

THE QUALITY OF STEAM-PjBL MIND MAPPING SKILLS FOR PROSEPECTIVE ELEMENTARY SCHOOL TEACHERS

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ABSTRACT

This study seeks to evaluate the quality of mind mapping generated by prospective elementary school teachers within the framework of project-based learning utilizing the STEAM (Science, Technology, Engineering, Arts, and Mathematics) methodology. Mind mapping serves as a technique to illustrate students' comprehension and concepts in the development of interdisciplinary learning projects. The evaluation emphasizes four primary aspects: the precision of interdisciplinary integration, the appropriateness of the project, the novelty of the concept, and the clarity of the visualization. This study employs a descriptive qualitative methodology, utilizing documentation and content analysis tools to examine students' mind mapping outputs following their engagement in STEAM-PjBL learning. The study's results show that most participants successfully integrated multiple scientific disciplines; however, they identified deficiencies in concept originality and visualization clarity. These findings offer significant insights into prospective instructors' preparedness to create interdisciplinary learning and establish a basis for enhancing future training methodologies.

Keywords: Mind Mapping, Project-Based Learning, and STEAM

ABSTRAK

Penelitian ini bertujuan untuk menganalisis kualitas mind mapping yang dihasilkan oleh calon guru Sekolah Dasar dalam konteks pembelajaran berbasis proyek dengan pendekatan STEAM (Science, Technology, Engineering, Arts, and Mathematics). Mind mapping digunakan sebagai alat untuk memvisualisasikan pemahaman dan ide mahasiswa dalam merancang proyek pembelajaran lintas disiplin. Fokus penilaian mencakup empat aspek utama, yaitu: ketepatan integrasi bidang ilmu, kesesuaian proyek, orisinalitas konsep, dan keterbacaan visualisasi. Penelitian ini menggunakan pendekatan deskriptif kualitatif dengan teknik dokumentasi dan analisis isi terhadap produk mind mapping mahasiswa setelah mengikuti pembelajaran STEAM-PjBL. Hasil penelitian menunjukkan bahwa sebagian besar peserta sudah mampu mengintegrasikan beberapa bidang ilmu dengan cukup baik, namun masih ditemukan kekurangan pada aspek orisinalitas konsep dan visualisasi yang terbaca dengan jelas. Temuan ini memberikan gambaran penting mengenai kesiapan calon guru dalam merancang pembelajaran

lintas disiplin dan menjadi dasar untuk peningkatan strategi pelatihan di masa mendatang.

Kata Kunci: Calon Guru, Mind Mapping, Project Based Learning, STEAM

A. Introduction

Education in the 21st century demands a paradigm shift in learning, no longer focusing solely on mastering content but also on developing critical thinking, creative, collaborative, and communicative skills. In this context, the teacher as a learning facilitator plays an important role in creating innovative and meaningful learning experiences for students. Therefore, prospective elementary school teachers need to be equipped with relevant and transformative learning approaches from the beginning of their education.

One approach that is widely developed and recommended is STEAM based learning (Science, Technology, Engineering, Arts, and Mathematics). STEAM integrates various disciplines into a single learning project that fosters students' conceptual and applied understanding. This approach is considered capable of developing students' problem-solving abilities and creativity through exploratory, collaborative, and real-world

experience - based activities (Gavari-Starkie et al., 2022; Jurado et al., 2020; Zhan et al., 2023). To strengthen the implementation of STEAM in the classroom, the Project-Based Learning (PjBL) model is a very suitable choice. PjBL emphasises learning through real-world projects, encouraging students to build knowledge through stages of investigation, design, and presentation. When combined with the STEAM approach, PjBL becomes a highly effective means of developing cross-disciplinary skills, including at the elementary education level (Hidayah et al., 2023; Nofia Henita et al., 2023; Nurhasnah et al., 2023).

The ability to visually present learning ideas and concepts is an important skill for prospective elementary school teachers. One effective form of visual representation is mind mapping, which can help organise material, show relationships between concepts, and make it easier for students to understand. In the context of 21st-century learning, mind mapping becomes increasingly

relevant when combined with the STEAM approach. STEAM is a learning approach that integrates several disciplines: science, technology, engineering, arts, and mathematics. This discipline is integrated holistically so that in the learning process, students do not feel any boundaries between disciplines. STEAM learning is an extension of the STEM approach with the addition of the arts, resulting in five disciplines (Baek, 2023; Bedewy & Lavicza, 2023; Hidayah et al., 2023; Lage-Gómez & Ros, 2024; Nofia Henita et al., 2023; Nurhasnah et al., 2023). The addition of this artistic element enhances creativity and aesthetics, allowing for the optimal development of students' potential not only cognitively but also in technical skills such as collaboration, communication, and imagination. This aligns with the benefits of STEAM learning, which can enhance 21st-century skills, particularly critical thinking, creativity, collaboration, and communication skills (Conde et al., 2020; Nugroho et al., 2019). At the elementary school level, learning naturally focuses on the holistic development of students, striving to optimise their diverse potential. The nature of science

learning, which is process-, product-, and scientific attitude-orientated, requires teachers to provide more meaningful learning by integrating various scientific disciplines into the lessons to be conducted.

On the other hand, tools for designing and visualising thoughts are very important in project-based learning. One visual method proven effective is mind mapping. This technique helps both students and future teachers organise ideas, connect concepts, and present their understanding in a structured and easily understandable visual form. In the context of STEAM-PjBL, mind mapping serves as a medium for representing thoughts, illustrating the quality of individual knowledge and creativity integration (Hariyadi et al., 2023; Hasanah et al., 2016). However, the quality of mind mapping produced by prospective elementary school teachers still varies greatly. Based on previous studies, weaknesses were still found in the proper integration of the five STEAM fields, the selection of less relevant projects, unoriginal ideas or concepts, and unclear or difficult-to-read visual displays. This condition highlights the need for a more in-depth evaluation of the quality of visual

products produced by prospective teachers through project-based learning.

Several studies have highlighted the importance of evaluating project-based learning products, including mind mapping. Research by Prasetyawati & Astuti, (2025) emphasises that the assessment of mind mapping should include four main aspects: integration of knowledge, project suitability, originality of concept, and visual readability. These four aspects reflect important dimensions in the pedagogical competence of prospective teachers, especially in designing engaging and meaningful interdisciplinary learning experiences.

In the context of the Elementary School Teacher Education (PGSD) study programme, it is important to ensure that students not only understand STEAM and PjBL concepts theoretically but are also able to apply them practically in the form of concrete learning projects. Products like mind maps created by students can be an early indicator of how they integrate knowledge, think creatively, and effectively convey ideas visually (Azizah et al., 2020). Unfortunately, studies on the quality of

mind mapping in the context of STEAM-PjBL for prospective elementary school teachers are still very limited, especially those that specifically assess all four aspects simultaneously. In fact, this capability mapping is very important as a basis for developing the teacher education curriculum and as a reference for improvement in integrated project-based learning.

Nevertheless, field practice shows that the quality of mind mapping produced by prospective elementary school teachers still varies. Some mind maps do not yet reflect the accuracy of integrating subject areas, the content is not fully aligned with the project topic, the ideas generated are not original enough, and the visualisations created are not clear. This could indicate a gap between the learning objectives of STEAM-PjBL and students' visual representation skills. To date, studies specifically analysing the quality of mind mapping results from STEAM-PjBL learning by prospective elementary school teachers based on four main aspects of field integration, project suitability, concept originality, and visual readability are still limited. Therefore, this research is important

to conduct in order to provide an empirical overview of the extent to which prospective elementary school teachers are able to produce mind maps that meet these quality criteria.

The results of this research are expected to make a significant contribution to the development of teacher education programmes, particularly in formulating more effective learning strategies and designing more appropriate assessments to measure students' thinking and visualisation skills. Additionally, these results can also serve as a reference for improving the quality of teacher training in facing the increasingly complex and interdisciplinary challenges of 21st-century learning.

B. Method

This research is a qualitative study aimed at deeply exploring the ability of prospective elementary school teachers to create project-based STEAM mind maps. This approach was chosen because the study focuses on understanding thinking processes, creativity, and the ability to integrate disciplinary concepts within STEAM, as well as

providing a detailed overview of mind mapping as a visual product of prospective elementary school teachers' thinking. This type of research is a case study that deeply examines the practices and works of 20 undergraduate students in the Elementary School Teacher Education programme at Tanjungpura University. The data collection techniques involved using an observation sheet to assess student work, which included evaluating the accuracy of integrating subject areas, project suitability, originality of concepts, and visual readability. Photos were used to document the students' mind mapping results. The collected data was analysed in several steps: first, data reduction involved grouping the data by quality level and integration pattern; next, categorisation was based on the four indicators explained earlier. After that, the researchers summarised the students' mind mapping abilities.

The research questions in this study consist of 4 aspects: how accurate is the integration of STEAM subject areas in the mind mapping created by prospective elementary school teachers?; how appropriate are the projects offered?; how original is

the concept in the mind mapping?;
 and how readable is the visualisation
 of the mind mapping?

C.Result and Discussion

The ability of prospective elementary school teachers in the aspect of integration accuracy: Out of 20 prospective elementary school teachers who are S1 PGSD students, all have integrated the disciplines of science, technology, engineering, art, and mathematics. Some interdisciplinary connections mapped by students are quite evident in the

disciplines within STEAM. This aligns with research stating that the success of STEAM is determined by the extent of interdisciplinary integration implemented contextually in learning (Chang & ChangTzeng, 2020; Ilma et al., 2023; Li & Yuan, 2022; Rahmawati, 2020). The results of the mind map show that the science discipline is related to the concepts of sound, the water cycle, plant growth, and natural phenomena, as seen in Figure 1.

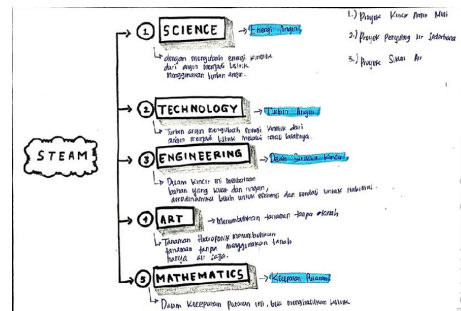
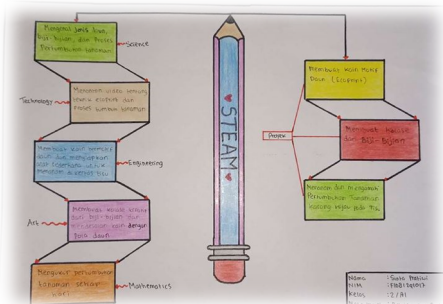
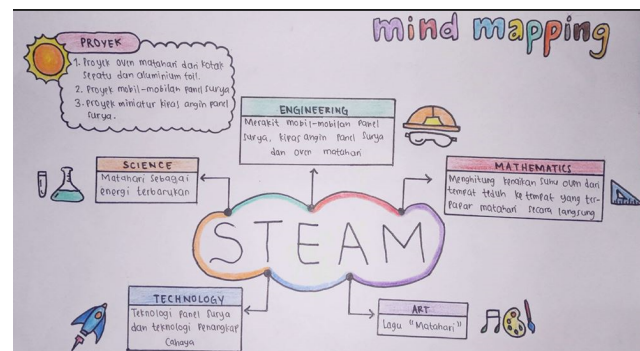


Figure 1 Mind Mapping related to plant growth and the water cycle

In Figure 2, it is known that students, as prospective elementary school teachers, pay attention to each discipline within STEAM. Technology is used through the design of simple tools or techniques such as filters, ecoprinting, documentation, and so on. Engineering involves designing or assembling models/prototypes of

various objects such as cars, windmills, terrariums, solar panels, and miniature ships. This project can be seen in Figure 2.



shows some recurring ideas, such as those related to cars, windmills, and boats. However, on the other hand, there are some quite unique concept ideas, such as the water cycle diorama, plant calendar, mini ship, and floating salt. Some more intriguing ideas include the erupting volcano model, the sound project with trumpets and cans, the terrarium, the leaf pattern fabric ecoprint, the human body model, and waste recycling. This demonstrates the courage of students in developing creativity to come up with new concepts that connect science and art. Originality in STEAM can be reflected in how students connect science and creativity to generate innovative solutions (Chen et al., 2022; González-pérez & Ramírez-montoya, 2022). This originality is an indicator of high-level thinking skills, which are essential in the era of Industry 4.0. Integrating art into STEAM opens up opportunities for creativity and personal expression, fostering the emergence of new ideas in learning (Ho et al., 2023).

The mind map visualisations presented by the students were generally interesting, using colours, icons, and a branch structure that made it easy for readers. This visual

element is important because mind mapping is not just a concept map but also a medium for communicating ideas. Good visualisation in STEAM can increase students' learning motivation and emotional engagement, making the learning product not only logical but also aesthetically pleasing. This aligns with the theory of multimedia learning proposed by Mayer, where the integrated presentation of text, images, and visual symbols can strengthen memory and understanding. Many students add interesting visual elements such as images, colours, symbols, characters, and creative illustrations like ice cream and flowers. Some other works appear simple and without illustrations, but they are still easy to read. Based on the analysis of elementary school teacher candidates' ability to create mind maps, it can be concluded that the main strengths of the STEAM-PjBL mind maps created lie in the STEAM theme, high visual readability, and fairly good artistic creativity. An aspect that deserves special attention is the integration between STEAM fields, which needs to be made deeper; for example, explaining why mathematics is necessary, not just

listing counting activities. Additionally, originality also needs to be expanded so that it doesn't revolve around classic projects like cars, windmills, and boats.

E. Conclusion

This study analyses the mind mapping products created by prospective elementary school teachers after participating in project-based learning with a STEAM approach. The aspects analysed are the accuracy of integrating scientific fields; project suitability; concept originality; and the readability of the visualisation. The research findings indicate that most students are already quite capable of integrating several fields of knowledge, but there are still shortcomings in the originality of concepts, which are still repetitive. The offered project aligns with the context and characteristics of elementary school students and supports the development of 21st-century skills.

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. <http://dx.doi.org/10.21831/jipi.v2i2.8561>
- Astuti, W., Sulastri, S., Syukri, M., & Halim, A. (2023). Implementasi pendekatan science, technology, engineering, and mathematics untuk meningkatkan kemampuan literasi sains dan kreativitas siswa. *Jurnal Pendidikan Sains*
<https://jurnal.usk.ac.id/JPSI/article/view/26646>
- Azizah, W. A., Sarwi, S., & Ellianawati, E. (2020). Implementation of Project -Based Learning Model (PjBL) Using STREAM-Based Approach in Elementary Schools. *Journal of Primary Education*, 9(3), 238–247. <https://doi.org/10.15294/jpe.v9i3.39950>
- Baek, S. (2023). Fostering Students' environmental competencies through a plant STEAM Education Program in Korean Elementary Schools. *Asia-Pacific Science Education*, 32(9), 488–520. <https://doi.org/10.1163/23641177-bja10069>
- Bedewy, S. El, & Lavicza, Z. (2023). STEAM + X - Extending the transdisciplinary of STEAM-based educational approaches: A theoretical contribution. *Thinking Skills and Creativity*, 48, 101299. <https://doi.org/10.1016/j.tsc.2023.101299>
- Chang, D. F., & ChangTzeng, H. C. (2020). Patterns of gender parity in the humanities and STEM programs: the trajectory under the expanded higher education system. *Studies in Higher Education*, 45(6), 1108–1120. <https://doi.org/10.1080/03075079.2018.1550479>

- Chen, S. Y., Lin, P. H., & Chien, W. C. (2022). Children's Digital Art Ability Training System Based on AI-Assisted Learning: A Case Study of Drawing Color Perception. *Frontiers in Psychology*, 13. <https://doi.org/10.3389/fpsyg.2022.823078>
- Conde, M. ., Sedano, F. J. R., Llamas, C. F., Goncalves, J., Lima, J., & Penalvo, F. J. G. (2020). RoboSTEAM Project Systematic Mapping: Challenge Based Learning and Robotics. *IEEE Global Engineering Education Conference (EDUCON)*, 214–221.
- Gavari-Starkie, E., Espinosa-Gutiérrez, P. T., & Lucini-Baquero, C. (2022). Sustainability through STEM and STEAM Education Creating Links with the Land for the Improvement of the Rural World. In *Land* (Vol. 11, Issue 10). [mdpi.com. https://doi.org/10.3390/land11101869](https://doi.org/10.3390/land11101869)
- González-pérez, L. I., & Ramírez-montoya, M. S. (2022). Components of Education 4.0 in 21st Century Skills Frameworks: Systematic Review. In *Sustainability (Switzerland)* (Vol. 14, Issue 3). <https://doi.org/10.3390/su14031493>
- Hariyadi, S., Rofiâ, A., Santosa, T. A., & ... (2023). Effectiveness of STEM-based mind mapping learning model to improve students' science literacy in the era of Revolution 4.0. *Jurnal Penelitian* <https://jppipa.unram.ac.id/index.php/jppipa/article/view/5125>
- Hasanah, A., Usman, B., & Heriansyah, H. (2016). the Use of Mind Mapping Technique in Improving Students' Writing Skill. *Proceeding of the First Reciprocal Graduate Research Symposium between University Pendidikan Sultan Idris and Kuala University*, 7(1).
- Hidayah, Y., Iskandar, R., Kusmayanti, I., & Saylendra, N. P. (2023). Building the character of unity through a STEAM approach in elementary schools. *Jurnal Geuthèë: Penelitian Multidisiplin*, 6(1), 44. <https://doi.org/10.52626/jg.v6i1.197>
- Ho, C. L., Lin, T. G., & Chang, C. R. (2023). Interactive multi-sensory and volumetric content integration for music education applications. *Multimedia Tools and Applications*, 82(4), 4847–4862. <https://doi.org/10.1007/s11042-022-12314-3>
- Ilma, A. Z., Wilujeng, I., Widowati, A., Nurtanto, M., & Kholifah, N. (2023). A Systematic Literature Review of STEM Education in Indonesia (2016-2021): Contribution to Improving Skills in 21 st Century Learning. *Pegem Journal of Education and Instruction*, 13(2), 134–146. <https://doi.org/10.47750/pegegog.13.02.17>
- Jurado, E., Fonseca, D., Coderch, J., & Canaleta, X. (2020). Social steam learning at an early age with robotic platforms: A case study in four schools in Spain. *Sensors (Switzerland)*, 20(13), 1–23. <https://doi.org/10.3390/s20133698>
- Lage-Gómez, C., & Ros, G. (2024). On the interrelationships between diverse creativities in primary education STEAM projects. *Thinking Skills and Creativity*, 51, 101456.

- <https://doi.org/10.1016/j.tsc.2023.101456>
- Li, J., & Yuan, L. (2022). The current situation and strategy of Olympic education for primary and secondary school students based on Science- Technology- Engineering- Art- Mathematics education in the context of physical literacy. *Frontiers in Psychology*, 13, 910599. <https://doi.org/10.3389/fpsyg.2022.910599>
- Nofia Henita, Yeni Erita, Deni Okta Nadia, & Rahmi Yulia. (2023). The Effect of the Steam Approach on Student Social Science Learning Outcomes in Elementary School. *Journal of Digital Learning and Distance Education*, 1(9), 362–368. <https://doi.org/10.56778/jdlde.v1i9.52>
- Nugroho, O. F., Permanasari, A., & Firman, H. (2019). The Movement Of STEM Education In Indonesia : Science Teachers ' Perspectives. *Jurnal Pendidikan Inklusi*, 8(3). <https://doi.org/10.15294/jpii.v8i3.19252>
- Nurhasnah, Festiyed, & Yerimadesi. (2023). A Review Analysis: Implementation of STEAM Project Based Learning in Science Learning. *SEJ (Science Education Journal)*, 7(1), 1–13. <https://doi.org/10.21070/sej.v7i1.1623>
- Prasetyawati, A. N., & Astuti, A. P. (2025). Implementation Project Based Learning-STEAM on Student's Creative Thinking Skill in Indonesia: A Bibliometric Review. *Journal of Lesson Study and Teacher Education (JLSTE)*, 6(1), 1–10.
- Rahmawati, Y. (2020). *STEAM in Practice*. September.
- Rochmah, E. N. (2023). Learning Environments as STEAM Support to Sharpen Elementary School Students' 21st Century Skills Learning Environments Sebagai Pendukung STEAM Guna Mengasah Kecakapan Abad 21 Siswa Sekolah Dasar. *Jurnal Pendidikan Sekolah Dasar*, 6(1), 61.
- Sheffield, R., Koul, R., Blackley, S., Fitriani, E., Rahmawati, Y., & Resek, D. (2018). Transnational examination of STEM education. *International Journal of Innovation in Science and Mathematics Education*, 26(8), 67–80.
- Uskoković, V. (2023). Natural sciences and chess: A romantic relationship missing from higher education curricula. *Heliyon*, 9(4), e15015. <https://doi.org/10.1016/j.heliyon.2023.e15015>
- Wahba, F. A. A., Tabieh, A. A. S., & Banat, S. Y. (2022). The power of STEAM activities in enhancing the level of metacognitive awareness of mathematics among students at the primary stage. *Eurasia Journal of Mathematics, Science and Technology Education*, 18(11). <https://doi.org/10.29333/EJMSTE/12562>
- Wahba, F. A., Tabieh, A. A. S., & Banat, S. Y. (2022). The power of STEAM activities in enhancing the level of metacognitive awareness of mathematics among students at the primary stage. *EURASIA Journal of Mathematics, Science and Technology Education*, 18(11).
- Zhan, Z., Yao, X., & Li, T. (2023). Effects of association interventions on students' creative thinking, aptitude, empathy, and design scheme in a

STEAM course: considering
remote and close association.
*International Journal of
Technology and Design
Education*, 33(5), 1773–1795.
[https://doi.org/10.1007/s10798-
022-09801-x](https://doi.org/10.1007/s10798-022-09801-x)