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INTEGRATING STEM AND PJBL TO PROMOTE ENVIRONMENTAL AWARENESS IN PRESCHOOL (SDG 13)

Dhian Gowinda Luh Safitri [1], Kartika Rinakit Adhe [2] , Melia Dwi Widayanti [3], Yes Matheos Lasarus Malaikosa [4] , Nurhenti Dorlina Simatupang [5]

Corresponding email: dhiansafitri@unesa.ac.id

Department of Early Childhood Education, Universitas Negeri Surabaya[1-5]

ABSTRAK

Penelitian ini menyelidiki efektivitas intervensi yang bertujuan untuk meningkatkan pemahaman dan penerapan STEM (Sains, Teknologi, Teknik, dan Matematika) dan PJBL (Pembelajaran Berbasis Proyek) oleh guru-guru pendidikan anak usia dini (PAUD). Intervensi ini mencakup sesi pengembangan profesional, diikuti dengan penilaian pre-test dan post-test. Hasilnya menunjukkan adanya peningkatan yang signifikan dalam pengetahuan dan keterampilan pedagogis guru. Modul guru, yang dibuat setelah intervensi, mencakup beragam tema seperti mitigasi bencana, pengelolaan sumber daya, dan konservasi lingkungan, yang mencerminkan kemampuan mereka dalam mengintegrasikan STEM dan PJBL ke dalam kegiatan yang menarik. Peningkatan yang signifikan pada nilai post-test menunjukkan keberhasilan intervensi dalam membekali guru dengan keterampilan yang diperlukan untuk merancang dan mengimplementasikan pembelajaran berbasis STEM dengan menggunakan pendekatan PJBL. Temuan ini menunjukkan bahwa intervensi semacam itu efektif dalam meningkatkan kemampuan pendidik anak usia dini, yang pada akhirnya bermanfaat bagi peserta didik dengan memberikan mereka pengalaman pendidikan yang dapat diterapkan dalam kehidupan nyata. Studi ini menyoroti pentingnya pengembangan profesional berkelanjutan dalam memajukan praktik pendidikan.

Katakunci : **Kesadaran Lingkungan, Pengembangan Profesional, PJBL, STEM,**

ABSTRACT

This study investigated the effectiveness of an intervention aimed at enhancing early childhood education (PAUD) teachers' understanding and application of STEM (Science, Technology, Engineering, and Mathematics) and PJBL (Project-Based Learning). The intervention included professional development sessions, followed by pre-test and post-test assessments. Results indicated significant improvements in teachers' knowledge and pedagogical skills. The teachers' modules, created post-intervention, covered diverse themes such as disaster mitigation, resource management, and environmental conservation, reflecting their ability to integrate STEM and PJBL into engaging activities. The significant increase in post-test scores demonstrated the intervention's success in equipping teachers with the necessary skills to design and implement STEM-based learning using the PJBL approach. These findings suggest that such interventions are effective in enhancing early childhood educators' capabilities, ultimately benefiting young learners by providing them with enriching, real-life applicable educational experiences. This study highlights the importance of continuous professional development in advancing educational practices.

Keywords : **STEM, PJBL, Environmental Awareness, Professional Development**

INTRODUCTION

Childhood is a crucial phase of character formation, where children tend to imitate adult behavior as part of their learning process. Imitation behavior in early childhood, as emphasized by Khaironi (2017), provides an ideal opportunity to instill positive habits. One form of introducing positive habits, particularly related to environmental care, is by reducing waste impact and fostering environmental awareness through meaningful activities. Current environmental issues, as revealed by Hilmi (2021), are closely related to human actions, which can lead to ecosystem disturbances and impact human life.

Changing human behavior, especially attitudes of indifference towards the environment, becomes a top priority in addressing these challenges. Providing motivation and understanding to the community or younger generations, as stated by Iskandar (2012), is key to forming awareness and caring attitudes towards the environment. School grounds could play a crucial role in children's environmental learning, with certain features stimulating play that promotes such learning (Tranter & Malone, 2004). The implementation of this awareness can be done through environmental literacy, which currently is a major challenge in protecting ecosystems (Bjorkland & Pringle, 2001).

Research highlights the importance of involving children in environmental sustainability efforts. Children aged 6-11 demonstrate awareness of environmental issues and provide various reasons for protecting nature, including maintaining a clean environment and safeguarding human health (Šorytė & Pakalniškienė, 2019). Urban green spaces like botanical gardens serve as crucial "holding environments" for children's environmental learning and connection to nature (Malone, 2004). To foster sustainable development, it is essential to understand how children engage with their local environments and learn to take collaborative action (Heft & Chawla, 2006). The welfare of children today is a key indicator of sustainable development progress, as current environmental degradation threatens to create a dangerous and unpredictable world for future generations (Timberlake & Thomas, 1991). Integrating children's needs into political, economic, and social systems is vital for ensuring a sustainable environment for future children.

Environmentally conscious behavior, aimed at maintaining the environment to support life now and in the future, is closely related to environmental sustainability (Steg et al., 2005). Efforts to increase environmentally conscious behavior

are expected to create awareness and concern for current environmental issues. One form of implementing these efforts is through the formation of communities or their integration into educational curricula, as done by Kampoeng Recycle (Andriyani & Hilmi, 2020). The presence of Kampoeng Recycle helps the community address environmental issues, especially waste, and fosters waste-conscious behavior. The triple C program in Kalimantan is also an example of actions to raise environmental awareness, especially among students (Sagena et al., 2023). These environmental awareness classes aim to instill environmental literacy awareness and knowledge. Several research programs have provided positive results in efforts to raise environmental awareness.

Situation analysis in Banyuwangi based on interviews conducted before the activities shows several challenges that need to be addressed in raising environmental awareness among early childhood teachers (PAUD). One of the main problems is the lack of understanding of the STEM (Science, Technology, Engineering, Mathematics) approach among PAUD teachers, which also hinders the integration of environmental concepts into their curriculum. The limited availability of relevant learning resources and the dominance of conventional teaching methods also hinder the development of a deep understanding of environmental issues among children.

To address these challenges, an intervention combining the Project-Based Learning (PJBL) approach with STEM is needed for PAUD teachers in Banyuwangi. This intervention should include an understanding of how to design learning projects relevant to the environment and facilitate student-centered learning. In efforts to increase environmental awareness among PAUD teachers in Banyuwangi, the utilization of technology becomes key in supporting community service programs. One approach that can be implemented is through the use of online learning platforms such as Moodle or Google Classroom to provide access to training modules and learning resources on the STEM and PJBL approaches. Digital learning resources based on multimedia such as instructional videos and infographics can also be developed to enhance their understanding of environmental issues. By utilizing existing technology, this program is expected to have a significant impact on increasing environmental understanding and awareness in Banyuwangi.

RESEARCH METHODS

This study employed a quantitative method to measure the

impact of STEM (Science, Technology, Engineering, and Mathematics) and PJBL (Project-Based Learning) integration training on the knowledge and practices of early childhood education (PAUD) teachers in Banyuwangi in raising environmental awareness. According to Ary (2002), quantitative research uses objective measurement and statistical analysis of numeric data to understand and explain phenomena.

The research process began with the distribution of questionnaires to gather initial data on the level of knowledge and practices of STEM PJBL that the teachers had implemented. After collecting the initial data, the researchers conducted a pre-test to assess the teachers' baseline knowledge of integrating STEM and PJBL. Next, an intensive training intervention was conducted to enhance the teachers' understanding of the integration of these two concepts. Following the intervention, a post-test was administered to evaluate the improvement in the teachers' understanding.

To ensure the validity and reliability of the data, a normality test was conducted using the Shapiro-Wilk or Kolmogorov-Smirnov test. If the data were normally distributed, a paired t-test was used to compare the pre-test and post-test scores to determine the significance of the differences before and after the intervention. According to Cresswell (2014), the paired t-test is a robust statistical method in quantitative research for comparing two related means and determining whether there is a statistically significant difference between them, making it particularly suitable for pre-test and post-test designs. In addition to the evaluation through pre-tests and post-tests, the researchers also analyzed the modules produced by the training participants. This analysis aimed to ensure that participants not only understood the concepts theoretically but were also able to apply them in practice.

The study involved 15 early childhood education teachers in Banyuwangi as research subjects. The selection of 15 respondents was justified by the consideration that this number was adequate to obtain reliable and valid data in the context of educational research. With a focused number of respondents, the researchers could conduct more in-depth and structured observations, ensuring that each respondent received sufficient attention and intervention during the training. This number also facilitated adequate statistical analysis to identify trends and effects of the intervention conducted.

Data Analysis

To evaluate the effectiveness of the intervention in this study, data were analyzed from the pre-test and

post-test scores of the participant. These scores were examined using the Paired Samples Test in IBM SPSS Statistics 22. If the t-table result was greater than the t-obtained at the 0.05 significance level, the null hypothesis could not be rejected, indicating that the intervention was not effective in improving teachers' understanding of PJBL and STEM. Conversely, if the t-obtained was greater than the t-table at the 0.05 significance level, the null hypothesis could be rejected, indicating that the intervention was effective in increasing teachers' knowledge about PJBL and STEM.

RESEARCH RESULTS AND DISCUSSION

The intervention session began with the collection of initial data to determine the level of knowledge and practices of STEM PJBL that PAUD teachers have already implemented. This data is crucial for tailoring the training material to the needs and actual conditions in the field. The data collection included questions about previous PJBL and STEM training experiences, the importance of environmental awareness material, the frequency of teaching using PJBL and STEM, and the types of STEM practices that have been conducted.

From the collected data, it can be analyzed that most teachers have not received PJBL and STEM training before, indicating an urgent need for training programs focused on these approaches. Additionally, all teachers agree that environmental awareness material is very important, reflecting a good awareness of the importance of this topic, although its implementation in the curriculum still needs improvement. Many teachers already practice PJBL and STEM in schools, although the frequency and methods used vary. Some teachers have used the PJBL approach in simple science experiments, while others focus more on STEM activities without PJBL integration.

After data collection, an intervention was conducted providing material related to STEM and the preparation of learning tools using PJBL syntax. The provided material included the introduction to STEM and PJBL, the basic concepts of STEM and PJBL, and the importance of integrating these two approaches in early childhood education. Additionally, the preparation of learning tools included how to develop lesson plans using PJBL syntax, including setting learning objectives, designing activities, and evaluation methods. The intervention also involved a demonstration on how to make a drip irrigator as an example of using simple technology in STEM learning, aimed at giving teachers hands-on experience in applying STEM concepts with the PJBL approach.

Furthermore the teachers filled out the survey again to measure their knowledge after the training.

The following are the pre-test and post-test results of the participants.

Table 1. Pre-test and Post-test Results of Participants

No.	Participant	Pre-test Score	Post-test Score
1	Participant 1	80	90
2	Participant 2	60	70
3	Participant 3	70	70
4	Participant 4	80	90
5	Participant 5	70	90
6	Participant 6	60	90
7	Participant 7	90	100
8	Participant 8	60	70
9	Participant 9	80	80
10	Participant 10	70	80
11	Participant 11	80	80
12	Participant 12	70	90
13	Participant 13	70	90
14	Participant 14	70	100
15	Participant 15	60	80

The data were then processed using the Kolmogorov-Smirnov Test through SPSS analysis.

Table 2. Data Normality Test

One-Sample Kolmogorov-Smirnov Test		
		Unstandardized Residual
N		15
Normal Parameters[a,b]	Mean	.0000000
	Std. Deviation	8.69999627
Most Extreme Differences	Absolute	.178
	Positive	.178
	Negative	-.143
Test Statistic		.178
Asymp. Sig. (2-tailed)		.200[c,d]
a. Test distribution is Normal.		
b. Calculated from data.		
c. Lilliefors Significance Correction.		
d. This is a lower bound of the true significance.		

Based on the normality test results, the significance value of 0.200 > 0.05 indicates that the data are normally distributed.

Table 3. Paired Sample T Test

Paired Samples Test									
		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Dev	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
ir 1	Pretest postest	-13.333	9.759	2.520	-18.738	-7.929	-5.292	14	.000

Identified Main Themes Based on Modules Prepared by PAUD Teachers

Table 1.4 Module Themes

Theme	**Activity**	**Integrating STEM and PJBL**
Disaster Mitigation	Flood Disaster Mitigation	Yes
	Environmental Conservation	Yes
Construction and Engineering	City Forest Diorama	Yes
	Building a Green City	Yes
Resource Management	Save electricity at home and school.	Yes
	Water Conservation	Yes
	Recycling Waste:	Yes
Crafting and Handicrafts	Making Paper from Pulp	Yes
	Making Photo Frames from Used Cardboard	Yes
Experiments and Simulations	Air Pollution Simulation	Yes
	Water Filtration	Yes
	Creating Mini Aquarium	Yes
Agriculture and Environment	Planting	Yes
	Making Butterfly Garden	Yes

CONCLUSION

Based on the data and analysis, it can be concluded that the intervention successfully enhanced teachers' understanding and knowledge about the integration of STEM (Science, Technology, Engineering, and Mathematics) and PJBL (Project-Based Learning). The pre-test and post-test results demonstrate a significant improvement in the teachers' comprehension of these educational approaches.

The identified main themes and activities from the modules prepared by PAUD teachers after the intervention reflect their ability to integrate STEM and PJBL into engaging and practical learning experiences. Themes such as disaster mitigation, construction and engineering, resource management, crafting and handicrafts, experiments and simulations, and agriculture and environment showcase a diverse range of activities that make learning both fun and relevant to real-life situations.

Moreover, the increase in teachers' knowledge about STEM and PJBL indicates that the intervention was effective in enhancing their pedagogical skills. Teachers are now more capable of designing and implementing STEM-based activities using the PJBL approach, which is crucial for fostering critical thinking, problem-solving, collaboration, and environmental awareness among young learners.

These findings suggest that such professional development programs are not only feasible but also beneficial in early childhood education, contributing significantly to the improvement of teaching practices and the overall educational experience for young children.

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