Unlocking potential: how project-based learning influences kindergarten motor skills

Desbloqueando el potencial: cómo el aprendizaje basado en proyectos influye en las habilidades motoras en el kinder

Authors

Anggarda Paramita Muji [1]
Alwen Bentri [2]
Jamaris Jamaris [2]
Rakimahwati Rakimahwati [2]
Abna Hidayati [2]
Darmansyah Darmansyah [2]
Hendra Hidayat [2,*]

[1] Doctoral Student of Universitas Negeri Padang (Indonesia)
[2] Universitas Negeri Padang (Indonesia)

*Corresponding author:
Hendra Hidayat
hendra.hidayat@ft.unp.ac.id

How to cite in APA

Paramita Muji, A., Bentri, A., Jamaris, J., Rakimahwati, R., Hidayati, A., Darmansyah, D., & Hidayat, H. (2025). Potencial de desbloqueio: como a aprendizagem baseada em projetos influencia as competências motoras no jardim de infância. *Retos*, *63*, 289–301. https://doi.org/10.47197/retos.v63.112107

Abstract

Introduction: various studies have shown that the Project-Based Learning (PBL) has a significant impact on learning across different educational levels. However, there is an empirical gap, particularly regarding the implementation of PBL in early childhood education. Research in this age is still limited, especially in evaluating the impact of PBL on early childhood motor skills.
Objective: this study aims to analyze the effectiveness of PBL in improving gross and fine motor skills in early childhood. The main focus of this study is to encouraging the development of childrens' entrepreneurial spirit through activities such as batik making, exploring the garden, and games.
Methodology: this research uses a pre-test and post-test experimental design to evaluate changes in motor skills quantitatively. The participants consist of 10 early childhood from TK Islam Nibras and 10 early childhood from TK Lentera Qolbu.
Results: the analysis results show that early childhood involved in PBL activities experienced significant improvement in coordination, body balance, large muscle strength, as well as the ability to complete tasks requiring hand precision and hand-eye coordination.
Conclusions: it is important for teachers to tailor the projects to each child's needs and abilities, and to provide an environment that supports their motor development.

Keywords

Gross and fine motor skills; kindergarten; motor skills; project-based learning; social skills.

Resumen

Introducción: Diversos estudios han demostrado que el Aprendizaje Basado en Proyectos (ABP) tiene un impacto significativo en el aprendizaje en diferentes niveles educativos. Sin embargo, existe una brecha empírica, particularmente con respecto a la implementación del ABP en la educación infantil. La investigación en esta etapa aún es limitada, especialmente en la evaluación del impacto del ABP en las habilidades motoras de los niños pequeños.
Objetivo: Este estudio tiene como objetivo analizar la efectividad del ABP en la mejora de las habilidades motoras gruesas y finas en la primera infancia. El enfoque principal de este estudio es fomentar el espíritu emprendedor de los niños a través de actividades como la elaboración de batik, la exploración del jardín y los juegos.
Metodología: Esta investigación utiliza un diseño experimental de pre-test y post-test para evaluar cuantitativamente los cambios en las habilidades motoras. Los participantes consisten en 10 niños de TK Islam Nibras y 10 niños de TK Lentera Qolbu.
Resultados: Los resultados del análisis muestran que los niños involucrados en actividades de ABP experimentaron una mejora significativa en la coordinación, el equilibrio corporal, la fuerza muscular grande, así como en la capacidad para completar tareas que requieren precisión manual y coordinación ojo-mano.
Conclusión: Es importante que los maestros adapten los proyectos a las necesidades y habilidades de cada niño, y que proporcionen un entorno que apoye su desarrollo motor.

Palabras clave

Habilidades motoras gruesas y finas; jardín de infantes; habilidades motoras; aprendizaje basado en proyectos; habilidades sociales.

Introduction

The development of motor skills in early childhood is very important as it relates to basic abilities that will influence other aspects such as cognitive, social, and emotional development (Gandotra et al., 2023), (Weber & Greiff, 2023). Motor skills are divided into two types, gross motor skills and fine motor skills (Özkan & Kale, 2023). In gross motor skills, the child's whole body becomes more active. Activities in this category include running, jumping, or walking. These exercises are performed to help the child coordinate their body balance. Meanwhile, fine motor skills involve movements that require small muscles, usually from joints such as the wrist and fingers. These activities typically include fine movements like cutting, pasting, or collage-making (Trouli & Linardakis, 2022).

There are many activities that can be done to enhance the development of children's motor skills, ranging from playing to creating mini-projects that stimulate their creativity and physical development. Generally, countries around the world do not immediately teach heavy academic lessons to children. Many of them teach fun activities such as playing, singing, discipline, and social interaction. In Japan, for example, children learn in open spaces. Teachers place a high value on manners and discipline, so children are accustomed to bowing to others and are highly disciplined (Wagatsuma & De Vos, 2022). Similarly, in Sweden, children often learn outdoors in parks and gardens. They place a strong emphasis on cleanliness. Additionally, children are taught social skills and are highly respectful of others (Sundevall & Jansson, 2020), (Booshi, 2024). In China, preschool children are taught cooking, gardening, and trading. They are taught how to create products and then how to market them (Junfeng & Halabi, 2024). In this way, they are introduced to business at a young age.

Many tasks are carried out by teachers to enhance children's motor skills. They provide children with the freedom to play, but also introduce mini-projects. One of the ways teachers achieve this is through the Project-Based Learning (PBL) model. In general, PBL is widely applied at the secondary school level, such as vocational schools and universities (Hidayat et al., 2024), (Hayashi et al., 2023). This is because, at higher education levels, students are required to complete a project as part of their studies. Projects in education are often used as a basis for determining academic grades (Ruiz-Ortega et al., 2019). This method has been proven to significantly improve learning outcomes. However, there are also studies that show PBL is effective for children in developing motor skills. Recent research indicates that the application of PBL can enhance children's physical engagement in activities that support the development of both gross and fine motor skills (Million, 2022), (Ferrero et al., 2021). This method allows children to interact directly with their social environment. PBL not only creates a product but also teaches the importance of life meaning from an early age, helping one another, and taking responsibility. Thus, they not only learn cognitively but also engage their bodies and physical abilities directly in the learning process.

In early childhood education, PBL has great potential to support the development of early childhood's motor skills, both gross and fine motor skills. Activities involving large movements, such as running or outdoor play, have been shown to be effective in improving balance, body strength, and coordination of gross motor skills in early childhood (Sutapa et al., 2021). Meanwhile, activities that focus more on fine motor skills, such as crafting, batik making, or collage, allow early childhood to enhance their precision, hand control, and manipulation skills (Basri et al., 2023). Thus, PBL provides a comprehensive and in-depth learning experience for early childhood's motor development in early childhood. PBL has great potential to support the development of both gross and fine motor skills. Through projects involving physical and manipulative activities, early childhood not only learn basic concepts but also enhance their body coordination and hand skills (Wade & Whiting, 1986). For example, activities such as making crafts, running with friends, or playing games that integrate body movements can strengthen various essential motor aspects for early childhood (Manners, 2019), (Ma & Luo, 2023).

Although the PBL approach is well known in education, its effectiveness in improving motor skills in early childhood, particularly at the kindergarten level, still requires further investigation. Various studies have shown that PBL has a significant impact on the effectiveness of learning across different educational levels (Isnandar et al., 2023), (Munawar et al., 2023), (Günay et al., 2019), (Shepherd et al., 2022). However, there is an empirical gap in the literature, particularly regarding the implementation of PBL in early childhood education. Research in this age group is still limited, especially in evaluating

the impact of PBL on early childhood's motor skills. Therefore, this study is a pre-experimental study that applies the PBL method in the learning process, and an analysis is conducted to assess the effectiveness of PBL in improving early childhood's gross and fine motor skills, while also filling the gap in the literature related to innovative learning approaches in early childhood education. This research aims to provide valuable insights into how PBL can be utilized to enhance motor development and contribute to the overall growth and development of young children. The main focus of this study is not only on the final product but also on encouraging the development of early childhood's entrepreneurial spirit through motor skill activities. In addition, this research seeks to explore the extent to which PBL can contribute to the development of both gross and fine motor skills in early childhood, and how a fun and project-based learning process can support that development.

Through this research, it is hoped that evidence will be found to support the importance of using PBL as an effective strategy in early childhood education, particularly in developing essential motor skills for early childhood's growth and development. Additionally, this study aims to provide new insights for educators in kindergartens in designing more interactive and enjoyable learning activities for early childhood.

Method

This study uses a pre-experimental design with a pre-test post-test method to measure the effectiveness of project-based learning in improving children's motor skills. This design was chosen because it allows the researcher to focus the analysis on the changes that occur within the treatment group without requiring a comparison with a control group (Abidin & Mashuri, 2023). This approach is considered appropriate for assessing the direct impact of project-based learning, especially in early childhood education settings that require flexibility and adaptation to the needs of learners. A pre-test is conducted to measure the children's initial abilities, while a post-test is used to evaluate the outcomes after the intervention is applied. The analysis of the changes between the pre-test and post-test provides a measurable overview of the effectiveness of this method in supporting children's motor development in a directed and significant manner.

Participants

The participants of this study consisted of 20 children aged 4–5 years enrolled in two kindergartens in Padang City, West Sumatra Indonesia, TK Islam Nibras and TK Lentera Qolbu. Each school contributed 10 children as participants. The sample was selected using purposive sampling, considering the children's willingness to participate in the entire intervention process, as well as their similar age and initial abilities. Both groups followed the same procedures to examine the consistency of project-based learning outcomes across the two schools.

Procedure

This experiment was conducted over four sessions, with the schedule as shown in Table 1.

Table 1 . Learning activity

Session	Student Activity
Session 1 Pre-test (Exploration in the school garden)	Initial test to measure early childhood's gross and fine motor skills. Activities involve outdoor exploration in the school garden, with gross motor movements such as running, jumping, or collaborative games that require body movement coordination.
Session 2 Project-Based Learning (PBL) Activity I	Early childhood engage in activities like leaf batik, which involves both gross and fine motor movements as well as body balance.
Session 3 Project-Based Learning (PBL) Activity II	Collage activity with leaves, such as cutting, pasting, or collaborative games that require hand-eye coordination.
Session 4 Evaluation and Post-test	Reflection and discussion on the completed projects. A follow-up test (post-test) to measure early childhood's motor skills after completing four sessions of project-based learning.

Before conducting the experiment according to the sessions outlined in Table 1, the instrument used to measure children's motor skills, namely the observation sheet, was first tested for validity and reliability. The validity test was conducted to ensure that the measurement tool accurately measures the intended construct (Khidzir et al., 2018). This test was carried out by examining the Pearson

correlation values (Güzel et al., 2024). The Pearson correlation test was used to assess the relationship between each item in the instrument and the construct being measured. Subsequently, the reliability test was performed by calculating Cronbach's alpha value. This testing phase aims to ensure that the instrument is consistent in measuring the construct used in the study (Cheung et al., 2024).

Data analysis

The data obtained from the pre-test and post-test were analyzed using statistical tests to determine whether there is a significant difference in the improvement of motor skills between the pre-test and post-test. Before conducting main analysis, a normality test was first performed to ensure that the data followed a normal distribution. The normality test was conducted using the Shapiro-Wilk test (González-Estrada et al., 2022). Once the data was confirmed to be normally distributed, the analysis proceeded with a t-test to compare the differences in pre-test and post-test scores between the two groups.

The data collection technique used an observation sheet with a checklist (√) in the columns provided under the next subheading. The observer, who is also the one filling out the observation sheet, was the teacher at the respective Kindergarten. The observer assessed aspects of the early childhood's motor skills, which include Gross Body Movement Coordination, Body Balance, and Hand-Eye Coordination. These were categorized as follows, (1) ND (Not Developed), meaning the child needs guidance or demonstration from the teacher to perform the task; (2) SD (Starting to Develop), meaning the child still requires reminders or assistance from the teacher; (3) DE (Developed as Expected), meaning the child can perform the task independently and consistently without needing reminders or demonstrations from the teacher; (4) DVW (Developed Very Well), meaning the child can perform the task independently and can even assist their peers who have not yet reached the expected level. The observation sheet underwent validity and reliability testing with 19 items related to the early childhood's motor skills, including Gross Motor Coordination, Balance, and Hand-Eye Coordination, with a total of 31 child respondents.

The data obtained from the pre-test and post-test were analyzed using statistical tests to determine if there was a significant difference in the improvement of motor skills between the pre-test and post-test. A t-test was used to compare the pre-test and post-test scores between the two groups. This t-test was employed to assess whether there was a substantial difference between the pre-test and post-test scores after the intervention. If the t-test results showed a p-value less than 0.05, it was concluded that the intervention had a significant impact on the improvement of the participants' motor skills (Voigt & Kingston, 2016).

Results

The validity test is conducted to assess the extent to which the measurement instrument, in this case the questionnaire, can reveal what it is intended to measure. A questionnaire is considered valid if its questions can reveal the construct that is desired in line with the research objectives (Ono, 2020). In this study, the validity test was carried out using Pearson's correlation, where each item in the questionnaire was tested against the construct being measured. Based on the results of the Pearson correlation test conducted on 31 respondents, it was found that all questionnaire items had correlation values higher than the r-table value (0.344) at a 5% significance level (Tarziyah, 2024). The lowest correlation value found was 0.449, indicating that all the questionnaire items are valid because they are higher than the r-table value. This confirms that the measurement instrument is valid for use in the research. The results of this test are displayed in Table 2.

The Cronbach Alpha function in SPSS is used for this test. If a person's responses to a statement are consistent, then the questionnaire can be considered reliable (Schrepp, 2020). A Cronbach alpha score > 0.7 indicates the reliability of the questionnaire (Ramzan & Khurram, 2023). The calculated r value (Cronbach alpha) of 0.929 is greater than the r-table value of 0.344, which means the questionnaire is deemed reliable. The results of this test are displayed in Table 3.

Table 2. Pearson correlation of motor skills assessment items

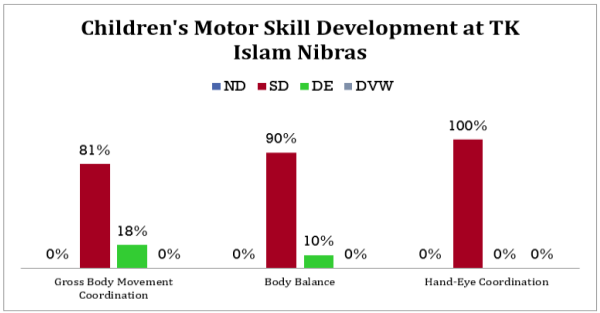
Item	r Count	r Table	Description
P1	0,449	0,344	Valid
P2	0,724	0,344	Valid
P3	0,635	0,344	Valid
P4	0,658	0,344	Valid
P5	0,679	0,344	Valid
P6	0,718	0,344	Valid
P7	0,719	0,344	Valid
P8	0,658	0,344	Valid
P9	0,830	0,344	Valid
P10	0,810	0,344	Valid
P11	0,689	0,344	Valid
P12	0,807	0,344	Valid
P13	0,566	0,344	Valid
P14	0,805	0,344	Valid
P15	0,685	0,344	Valid
P16	0,634	0,344	Valid
P17	0,755	0,344	Valid
P18	0,596	0,344	Valid
P19	0,791	0,344	Valid

Table 3. Cronbach's Alpha

Reliability statistics	
Cronbach's Alpha	N Item
.929	19

The effectiveness of the PBL model on motor skills in Kindergarten was assessed using two types of tests, pretest and posttest. The pretest was conducted before the early childhood participated in the PBL activities, while the posttest was administered after they engaged in the PBL to evaluate the development of their motor skills. The data from the observations can be seen in Figure 1.

Figure 1. Early childhood's motor skill development at TK Islam Nibras (Pre-test)



The observation results for 10 students in the aspect of gross body movement coordination showed that 81% were in the beginning to develop category, while 18% were in the developing as expected category. In the aspect of body balance, 90% were in the beginning to develop category, and 10% were in the developing as expected category. For the aspect of hand-eye coordination, 100% were in the beginning to develop category.

The observation results of 10 students on the aspect of body movement coordination show that 98% fall under the starting to develop category, and 2% fall under the developing as expected category, as shown in Figure 2. On the aspect of body balance, 83% are in the starting to develop category, and 18% are in the developing as expected category. On the aspect of eye-hand coordination, 83% fall under the starting to develop category, and 18% fall under the developing as expected category.

Figure 2. Early childhood's motor skill development at TK Lentera Qolbu (Pre test)

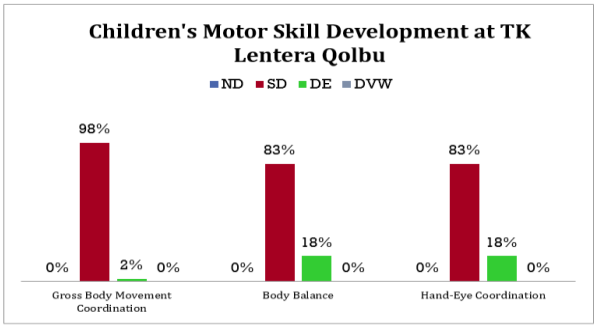
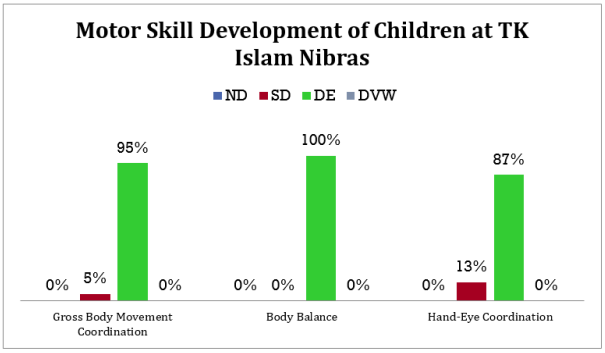
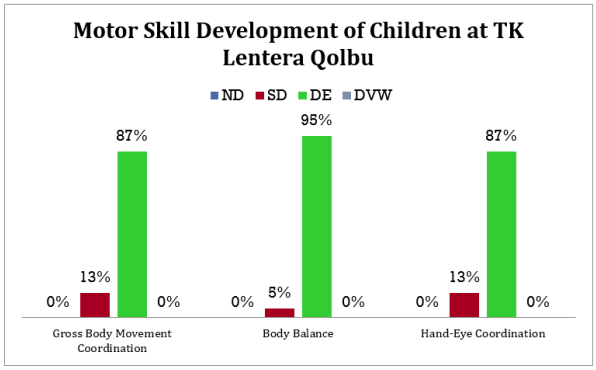


Figure 3. Trial 2 motor skill development of early childhood at TK Islam Nibras



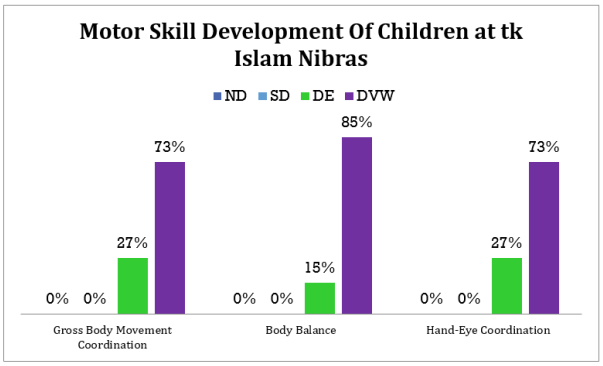
The observation results of 10 students on the aspect of body movement coordination show that 95% fall under the starting to develop category, and 5% fall under the developing as expected category, as shown in Figure 3. On the aspect of body balance, 100% are in the starting to develop category. On the aspect of eye-hand coordination, 87% fall under the starting to develop category, and 13% fall under the developing as expected category.

Figure 4. Trial 2 motor skill development of early childhood at TK Lentera Qolbu



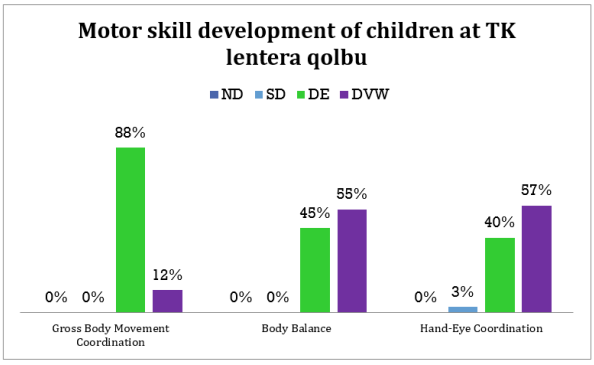
The observation results of 10 students at TK Lentera Qolbu, indicate the following: In the aspect of body movement coordination, 13% were in the starting to develop category, while 87% were in the developing as expected category. In the aspect of body balance, 5% were in the starting to develop category, and 95% were in the developing as expected category. In the aspect of hand-eye coordination, 13% were in the starting to develop category, and 87% were in the developing as expected category.

Figure 5. Trial 3 motor skill development of early childhood at TK Islam Nibras



The observation results of 10 students at TK Islam Nibras after the third trial indicate that, in the aspect of body movement coordination, 27% were in the developing as expected category, and 73% were in the developing very well category. In the aspect of body balance, 15% were in the developing as expected category, and 85% were in the developing very well category. In the aspect of hand-eye coordination, 27% were in the developing as expected category, and 73% were in the developing very well category.

Figure 6. Trial 3 motor skill development of early childhood at TK Lentera Qolbu



The observation results of 10 students at Lentera Qolbu, presented in Graph 6, show the following, in the aspect of body movement coordination, 88% were in the developing as expected category, and 12% were in the developing very well category. In the aspect of body balance, 45% were in the developing as expected category, and 55% were in the developing very well category. In the aspect of hand-eye coordination, 3% were in the beginning to develop category, 40% were in the developing as expected category, and 57% were in the developing very well category.

In Table 4, it can be concluded that the learning outcomes of the students at TK Islam Nibras, totaling 10 students, show the following results: the first trial (pre-test) was conducted before the students engaged in learning using the PBL model, with an average score of 55.30; the second trial (post-test) showed the learning outcomes after the students implemented the PBL model, with an average score of 73.60; and the third trial showed the outcomes after further implementation of the PBL, with an average score of 91.40. Based on the results from trial 1 to trial 3, it is evident that there was significant improvement in the students' development, and it can be concluded that collaborative project-based learning is effective in enhancing early childhood's motor skills in Kindergarten.

Table 4. Recapitulation of the trial test at TK Islam Nibras

Activity	N	Mean	t-statistic	df	t-value	Normality >0,05	Homogeneity >0,05	p-value <0,05	Summary
Trial 1 Trial 2	10 10	55.30 73.60	12.385	18	2.101	0,797	0,589	0,000	The data is normal, homogeneous, and there is a difference in the average results between test 1 and test 2.
Trial 2 Trial 3	10 10	73.60 91.40	7.622	18	2.101	0,816	0,091	0,000	The data is normal, homogeneous, and there is a difference in the average results between test 2 and test 3.
Trial 1 Trial 3	10 10	55.30 91.40	15.339	18	2.101	0.772	0,144	0,000	The data is normal, homogeneous, and there is a difference in the average results between test 1 and test 3.

Table 5. Recapitulation of the trial test at TK Lentera Qolbu

Activity	N	Mean	t-statistic	df	t-value	Normality >0,05	Homogeneity >0,05	p-value <0,05	Summary
Trial 1 Trial 2	10 10	56.30 73.20	8.361	18	2.101	0,983	0,721	0,000	The data is normal, homogeneous, and there is a difference in the average results between test 1 and test 2.
Trial 2 Trial 3	10 10	73.20 87.20	5.295	18	2.101	0,894	0,656	0,000	The data is normal, homogeneous, and there is a difference in the average results between test 2 and test 3.
Trial 1 Trial 3	10 10	56.30 87.20	12.984	18	2.101	0,877	0,247	0,000	The data is normal, homogeneous, and there is a difference in the average results between test 1 and test 3.

In Table 5, it can be concluded that the learning outcomes of the students at TK Lentera Qolbu, totaling 10 students, were as follows. Test 1 was conducted before the students engaged in learning using the PBL model, with an average score of 56.30. Test 2 was conducted after the students participated in learning using the PBL model, with an average score of 73.20. Test 3 was conducted after further implementation of the project-based learning, with an average score of 87.20. Based on these analysis results, it can be concluded that the Project-Based Learning model developed by the researcher effectively improves early childhood's motor skills.

Discussion

The first session in the project-based learning activity involved outdoor exploration in the school garden, featuring gross motor movements such as running, jumping, or collaborative games requiring gross motor coordination. This initial session with these activities is illustrated in Figure 7.

In this activity, the children were given the freedom to play, dance, and even chase each other. This helped strengthen their gross motor skills while also supporting the development of their emotional skills (Özkan & Kale, 2023). The images above show children playing and dancing, capturing the joyful and happy atmosphere during the activity (Muji et al., 2024), (Haugland et al., 2023). These moments highlight the importance of an environment that supports exploration and creativity, as advocated by Maria Montessori in Lillard's (2017) study. The implementation of the PBL model through play, as applied at TK Islam Nibras and TK Lentera Qolbu, demonstrates that play not only enhances children's motor skills but also strengthens their emotional and social development. As Maria Montessori expressed, enjoyable and free learning experiences support children's independence and creativity.

Additionally, Froebel's view that play is a way for children to gain new knowledge is also relevant, as through play, children not only learn physical skills but also learn to manage their emotions and interact with their social environment (Aisyah et al., 2023).

Figure 7. Coordination of gross body movements and balance in early childhood at kindergarten

After completing the physical activities and outdoor exploration on the first day, the program continued the following day with an activity involving leaf-based batik art. This activity is illustrated in Figure 8.

Figure 8. The PBL activity of batik using leaves

The batik project activity using leaves for children has significant benefits in the development of both gross and fine motor skills. Recent studies have shown that children's involvement in activities that require large body movements, such as collecting materials or using tools to apply colors, can strengthen their large muscles and improve body coordination. Batik-making is also an Indonesian cultural heritage that fosters creativity in children from an early age, contributing indirectly to cultural development. Observations at both TK Islam Nibras and TK Lentera Qolbu schools showed significant improvement in children's motor skills through this batik project. This activity not only supports the development of both gross and fine motor skills but also stimulates children's creativity, giving them the freedom to express their imagination, while introducing them to important cultural values. In line with the research by (Utomo, 2023), (Syed Shaharuddin et al., 2021) and (Rizkyhimawan et al., 2024), it shows that traditional art activities, such as batik, not only enhance children's motor skills but also provide an opportunity for them to recognize and appreciate local culture.

After carrying out the batik activity in the previous session, the third session was conducted the following day as a continuation of the PBL implementation. In this session, the activity involved creating a collage using leaves, such as cutting, pasting, or engaging in collaborative games that require hand-eye coordination. This activity is shown in image 9.

Figure 9. PBL activity of leaf collage for hand-eye coordination

Activities such as sticking and cutting leaves can enhance hand-eye coordination, which is crucial for the development of fine motor skills. The analysis results at TK Islam Nibras and Lentera Qolbu showed an improvement in motor skills among students through this activity. Additionally, this activity stimulates children's creativity by giving them the freedom to create patterns according to their imagination, while also training their cognitive abilities in understanding shapes and structures. This aligns with the findings in a study by (Sutapa et al., 2021), (Muji et al., 2019), which revealed that art activities, such as drawing and cutting, can stimulate fine motor skill development while also enhancing children's thinking skills. A comparison with other research, such as that conducted by (Frikha & Alharbi, 2023), which also explored the benefits of fine motor activities in children, shows that involvement in manual activities contributes to the improvement of hand-eye coordination and fine motor skills.

This series of analyses has proven that the implementation of Project-Based Learning (PBL) is an effective strategy in early childhood education, particularly in developing motor skills. Activities that involve exploration, play, running, and hand involvement, such as sticking and cutting leaves, have been shown to enhance both gross and fine motor coordination in children. Indirectly, these activities have also influenced their creativity and cognitive abilities. Therefore, this study has provided evidence supporting the importance of PBL as a highly relevant and beneficial method in supporting early childhood development.

Conclusions

The implementation of Project-Based Learning (PBL) has proven to be a highly effective method in developing motor skills in early childhood. Through the involvement of children from two educational institutions, TK Islam Nibras and TK Lentera Qolbu, in a series of challenging yet enjoyable activities, the results show significant improvement in both gross and fine motor skills. Additionally, this method has also had a substantial positive impact on the children's social and emotional development, which is crucial for their growth.

This research is expected to provide benefits for individuals working in kindergartens, those with an interest in this field, or those aspiring to conduct research in the future. The findings are expected to contribute to improving the quality of learning in kindergartens, including improvements that can be implemented in the early childhood curriculum. This pre-experimental study can also serve as a valuable resource for enhancing motor skills at various stages of development. Additionally, the analysis results are anticipated to be a reference for the development of knowledge related to this topic. However, it is important to note that this study has limitations, as it was only conducted in kindergartens in Padang City, Indonesia. Therefore, future research is recommended to expand the geographic scope and participant numbers. Academics should also conduct a more in-depth review of the scientific literature on factors that contribute to the improvement of motor skills in the kindergarten education curriculum.

Acknowledgements

We would like to express our gratitude to Universitas Negeri Padang, particularly the Faculty of Education, for their unwavering support and invaluable resources throughout our research. Their

commitment to academic excellence, along with the encouragement provided by the faculty members, has been instrumental in the completion of this work. We are sincerely thankful for the guidance, expertise, and opportunities that have enriched our academic journey. Without their support, this study would not have been possible.

Conflit of Interest

The researchers have no conflicts both with the re-searchers and the results of other studies.

References

Abidin, Z., & Mashuri, M. (2023). The Effectiveness of Guided Imagery on Sleep Quality in the Elderly in Mojo Community Health Center Padang, Lumajang. *Jurnal Aisyah : Jurnal Ilmu Kesehatan*, *8*(1), 61–68. https://doi.org/10.30604/jika.v8i1.1383.

Aisyah, E. N., Harun, H., & Rohman, A. (2023). Proceedings of the International Conference on Educational Management and Technology (ICEMT 2022). In *Proceedings of the International Conference on Educational Management and Technology (ICEMT 2022)* (Vol. 2). Atlantis Press SARL. https://doi.org/10.2991/978-2-494069-95-4.

Basri, N., Saputra, R. J., Halim, F., & Syahrin, A. (2023). Development of Creative Activities Through Batik Decorative Art Variety to Improve Kindergarten Teachers'creativity. *Jurnal PAJAR (Pendidikan Dan Pengajaran)*, *7*(2), 386–396.

Booshi, F. (2024). *Playgrounds in perspective; an exploration of the Swedish schoolyard development*.

Cheung, G. W., Cooper-Thomas, H. D., Lau, R. S., & Wang, L. C. (2024). Reporting reliability, convergent and discriminant validity with structural equation modeling: A review and best-practice recommendations. In *Asia Pacific Journal of Management* (Vol. 41, Issue 2). Springer US. https://doi.org/10.1007/s10490-023-09871-y.

Ferrero, M., Vadillo, M. A., & León, S. P. (2021). Is project-based learning effective among kindergarten and elementary students? A systematic review. *PLoS ONE*, *16*(4 April), 1–14. https://doi.org/10.1371/journal.pone.0249627.

Frikha, M., & Alharbi, R. S. (2023). Optimizing Fine Motor Coordination, Selective Attention and Reaction Time in Children: Effect of Combined Accuracy Exercises and Visual Art Activities. *Children*, *10*(5). https://doi.org/10.3390/children10050786.

Gandotra, A., Kotyuk, E., Bizonics, R., Khan, I., Petánszki, M., Kiss, L., Paulina, L., & Cserjesi, R. (2023). An exploratory study of the relationship between motor skills and indicators of cognitive and socio-emotional development in preschoolers. *European Journal of Developmental Psychology*, *20*(1), 50–65. https://doi.org/10.1080/17405629.2022.2028617.

González-Estrada, E., Villaseñor, J. A., & Acosta-Pech, R. (2022). Shapiro-Wilk test for multivariate skew-normality. *Computational Statistics*, *37*(4), 1985–2001. https://doi.org/10.1007/s00180-021-01188-y.

Günay, C., Doloc-Mihu, A., Gluick, T., & Moore, C. A. (2019). *Project-Based Learning Improves Critical Thinking for Software Development Students*. 105–105. https://doi.org/10.1145/3349266.3351362.

Güzel, A., Uçan Yamaç, S., Turan, S., & Üner, S. (2024). Turkish validity and reliability of the Lawton instrumental activities of daily living scale. *Turkish Journal of Public Health*, *22*(1), 59–71. https://doi.org/10.20518/tjph.1364063.

Haugland, E. S., Nilsen, A. K. O., Okely, A. D., Aadland, K. N., & Aadland, E. (2023). Multivariate physical activity association patterns for fundamental motor skills and physical fitness in preschool children aged 3–5 years. *Journal of Sports Sciences*, *41*(7), 654–667. https://doi.org/10.1080/02640414.2023.2232219.

Hayashi, V. T., Arakaki, R., Almeida, F. V. de, & Ruggiero, W. V. (2023). The Development of Sustainable Engineering with PjBL during the COVID-19 Pandemic †. *International Journal of Environmental Research and Public Health*, *20*(5). https://doi.org/10.3390/ijerph20054400.

Hidayat, H., Anwar, M., Harmanto, D., Dewi, F. K., Orji, C. T., & Isa, M. R. M. (2024). Two Decades of Project-Based Learning in Engineering Education: A 21-Year Meta-Analysis. *TEM Journal*, *13*(4), 3514–3525. https://doi.org/10.18421/TEM134-84.

Isnandar, Ichwanto, M. A., & Ansyorie, M. M. Al. (2023). Sister-cousin TF model based on the influence of work preparedness and learning outcome. *Social Sciences & Humanities Open*, *8*(1), 100722. https://doi.org/https://doi.org/10.1016/j.ssaho.2023.100722.

Junfeng, W., & Halabi, K. N. M. (2024). Revitalising Packaging Design of Children Food Brand for Marketing Strategy in China. *International Journal of Business and Technology Management*, *6*(3), 150–160.

Khidzir, K. A. M., Ismail, N. Z., & Abdullah, A. R. (2018). Validity and River. *International Journal of Development and Sustainability*, *7*(3), 1026–1037. www.isdsnet.com/ijds.

Lillard, A. S. (2017). *Montessori: The science behind the genius*. Oxford University Press.

Ma, F. F., & Luo, D. M. (2023). Relationships between physical activity, fundamental motor skills, and body mass index in preschool children. *Frontiers in Public Health*, *11*(April), 1–7. https://doi.org/10.3389/fpubh.2023.1094168.

Manners, L. (2019). *The Early Years Movement Handbook: A Principles-Based Approach to Supporting Young Children's Physical Development, Health and Wellbeing*. Jessica Kingsley Publishers.

Million, H. S. (2022). *Early Childhood Intervention Curriculum Creation: Using Playful Project-Based Learning*. Otterbein University.

Muji, A. P., Bentri, A., Jamaris, Rakimahwati, & Hidayati, A. (2024). Designing an Information Technology Platform for Imparting Entrepreneurship Values in Social-Emotional Learning for Kindergarten Children Using EFA and CFA. *International Journal on Informatics Visualization*, *8*(2), 948–956. https://doi.org/10.62527/joiv.8.2.2536.

Muji, A. P., Bentri, A., Suryana, D., Yaswinda, Yulastri, A., Amir, A., Hidayati, A., & Hidayat, H. (2019). The effectiveness of the implementation of lesson plans based on entrepreneurial values in the kindergarten. *International Journal of Scientific and Technology Research*, *8*(12), 121–128.

Munawar, R. M., Jaenudin, D., & Retnowati, R. (2023). Project-Based Learning With Digital Storytelling To Improve Science Literacy of 10Th-Grade Students in Ma Al Manshuriyah School. *Journal of Science Education and Practice*, *7*(1), 46–52. https://doi.org/10.33751/jsep.v7i1.7304.

Ono, S. (2020). Uji Validitas dan Reliabilitas Alat Ukur SG Posture Evaluation. *Jurnal Keterapian Fisik*, *5*(1), 55–61. https://doi.org/10.37341/jkf.v5i1.167.

Özkan, Z., & Kale, R. (2023). Investigation of the effects of physical education activities on motor skills and quality of life in children with intellectual disability. *International Journal of Developmental Disabilities*, *69*(4), 578–592. https://doi.org/10.1080/20473869.2021.1978267.

Ramzan, N., & Khurram, A. F. A. (2023). Construction and Validation of the Teachers' Motivation Questionnaire (TMQ): A Detailed Exploration. *Review of Education, Administration & Law*, *6*(2), 381–394. https://doi.org/10.47067/real.v6i2.338.

Rizkyhimawan, A., Sugiarto, E., & Wibawanto, W. (2024). *Catharsis : Journal of Arts Education Genealogical Inheritance Model of Javanese Coastal Batik : a Double Case Study on Batik-Making Families in Lasem and Tuban*. *13*(1), 9–24.

Ruiz-Ortega, A. M., Gallardo-Rodríguez, J. J., Navarro-López, E., & Cerón-García, M. del C. (2019). Project-led-education experience as a partial strategy in first years of engineering courses. *Education for Chemical Engineers*, *29*, 1–8. https://doi.org/10.1016/j.ece.2019.05.004.

Schrepp, M. (2020). On the Usage of Cronbach's Alpha to Measure Reliability of UX Scales. *Journal of Usability Studies*, *15*(4), 247–258.

Shepherd, D. C., Fronchetti, F., Liu, Y., Hou, D., Dewaters, J., & Small, M. M. (2022). Project-Sized Scaffolding for Software Engineering Courses. *Proceedings - Designing and Running Project-Based Courses in Software Engineering Education, DREE 2022*, 27–31. https://doi.org/10.1145/3524487.3527362.

Sundevall, E. P., & Jansson, M. (2020). Inclusive parks across ages: Multifunction and urban open space management for children, adolescents, and the elderly. *International Journal of Environmental Research and Public Health*, *17*(24), 1–17. https://doi.org/10.3390/ijerph17249357.

Sutapa, P., Pratama, K. W., Rosly, M. M., Ali, S. K. S., & Karakauki, M. (2021). Improving motor skills in early childhood through goal-oriented play activity. *Children*, *8*(11), 1–11. https://doi.org/10.3390/children8110994.

Syed Shaharuddin, S. I., Shamsuddin, M. S., Drahman, M. H., Hasan, Z., Mohd Asri, N. A., Nordin, A. A., & Shaffiar, N. M. (2021). A Review on the Malaysian and Indonesian Batik Production, Challenges, and Innovations in the 21st Century. *SAGE Open*, *11*(3). https://doi.org/10.1177/21582440211040128.

Tarziyah, I. (2024). The Influence of Internal Communication in the Organization on Employee Performance of PT Wahyu Abadi (Cikarang) (Fa'uzobihi) The Influence of Internal Communication in the Organization on PT Wahyu Abadi (CIKARANG) Employee Performance. *Jurnal Ilmu Sosial Dan Pendidikan (JISIP)*, *8*(2), 2598–9944.

Trouli, K., & Linardakis, M. (2022). Relations of gross and fine motor skills with graphomotor skills in preschool years. *European Psychomotricity Journal*, *15*(Gallahue 2011), 31–40.

Utomo, S. (2023). The Effectiveness of Scientific Learning Model Based on Local Wisdom of Kendal Batik on Learning Ability of Early Childhood Students. *Asian Journal of Assessment in Teaching and Learning*, *13*(2), 75–85. https://ojs.upsi.edu.my/index.php/AJATeL/article/view/9880.

Voigt, C. C., & Kingston, T. (2016). *Bats in the Anthropocene : Conservation of Bats in a Changing World. Springer Cham, London/NY. pp. 600.*

Wade, M. G., & Whiting, H. T. A. (1986). *Motor development in children: Aspects of coordination and control*. Nijhoff Leiden, The Netherlands.

Wagatsuma, H., & De Vos, G. A. (2022). *Heritage of endurance: Family patterns and delinquency formation in urban Japan*. Univ of California Press.

Weber, A. M., & Greiff, S. (2023). ICT Skills in the Deployment of 21st Century Skills: A (Cognitive) Developmental Perspective through Early Childhood. *Applied Sciences (Switzerland)*, *13*(7). https://doi.org/10.3390/app13074615.

Authors' and translators' details:

Anggarda Paramita Muji	anggardaparamitamuji@gmail.com	Author
Alwen Bentri	alwenbentri@fip.unp.ac.id	Author
Jamaris Jamaris	jamaris@fip.unp.ac.id	Author
Rakimahwati Rakimahwati	rakimahwati@fip.unp.ac.id	Author
Abna Hidayati	abnahidayati@fip.unp.ac.id	Author
Darmansyah Darmansyah	darmansyah@fip.unp.ac.id	Author
Hendra Hidayat	hendra.hidayat@ft.unp.ac.id	Translator