning, including the use of software, applications or digital tools that can enhance interactivity and creativity in projects.

- Measurement of learning outcomes

Establish clear evaluation methods that are appropriate to the mathematics project. Evaluation should include assessment of understanding of concepts, application of mathematics and quality of presentation or final product.

- Effective teamwork

Encourage effective teamwork by providing guidance on the roles and responsibilities of each team member. This can improve collaboration and fair distribution of tasks.

- Contextual

Incorporate real-world (contextual) elements into the mathematics project. This can help students understand the practical application of mathematical concepts and increase motivation to learn.

- Reflection and self-learning

Allow time for reflection and self-evaluation at the end of the project. Students can think about what they have learnt, what obstacles they have faced and how they can improve their skills in the future.

- Problem-solving training

The projects given to students can encourage them to develop mathematical problem solving skills. Teachers can teach problem-solving strategies and provide opportunities for students to face challenges and find solutions.

- Discussion facilities

Teachers can facilitate group discussions or presentations in class or outside of class (whatsapp group) to promote different ideas and collaborative learning related to learning media or mathematical concepts.

- Collaboration with practitioners or experts

Collaboration with practitioners or experts in the field of mathematics learning media should also be undertaken in order to provide additional insights, feedback or even enrichment of learning materials for students.

Implementing these recommendations can help to create a more effective project-based learning environment and motivate students to be more actively involved in understanding and applying mathematical concepts. According to the research by Rahma et al. (2023) that when implementing project-based learning, teachers need to choose appropriate materials, understand the context and the projects given to students so that what is expected in learning can be achieved.

### **Conclusion and Suggestion**

Based on the results obtained, 7 (seven) evaluation materials for PjBL in mathematics learning media courses were obtained, namely 1) effectiveness of project-based learning, 2) challenges in implementing project-based learning, 3) students' responses, 4) students' skills, 5) students' creativity, 6) application of learning media, and 7) recommendations for improvement. With these findings, it is hoped that it can be a concern for educators to be able to correct deficiencies and improve the learning process through PjBL.

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