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Analysis of STEM (Science, Technology, Engineering, and Mathematics) Project Seminar Results on The Effectiveness Of Project-Based Learning In The Primary School Teacher Education Program At Universitas Pattimura

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Abstract

This study aims to analyze the results of STEM (Science, Technology, Engineering, and Mathematics) project seminars and assess the effectiveness of Project-Based Learning (PjBL) in the Primary School Teacher Education (PGSD) Program at Universitas Pattimura. The background of the research stems from the demands of the 21st-century curriculum, which emphasizes the development of critical, collaborative, creative, and communicative competencies through contextual and applicable learning. The study employs a quantitative descriptive approach with data collected through seminar observations, project documentation, and student perception questionnaires. The research participants included fourth-semester students who had participated in STEM project seminars and project supervisors. The number of students was 30 students. Data were analyzed using the interactive model of Miles and Huberman, which includes data reduction, data display, and conclusion drawing. The integration of STEM project seminars based on Project-Based Learning (PjBL) can enhance teachers' pedagogical competence and their skills in developing learning activities aligned with the *Merdeka Curriculum*. The results show that the STEM project seminars were successfully implemented, marked by active student engagement, systematic presentations, and innovative products that practically integrated STEM elements. Project-Based Learning was found effective in enhancing conceptual understanding, 21st-century skills, as well as students' motivation and self-confidence. However, in-depth mastery of STEM concepts and students' professional readiness still require improvement through intensive guidance and training. Overall, the STEM project seminar plays a strategic role as both an evaluation medium and a reinforcement of project-based learning within teacher education. The study recommends the development of integrative STEM guidelines and a more systematic project evaluation model to support the achievement of professional competencies among PGSD students.

Keywords: 21st-century skills, Learning effectiveness, PGSD students, Project-Based Learning, STEM project seminar

Introduction

The development of 21st-century education demands a shift in learning paradigms from teacher centered to student-centered approaches, with an emphasis on the development of Higher Order Thinking Skills (HOTS), collaboration, creativity, and communication. The 21st-century era calls for a transformation in students' perspectives on learning quality, particularly in developing skills and transforming knowledge into various scientific development fields (Atalay & Boyaci, 2019). The research was conducted by Fiardilla et al. (2025) show that project based learning can improve active participation in attending lecturer. In this context, the Project-Based Learning (PjBL) model emerges as a relevant approach to meet these needs.

Project-Based Learning (PjBL) has been widely adopted at various educational levels, including higher education, due to its ability to train learners in solving real-world problems and producing applicable products (Bell, 2010; Krajcik & Blumenfeld, 2006). PjBL provides space for students to learn through exploring real-life problems, designing solutions, and presenting results in the form of authentic products. In the context of primary teacher education, PjBL is considered relevant as it not only fosters conceptual understanding but also cultivates pedagogical skills, teamwork, and critical reflection. According to Anggraini & Wulandari (2021), the use of PjBL learning methods can increase student engagement. This makes the learning process less monotonous and boring, and allows students to better understand the material through a variety of activities implemented by the PjBL model. According to Furi et al. (2018), the use of this method in science subjects received a positive response from students, while student engagement in the learning process increased by 35%.

In line with the direction of the *Merdeka Curriculum* and the strengthening of interdisciplinary approaches, the integration of STEM (Science, Technology, Engineering, and Mathematics) in learning has become a critical necessity. STEM not only supports mastery of academic content but also facilitates the development of essential 21st-century skills for prospective educators. In teacher education, particularly in the Primary School Teacher Education (PGSD) program, this approach is believed to enhance students' professional readiness in designing and implementing innovative and meaningful learning experiences. The integration of STEM project seminars based on Project-Based Learning (PjBL) can improve teachers' pedagogical competence and their skills in developing learning activities aligned with the Merdeka Curriculum (Kade et al., 2024).

The National Education Standards Agency states that the 21st-century national education paradigm aims to develop individuals who are creative, independent, and critical, without losing a sense of responsibility. This 21st-century education paradigm has become a reference for educational implementation in Indonesia. The integration of PjBL and STEM is believed to offer a comprehensive learning experience, encouraging students to design creative and relevant learning solutions that meet the needs of elementary school students.

According to Rohmah et al. (2019), the STEM learning model can shape students' character, as it requires them to think as problem-solvers, inventors, innovators, and technology-literate individuals. It fosters independence, logical and critical thinking, and the ability to connect acquired knowledge with everyday life. Furthermore, Hebebci & Usta (2022) states that the goals of STEM challenge students to solve problems and think creatively and critically.

As a form of implementing PjBL and the STEM approach, the Primary School Teacher Education (PGSD) Program at Universitas Pattimura has conducted a STEM project seminar showcasing students' work in the form of project presentations based on the integration of science, technology, engineering, and mathematics. According to Sambite et al. (2019), the application of PjBL using simple teaching aids in Physics learning can enhance students' higher-order thinking

skills in each learning cycle. However, the effectiveness of this seminar as part of learning and evaluation strategies has not been systematically studied. There is still a lack of empirical data illustrating the extent to which the STEM project seminar contributes to students' competencies cognitive, affective, or professional skills.

The main issues identified include the suboptimal integration of STEM elements in student projects, the variation in project quality among students, and the limited empirical data supporting the seminar's role as a learning evaluation strategy. Another finding on STEM learning by Ismayani (2016) indicates that the creativity level of vocational high school students was influenced by the implementation of STEM project-based learning. The study concluded that the average level of students' creative thinking skills significantly increased after participating in STEM PjBL instruction compared to before, and statistical analysis showed a significant difference in skill achievement before and after the learning process. This means that when STEM learning is effectively integrated with the PjBL model, it can significantly enhance students' creativity.

Furthermore, Afriana et al. (2016) stated that STEM learning can also be integrated into cooperative learning models, Problem-Based Learning (PBL), Project-Based Learning (PjBL), and other instructional models. The implementation of PjBL in physics learning increase 21st-century skill especially in collaboration skill (Sirait & Amnie, 2023). The findings of this study show an improvement in the posttest results, as indicated by an n-gain score of 0.783, which signifies that students' creative thinking skills increased to a high category. The questionnaire data analysis also revealed positive results, indicating that students felt the implemented learning was beneficial for them. Furthermore, the effect size value of 0.98 falls into the large category. Thus, it can be concluded that the implemented learning had a significant impact on students' creative thinking skills (Kristiani et al., 2017).

Based on before mentioned points, this study aims to identify the supporting and inhibiting factors that influence the successful implementation of the seminar, serving as a foundation for curriculum and instructional strategy development within the PGSD environment. It also seeks to analyze the implementation of the STEM project seminar within the PGSD Program at Univercity Pattimura and evaluate its effectiveness in the context of project based learning. The focus of this study is to observe the presentation of students' STEM project results.

This study is expected to contribute to the development of a more effective and contextual STEM based project learning evaluation model in the education of prospective primary school teachers. Conducting this research is essential to analyze the quality of the STEM project seminar implementation and to assess its effectiveness as an integral part of project-based learning.

Research Method

This study employs a quantitative descriptive approach aimed at gaining an in-depth understanding of the process and outcomes of the STEM project seminar implementation, as well as its contribution to the effectiveness of Project-Based Learning (PjBL) in the Primary School Teacher Education (PGSD) Program at Universitas Pattimura. This approach was chosen because it is suitable for uncovering meaning, perceptions, and students' subjective experiences in real-life contexts.

According to Robert & Taylor (1992), qualitative research is a research procedure that produces descriptive data in the form of spoken or written words and observed behaviors. Meanwhile, Moleong (2017) asserts that the qualitative approach is appropriate for studies focusing on

meaning, subjective experience, and social interaction. In this context, the study explores students' and lecturers' perceptions regarding the effectiveness of the STEM project seminar and its impact on learning outcomes and the development of 21st century skills.

This is further supported by Sugiyono (Kuantitatif, 2016), who explains that descriptive statistics are used to analyze data by describing or illustrating the data that has been collected as it is, without the intention of making conclusions that apply to the general population or generalizations.

The research subjects consisted of fourth-semester students of the PGSD Program at Universitas Pattimura who had undergone supervision by lecturers. The number of participant 30 students. Data collection techniques included observations during the implementation of the STEM project seminar to assess the quality of presentations, participant interactions, and the integration of STEM elements within the projects.

Following this, a student perception questionnaire instrument was administered using a Likert scale comprising 15 items. The aspects measured included conceptual understanding, learning activeness, critical thinking, and collaboration skills, as well as learning motivation.

The sampling technique in this study used purposive random sampling. The collected data were then analyzed through data presentation. The data were organized in narrative and tabular forms to facilitate interpretation. Subsequently, conclusions were drawn through the process of generalizing the patterns that emerged from the findings.

Quantitative data comes from the calculation of questionnaire results using the following formula:

$$Percentage = \frac{total\ participant\ score}{maximum\ score} x\ 100\%$$

Result and Discussion

The STEM project seminar was conducted as part of the final activity of a project-based course attended by 30 fourth-semester students of the PGSD Program at Universitas Pattimura. The students developed instructional projects that integrated elements of Science, Technology, Engineering, and Mathematics, and then presented their project results before a panel of examiners and peers. This activity was not only intended as a presentation forum but also served as an evaluative and reflective platform to assess students' learning achievements and professional development.

The observation questionnaire consisted of 15 statement items using a Likert scale of 1–5 (1 = very poor, 5 = very good). The following is a summary of the observation results of the STEM seminar:

Table 1. Results of the STEM Observation Questionnaire

Assessed Aspect	Average Score	Assessment Category
Ability to answer questions from lecturers and the audience	3.7	Fair
Clarity in delivering project objectives	4.2	Good

Innovation and creativity	3.8	Fair
Integration of STEM elements	3.9	Fair
Learning reflection	4.2	Good
Project implementation process	4.1	Good
Project outcomes/products	4.0	Good

In general, the STEM project seminar was conducted successfully, demonstrating adequate STEM integration and serving as an effective presentation platform. However, mastery of STEM concepts and the ability to answer questions still require further reinforcement.

The results of the questionnaire administered to 30 students revealed that 87.5% stated they had a better understanding of STEM concepts through the project. Meanwhile, 90% felt more active during the learning process. Additionally, 85% of students reported that their lecturers provided good project guidance. Furthermore, 80% stated that the STEM seminar enhanced their confidence, learning reflection, and insights gained from their peers' project presentations.

Moreover, 88% of students indicated that the project helped them think critically, collaborate effectively, and connect theory with practice. Also, 95% stated that the project was meaningful and increased their motivation to learn. These findings indicate that students perceive the project-based learning approach combined with the STEM project seminar as an effective and meaningful learning strategy.

Observation results showed that the implementation of the STEM project seminar generally ran well. Students were able to clearly convey the objectives of their projects, demonstrated active participation during the seminar, and presented relevant and applicable final products. This aligns with the characteristics of authentic learning, where students are engaged in real-world tasks that reflect professional situations (Herrington & Oliver, 2000).

However, the integration of STEM elements in some projects was still considered fair. This indicates that students have not yet fully understood how to comprehensively combine science, technology, engineering, and mathematics. This is consistent with the findings of Fadhilah et al. (2022), who stated that integrative cross-disciplinary understanding requires intensive guidance and continuous practice.

Another weakness lies in students' ability to respond to questions from lecturers or the audience, suggesting the need to strengthen conceptual mastery of STEM. According to Learn (2000), deep conceptual understanding is a prerequisite for the transfer of knowledge to new situations, which is expected in the seminar forum.

Perception survey results indicated that the majority of students regarded project-based learning as highly effective in enhancing their understanding of the material, encouraging active learning, and developing critical thinking and collaboration skills. These findings support the theory of who emphasize that PjBL fosters meaningful learning experiences because it is grounded in real-world problem solving (Krajcik & Blumenfeld, 2006).

Moreover, these results are consistent with the research by Anggraeni et al. (2021), which found that the application of PjBL in the PGSD context significantly improved students' critical thinking and reflective abilities. Through the project seminar, students not only produce a product but also learn how to justify their ideas and processes scientifically, as recommended in reflective learning practices (Darling-Hammond, 2012).

Conclusion

This study demonstrates that the STEM project seminar in the PGSD Program at Universitas Pattimura is an effective learning and evaluation strategy to support the implementation of Project-Based Learning (PjBL). The results of observations and questionnaires indicate that students were actively engaged in the process of project development and presentation, and gained benefits in terms of enhanced conceptual understanding, critical thinking skills, collaboration, and scientific reflection.

Nevertheless, the integration of STEM components in student projects has not yet reached an optimal level. Certain elements, such as technology and engineering, were still underrepresented, and students' ability to answer questions and explain the scientific principles behind their projects needs further improvement. The role of lecturers as supervisors has proven to be crucial in determining the quality of the projects and the depth of students' reflections.

Therefore, the STEM project seminar can be regarded as an effective means of developing the pedagogical competencies of prospective primary school teachers.

Reference

Afriana, J., Permanasari, A., & Fitriani, A. (2016). Penerapan project based learning terintegrasi STEM untuk meningkatkan literasi sains siswa ditinjau dari gender. *Jurnal Inovasi Pendidikan IPA*, *2*(2), 202–212.

Anggraeni, P., Sopandi, W., Septinaningrum, S., Hayati, A., Tursinawati, T., & Gumala, Y. G. Y. (2021). Keterampilan Berpikir Kritis Mahasiswa PGSD Melalui Pembelajaran Read-Answer-Discuss-Explain-And Create (RADEC) yang Berorientasi Penyelidikan. *Caruban: Jurnal Ilmiah Ilmu Pendidikan Dasar*, *4*(1), 10–19.

Anggraini, P. D., & Wulandari, S. S. (2021). Analisis penggunaan model pembelajaran project based learning dalam peningkatan keaktifan siswa. *Jurnal Pendidikan Administrasi Perkantoran (JPAP)*, *9*(2), 292–299.

Atalay, N., & Boyaci, S. (2019). Slowmation Application in Development of Learning and Innovation Skills of Students in Science Course. *International Electronic Journal of Elementary Education*, *11*(5), 507–518.

Bell, S. (2010). Project-based learning for the 21st century: Skills for the future. *The Clearing House*, *83*(2), 39–43.

Darling-Hammond, L. (2012). *Powerful teacher education: Lessons from exemplary programs*. John Wiley & Sons.

Fadhilah, N., Nurdiyanti, N., Anisa, A., & Wajdi, M. (2022). Integrasi STEM-problem based learning melalui daring terhadap keterampilan berpikir kritis mahasiswa pendidikan biologi. *JIPI (Jurnal IPA & Pembelajaran IPA)*, *6*(1), 1–10.

Fiardilla, F., Arisandi, M., Yernisa, Y., & Sirait, J. V. (2025). An Analysis of Student Participation in Marketing Management Through Project Based Learning Model. *Journal of Educational Sciences*, 954–963.

Furi, L. M. I., Handayani, S., & Maharani, S. (2018). Eksperimen model pembelajaran project based learning dan project based learning terintegrasi stem untuk mengingkatkan hasil belajar dan kreativitas siswa pada kompetensi dasar teknologi pengolahan susu. *Jurnal Penelitian Pendidikan*, *35*(1), 49–60.

Hebebci, M. T., & Usta, E. (2022). The effects of integrated STEM education practices on problem solving skills, scientific creativity, and critical thinking dispositions. *Participatory Educational Research*, *9*(6), 358–379.

Herrington, J., & Oliver, R. (2000). An instructional design framework for authentic learning environments. *Educational Technology Research and Development*, *48*(3), 23–48.

Ismayani, A. (2016). *Pengaruh penerapan STEM project-based learning terhadap kreativitas matematis siswa SMK. Indonesian Digital Journal of Mathematics and Education, 3 (4), 264–272*.

Kade, A., Ningsih, P., Mubarik, M., Zaky, M., Rahma, N., & Kaipal, K. (2024). Optimizing Science Learning Through Workshops of STEM-Project-Based Learning on Merdeka Curriculum. *Mattawang: Jurnal Pengabdian Masyarakat*, *5*(4), 212–217.

Krajcik, J., & Blumenfeld, P. (2006). 19. Project-Based Learning. *The Cambridge Handbook of the Learning Sciences*, 317–333.

Kristiani, K. D., Mayasari, T., & Kurniadi, E. (2017). Pengaruh pembelajaran STEM-PjBL terhadap keterampilan berpikir kreatif. *Prosiding SNPF (Seminar Nasional Pendidikan Fisika)*, 266–274.

Kuantitatif, P. P. (2016). Metode penelitian kunatitatif kualitatif dan R&D. *Alfabeta, Bandung*.

Learn, H. P. (2000). Brain, mind, experience, and school. *Committee on Developments in the Science of Learning*, 14–15.

Moleong, L. J. (2017). Metodologi Penelitian Kualitatif (Edisi Revisi). vol. 103. *PT Remaja Rosdakarya*.

Robert, B., & Taylor, S. J. (1992). Pengantar Metode Penelitian Kualitatif. alih bahasa-Arif Furchan Cet-1. *Usaha Nasional. Surabaya-Indonesia*.

Rohmah, U. N., Ansori, Y. Z., & Nahdi, D. S. (2019). Pendekatan pembelajaran stem dalam meningkatkan kemampuan literasi sains siswa sekolah dasar. *Prosiding Seminar Nasional Pendidikan*, *1*, 471–478.

Sambite, F. C., Mujasam, M., Widyaningsih, S. W., & Yusuf, I. (2019). Penerapan project based learning berbasis alat peraga sederhana untuk meningkatkan HOTS peserta didik. *Berkala Ilmiah Pendidikan Fisika*, *7*(2), 141–147.

Sirait, J. V., & Amnie, E. (2023). Analysis of students' collaboration skills through project-based learning model. *Gagasan Pendidikan Indonesia*, *4*(1), 43–50.