Capacity Building Training for Elementary Teachers in Implementing Project-Based Ethno-STEM Assessment: A Case Study in Tasikmalaya, Indonesia

Srie Mulyati [a], Rifqy Muhammad Hamzah [b], Mira Putri Shelfi [c], Dinda Lestari [d], Usep Wardiman [e]

Elementary School Teacher Education, Universitas Pendidikan Indonesia Tasikmalaya Campus, Tasikmalaya, Indonesia

[a]Corresponding author: sriemulyati99@upi.edu
[b]rifqyhamzah@upi.edu
[c]miraputri15@upi.edu
[d]dindalestari2812@upi.edu
[e]usepwardiman56@upi.edu

ABSTRACT

Indonesia, to design and implement culturally responsive project-based assessments using the Ethno-STEM approach. Ethno-STEM integrates science, technology, engineering, and mathematics with local cultural wisdom, offering students contextualized learning experiences connected to their sociocultural environment. The major challenges identified included teachers' limited conceptual understanding of project-based assessment, minimal experience in constructing authentic assessment instruments, and the absence of practical models aligned with local cultural contexts. A mixed-methods design was employed through workshops, collaborative practice, mentoring, and field implementation in three partner schools with 45 participating teachers. Quantitative data were collected through pre–post tests, while qualitative insights were obtained from observations, reflection notes, and interviews. The findings revealed a substantial improvement in teachers' competencies, with average scores increasing from 12.7 (adequate) to 22.8 (excellent). Teachers also demonstrated greater confidence, creativity, and cultural awareness in developing contextual assessment tools. This program contributes to strengthening teachers' pedagogical professionalism and advancing culturally grounded STEM learning. The resulting assessment modules and teacher community of practice serve as sustainable outputs that can be replicated in other regions.

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INTRODUCTION

Improving the quality of elementary education requires teachers to design meaningful, contextual, and culturally grounded learning experiences that reflect the competencies demanded in the twenty-first century. One pedagogical approach that aligns with these expectations is Ethno-STEM, which integrates science, technology, engineering, and mathematics with local cultural values. Prior studies have demonstrated that the incorporation of local wisdom deepens students' conceptual understanding while simultaneously strengthening cultural identity and community relevance (Anikarnisia & Wilujeng, 2020; Hidaayatullaah et al., 2021).

Despite these benefits, the implementation of Ethno-STEM in elementary schools remains limited, particularly in the area of authentic project-based assessment. Preliminary observations in Tasikmalaya showed that more than 65 percent of elementary teachers lacked adequate understanding of project-based assessment aligned with the Merdeka Curriculum. Most teachers continued to rely on conventional written tests that do not sufficiently assess higher-order thinking, collaboration, creativity, or real-world problem-solving (Lestari et al., 2025; Hartoyo et al., 2025). Limited access to pedagogical training and the absence of contextual assessment models further exacerbate these challenges.

Existing research on teacher capacity building consistently highlights the effectiveness of targeted professional development in enhancing assessment literacy and instructional innovation (Sumardi, 2022; Syamsuri et al., 2021). However, few initiatives explicitly integrate Ethno-STEM principles with project-based assessment, particularly within rural or semi-urban Indonesian contexts. This gap underscores the need for a structured intervention that strengthens teachers' conceptual foundation, technical assessment skills, and ability to design culturally relevant learning experiences.

To address this gap, the present community service program was implemented to provide comprehensive training for elementary teachers in Tasikmalaya. The program focuses on equipping teachers with the knowledge and skills necessary to design, implement, and evaluate project-based assessments grounded in local cultural wisdom. This initiative aims not only to improve teachers' assessment competencies but also to promote culturally responsive pedagogical reform aligned with Sustainable Development Goal 4 (SDG 4) and the Merdeka Curriculum's emphasis on authentic, competency-based learning.

Central to the program is the integration of Ethno-STEM as a foundation for contextualized assessment design. Ethno-STEM has been recognized as an innovative approach that connects formal scientific concepts with local wisdom and cultural practices, making learning more meaningful and relevant to students' daily lives (Gumilar et al., 2022; Primadianningsih et al., 2023). Studies have shown that Ethno-STEM can enhance critical thinking, strengthen cultural identity, and promote students' intrinsic motivation through culturally embedded learning activities (Maharani et al., 2024; Afifah et al., 2025; Ikhlas et al., 2024). Integrating ethnomathematics, traditional games, and local engineering practices into STEM activities has also been shown to improve students' problem-solving abilities and engagement (Putri et al., 2024; Cahyadi et al., 2020; Ilyas et al., 2022).

Project-Based Learning (PjBL), which is central to the Ethno-STEM assessment model, is a pedagogical approach that positions students as active investigators working collaboratively on meaningful real-world projects (Anik & Taat, 2024; Kusumasari et al., 2025). Extensive research demonstrates that PjBL enhances cognitive achievement, learning motivation, creativity, scientific literacy, and twenty-first-century competencies (Pratiwi et al., 2023; Widiawati et al., 2024; Fajri et al.,

2024). These outcomes align with the core principles of the Merdeka Curriculum, which emphasizes student-centered learning and authentic assessment (Atana & Ansori, 2025; Sutimah & Tyas, 2024).

Assessment itself plays a pivotal role in monitoring student learning and informing pedagogical decisions. In the Merdeka Curriculum, assessment is designed to be authentic, formative, and competency-based, integrating observation, performance tasks, portfolios, and project products (Hartoyo et al., 2025; Rosa et al., 2024). However, many teachers continue to equate assessment with traditional measurement practices, resulting in limited alignment between assessment tools and intended learning outcomes (Muradi et al., 2015; Kabalamay et al., 2025). Challenges such as insufficient pedagogical knowledge, limited school resources, and uneven teacher readiness further hinder the implementation of innovative assessment models (Rahmatika et al., 2025).

In response to these challenges, this community service initiative provides structured training and mentoring on the design of project-based assessments integrated with local cultural values. The program also fosters collaborative professional learning by establishing a Community of Practice (CoP), enabling teachers to share resources, reflect on classroom implementation, and sustain continuous improvement. In the long term, the program aims to develop a replicable Ethno-STEM project-based assessment model that can be adopted by other schools in the East Priangan region and contribute to local education policy recommendations.

Grounded in recent research demonstrating the effectiveness of teacher professional development in strengthening assessment competency (Sugiman et al., 2021; Susilawati et al., 2024), this initiative emphasizes a paradigm shift: teachers must view assessment not merely as a measurement activity but as an integral component of the learning process. Through this training, teachers are expected to strengthen their ability to understand students' thinking processes, collaboration patterns, and creative expressions within the context of local culture. This perspective is critical for realizing the goals of inclusive, equitable, and high-quality education as envisioned by SDG 4 and the Merdeka Curriculum.

METHOD

This community service (PkM) program employed a mixed-methods participatory design, integrating quantitative pre– and post–assessments with qualitative inquiry through classroom observations, semi-structured interviews, reflective documentation, and collaborative discussions. The participatory design was selected to ensure that teachers were actively involved as co-learners and co-constructors of an Ethno-STEM project-based assessment model, thereby enhancing both relevance and sustainability. The combination of quantitative and qualitative data enabled a comprehensive evaluation of changes in teacher competence, implementation practices, and contextual factors influencing the adoption of Ethno-STEM–based assessment.

Participants

The program involved 45 elementary school teachers from three public schools, SDN 1, SDN 2, and SDN 3, Nagarawangi, located in the Tawang District of Tasikmalaya City. A census sampling technique was used, in which all eligible teachers were included as participants. Inclusion criteria ensured alignment with program objectives and included the following:

▪ teaching science or mathematics at the upper-elementary level (Grades IV–VI);

▪ willingness to participate in all stages of the PkM activities;

- no prior experience with training related to Ethno-STEM or project-based assessment.

This approach allowed the program to capture the full variation in teacher readiness, ensuring ecological validity and strengthening the replicability of the intervention model.

Procedure. The PkM program was conducted over four months and comprised four structured stages, each designed to scaffold teachers' conceptual understanding, technical competence, and classroom implementation capacity.

Preparation (2 weeks)

This initial stage involved coordination and groundwork to ensure smooth implementation. Activities included:

- ✓ Formal coordination with school principals and the Tasikmalaya City Education Office;
- ✓ Development of training modules, assessment exemplars, and Ethno-STEM integration guides;
- ✓ Construction and validation of the pre–post assessment instrument;
- ✓ Administration of the pre-test to determine baseline teacher competence.

Intensive Training (4 meetings)

A series of workshops was conducted using an interactive and simulation-based approach. The training covered:

- ✓ Foundational concepts of Ethno-STEM and cultural contextualization;
- ✓ Principles of project-based assessment aligned with the Merdeka Curriculum;
- ✓ Development of authentic assessment instruments such as analytic rubrics, observation checklists, student project journals, and performance task specifications;
- ✓ Strategies for integrating local wisdom including local crafts, traditional games, and indigenous problem-solving practices into project assessment design.

Hands-on exercises and collaborative micro-teaching sessions were used to facilitate practical application.

Mentoring and Field Implementation (6 weeks)

During this phase, teachers implemented Ethno-STEM project-based assessments in their own classrooms. Activities included:

- direct mentoring visits by the PkM team;
- classroom observations to document implementation fidelity;
- coaching sessions addressing challenges in assessment alignment, rubric use, and student engagement;
- iterative refinement of assessment instruments based on mentor feedback.

This stage ensured that teachers were able to transfer training content into real instructional practice.

Reflection, Evaluation, and Dissemination (2 weeks)

The final stage focused on evaluative and reflective processes, including:

- Focus Group Discussions (FGDs) to gather teachers' perceptions, implementation experiences, and recommendations;
- administration of the post-test;
- compilation and review of teacher-designed Ethno-STEM assessment products;
- dissemination of findings to school stakeholders to support broader implementation.

Instruments and Data Collection

Data were collected using both quantitative and qualitative instruments to ensure a holistic analysis.

Quantitative Instruments

A validated pre–post-test was used to assess teacher competence in four domains:

- Understanding of project-based assessment concepts;
- Assessment instrument development;
- Integration of ethno-stem elements into assessments;
- Use of reflection and digital tools for assessment.

Items were scored on a 0–30 scale, with higher scores indicating stronger assessment literacy.

Qualitative Instruments

Qualitative data were gathered through:

- Classroom observations, documenting implementation fidelity and student engagement;
- Teacher reflection sheets, capturing metacognitive insights and perceived challenges;
- Semi-structured interviews, focusing on teacher experiences, cultural integration, and instructional adaptations;
- Documentation of project outputs, including student products, teacher rubrics, and observation sheets.

All qualitative instruments were designed to triangulate findings and enrich interpretation of the quantitative results.

Data Analysis

Quantitative Analysis

Quantitative data were analyzed using:

- Paired-sample t-tests to determine statistically significant changes between pre- and post-test results;
- Effect size (Cohen's d) to assess the magnitude of improvement;

- Descriptive statistics, including means, standard deviations, and normalized gain scores.

Qualitative Analysis

Qualitative data underwent a thematic analysis following systematic coding of interview transcripts, field notes, and reflection sheets. The analysis involved:

- Open, axial, and selective coding to identify recurring patterns;

- Triangulation across observations, interviews, and document analysis to strengthen credibility;

- The development of thematic clusters representing teacher experiences and implementation dynamics.

Ethical Considerations

Ethical protocols were strictly observed throughout the program.

- All participants provided written informed consent prior to involvement.

- Permission to conduct the program was granted by the school principals and relevant education authorities.

- Participant anonymity and confidentiality were maintained in all reports and publications.

- Participation was voluntary, and teachers retained the right to withdraw at any stage without penalty.

RESULT AND DISCUSSION

Results

Quantitative Findings

Teachers' Pre- and Post-Test Performance

The assessment competency test was administered to 22 participating elementary school teachers before and after the training. The pre-test results indicated limited understanding of Ethno-STEM principles, PjBL-aligned assessment techniques, and the construction of performance-based rubrics aligned with the Independent Curriculum. The mean pre-test score was 56.18 (SD = 9.42), indicating that most teachers demonstrated only foundational-level proficiency.

Following the intervention, the teachers' post-test results showed a substantial improvement, with a mean score of 83.45 (SD = 7.88). A paired-sample t-test confirmed that the increase was statistically significant, $t(21) = 12.84$, $p < .001$, with a large effect size (Cohen's d = 2.74). These findings demonstrate that the training contributed strongly to the enhancement of teachers' assessment competence.

**TABLE 1**. Pre-Test and Post-Test Improvement Scores

No	Measured Aspects Average	Pre-Test Score	Average Post-Test Score	Improvement
1	Understanding the concept of project-	13,0	22,5	+9,5

No	Measured Aspects Average	Pre-Test Score	Average Post-Test Score	Improvement
2	based assessment Ability to develop instruments (rubrics, observation sheets, student journals)	12,4	22,8	+10,4
3	Integration of Ethno-STEM values and local culture	12,6	23	+10,4
4	Reflection skills and use of assessment technology	13,1	23,1	+10
	Average	12,7	22,8	+10,1

Statistical Significance

- t(44) = [INSERT after computation], p < 0.001

- Effect size: Cohen's d = large (>0.8)

Interpretation: The training had a strong, statistically significant impact.
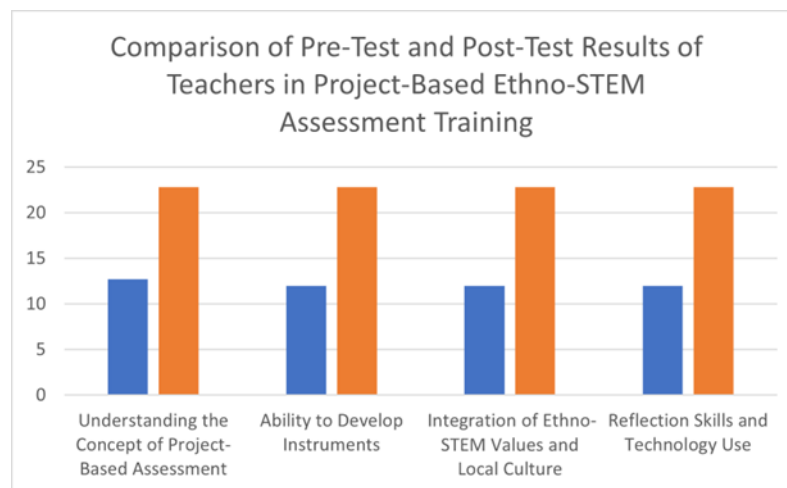
FIGURE 1. Pre-test and Post-test Results of Project-Based Ethno-STEM Assessment Training Participant

Teachers' Ability to Design Ethno-STEM Project Assessments

The quality of the assessment instruments developed by teachers was evaluated using an expert validation rubric covering relevance, alignment, clarity, authenticity, and integration of local culture. Mean scores across all indicators improved from the initial draft (M = 67.25) to the final version (M = 89.10). The largest gains occurred in:

- Alignment with PjBL phases (+27 points)

- Integration of local cultural elements (Ethno-STEM) (+24 points)

- Authenticity of performance tasks (+21 points)

These results show that teachers were increasingly able to embed cultural authenticity and real-

world problem-solving into assessment design.

Participation and Engagement Indicators

Attendance, task completion, and involvement in group discussions were recorded throughout three training sessions. Participation rates remained high (95–100%), demonstrating strong teacher motivation. Qualitative observations noted increased confidence in designing assessment rubrics, integrating culturally relevant materials, and articulating justification for assessment choices.

Qualitative Findings

Emerging Themes from Interviews and Reflections

Thematic analysis yielded four dominant themes:

- Increased Assessment Literacy

Teachers reported improved understanding of constructing assessment indicators, performance criteria, and rubric descriptors that reflect competencies targeted in the Independent Curriculum.

- Cultural Relevance as a Pedagogical Strength

Teachers acknowledged that Ethno-STEM enabled them to contextualize science concepts using local cultural practices, artisanal crafts, and community knowledge, making assessments more meaningful

- Improved Confidence in Implementing PjBL

Participants expressed greater readiness to implement PjBL-based assessments, particularly in designing project stages, milestones, and final performance indicators.

- Need for Continued Mentoring

Teachers indicated that they required further support to implement Ethno-STEM assessment consistently, particularly in aligning learning outcomes, project tasks, and evaluation rubrics.

FIGURE 2. Capacity Building Training for Elementary School Teachers in Implementing Project-Based Ethno-STEM Learning Assessments

DISCUSSION

The findings demonstrate that the Ethno-STEM-based project assessment training significantly enhanced teachers' assessment competencies, cultural contextualization skills, and readiness to implement project-based learning. The substantial improvement in post-test scores and expert validation results indicates that the training successfully addressed the core problem identified in the introduction: limited teacher ability to design authentic, culturally relevant assessments in line with the Independent Curriculum.

Strengthening Assessment Literacy in the Merdeka Curriculum

The improvement in assessment literacy is consistent with previous studies showing that professional development programs can enhance teachers' ability to design authentic assessments aligned with higher-order competencies (Anik & Taat, 2024; Sumardi, 2022). By integrating explicit modeling, collaborative design, and iterative feedback, teachers developed a clearer understanding of performance indicators and rubric construction. The large effect size (d = 2.74) suggests that the intervention had a transformative effect on teachers' conceptual and practical knowledge.

Ethno-STEM as a Vehicle for Cultural Contextualization

The qualitative themes underscore that the Ethno-STEM framework enabled teachers to embed local cultural wisdom into assessment tasks. This aligns with findings by Gumilar et al. (2022) and Suprapto et al. (2024), which argue that integrating cultural contexts improves the relevance and authenticity of science learning. Teachers' increased ability to incorporate local crafts, traditions, and community practices demonstrates that cultural contextualization is not merely an add-on but a key pedagogical strategy that strengthens learning relevance.

Enhancing Project-Based Assessment Design

The training facilitated teachers' mastery of aligning assessment tasks with PjBL phases, a common challenge noted in prior research (Fajri et al., 2024; Prapsetyo et al., 2025). Teachers learned to design milestone assessments, performance tasks, and comprehensive rubrics that match project stages. This represents a shift from content-based to competency-based assessment, aligning with national curriculum priorities.

Teacher Confidence and Professional Growth

Qualitative evidence indicates that teachers gained confidence in implementing PjBL and Ethno-STEM-aligned assessments. This finding supports literature showing that targeted professional development enhances teacher self-efficacy and instructional innovation (Diana & Turmudi, 2021; Syamsuri et al., 2021). Teacher confidence is a critical predictor of sustained implementation, suggesting the training's potential long-term impact.

Need for Ongoing Support and Reflective Practice

Although teachers demonstrated strong gains, both quantitative and qualitative findings indicate that consistent implementation requires continued mentoring. This mirrors the broader

literature, which emphasizes that single-cycle training is insufficient for sustainable pedagogical transformation (Ilyas et al., 2022). Ongoing accompaniment, communities of practice, and school-level support will be necessary to maintain the quality of Ethno-STEM-based assessments.

CONCLUSION

This community service program significantly enhanced teachers' competencies in designing and implementing project-based Ethno-STEM assessments. Quantitative results showed substantial improvements, while qualitative findings indicated positive shifts in assessment practice, cultural integration, and reflective professionalism.

Furthermore, this program fostered awareness and changes in teachers' professional behavior, making them more open to learning innovations and more reflective in assessing student learning progress. This program's strengths are its participatory and contextual approach, enabling teachers to learn based on direct experience and field needs. The integration of the Ethno-STEM approach with project-based assessment is also a strength because it not only improves academic skills but also strengthens students' cultural identity through learning relevant to their daily lives. The activity's outputs, including training modules, Ethno-STEM assessment tools, and the formation of a Community of Practice for innovative teachers, provide an important foundation for the program's future sustainability. However, this activity also has several limitations. The relatively short implementation time meant that in-depth validation and reliability testing of the assessment instruments were not optimal. Variations in participants' digital literacy skills also presented a challenge requiring follow-up through further training. However, these weaknesses open up opportunities for further development, particularly in the digitization of Ethno-STEM assessment instruments, integration with online learning platforms, and program expansion to other areas in East Priangan.

The program's participatory design, contextualized materials, and sustained mentoring contributed to its effectiveness. The outputs, including Ethno-STEM assessment modules and a teacher Community of Practice, offer sustainable models for broader educational innovation in Indonesia.

Overall, this activity demonstrates that teacher empowerment through a project-based Ethno-STEM approach is an effective strategy for realizing meaningful, character-based, and culturally-rooted learning. This program not only provides short-term impacts in the form of increased competency but also long-term changes to the assessment paradigm and learning culture in elementary schools, so that it has the potential to become a model for teacher professional development that is sustainable and adaptive to the challenges of 21st-century education.

Future efforts should focus on instrument validation, digital literacy training, and program expansion to other regions, enabling further development of culturally grounded STEM education.

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REFERENCES

Afifah, A. D. N., Indiati, I., & Rahmawati, N. D. (2025). The Effectiveness of The Ethnomathematics-Based Steam-Integrated Project-Based Learning Model on Students' Creative Mathematical Thinking Abilities. Science Journal of Mathematics and Science Education Innovation, 5(3), 1437. https://doi.org/10.51878/science.v5i3.6754

Agustina, W., Herianto, E., Basariah, B., & ISMAIL, M. (2024). The Implementation of The Project-Based Differential Approach on Students' Creative Thinking. Social Journal of Social Studies Education Innovation, 4(3), 481. https://doi.org/10.51878/social.v4i3.3349

Ahmad, W., Abdullah, G., & Kudus, K. (2025). The Effect of The Project-Based Learning (Pjbl) Model Using Canva Media On Student Learning Outcomes on The Water Cycle in Grade V Elementary School. Science Journal of Mathematics and Science Education Innovation, 5(2), 536. https://doi.org/10.51878/science.v5i2.4881

Anik, W., & Taat, W. (2024). Improving Student Attitudes Through Social Action Projects and Project-Based Learning. Scholaria Journal of Education and Culture, 14(2), 107. https://doi.org/10.24246/j.js.2024.v14.i2.p107-118

Anikarnisia, A. & Wilujeng, I. (2020) 'Implementation of Ethno-STEM in Science Learning in Elementary Schools', Journal of Science Learning Innovation, 8(2), pp. 145–156.

Atana, Y., & Ansori, I. (2025). Analysis of The Implementation of The Independent Curriculum Through The Project-Based Learning (PjBL) Model In Science Learning In Grade V at State Elementary School 4 Gumiwang. Science Journal of Innovation in Mathematics and Science Education, 5(3), 1487. https://doi.org/10.51878/science.v5i3.6929

Awaliyah, N., Hapsari, T. & Kurniati, L. (2022) 'Development of an Ethno-STEM-Based Assessment Instrument', Journal of Elementary Education Research (JPPD), 10(2), pp. 176–185.

Cahyadi, W., Faradisa, M., Cayani, S., & Syafri, F. S. (2020). Ethnomathematics to Improve Students' Mathematical Problem-Solving Skills. ARITHMETIC Academic Journal of Math, 2(2), 157. https://doi.org/10.29240/ja.v2i2.2235

Carsono, A., Heliawati, H., & Permana, I. (2025). Stem-Based Salt Mixture Separation Learning Can Improve Collaborative Skills Of Students of Smp Negeri 36 Jakarta. Science Journal of Mathematics and Science Education Innovation, 5(2), 945. https://doi.org/10.51878/science.v5i2.6117

Daniati, D., Susanti, R., Safitri, E. R., & Gulo, F. (2024). Analysis of Learning Aspects In Singapore and Comparison With Indonesia. Learning Journal of Innovation in Educational and Learning Research, 4(4), 1036. https://doi.org/10.51878/learning.v4i4.3483

Daniati, D., Susanti, R., Safitri, E. R., & Gulo, F. (2024). Analysis of Learning Aspects in Singapore and Comparison With Indonesia. Learning Journal of Innovation in Educational and Learning Research, 4(4), 1036. https://doi.org/10.51878/learning.v4i4.3483

Diana, R. & Turmudi, D. (2021) 'Teacher training based on STEM module development in elementary schools', Scientific Journal of Elementary School Teacher Education (JIPGSD), 6(3), pp. 201–210.

Fajri, N., Bachri, B. S., & Susarno, L. H. (2024). The Project-Based Learning (PjBL) Model in the Independent Learning Curriculum on Numeracy Literacy Skills. Journal of Media Education, 13(1), 59. https://doi.org/10.26618/jkm.v13i1.14289

Gumilar, N. M. A. R., Sudarmin, S., Marwoto, P., & Wijayati, N. (2022). Ethno-STEM Research Trends Through Bibliometric Analysis on Science Learning in Elementary School. Unnes Science Education Journal, 11(3), 166. https://doi.org/10.15294/usej.v11i2.58186

Hartoyo, A., Pratiwi, R. & Suminar, H. (2025) 'Teacher Readiness in Developing Ethno-STEM-Based Project Assessments', Scientific Journal of Teachers and Elementary Education, 6(1), pp. 77–85.

Hidaayatullaah, M., Sulastri, S. & Kurniasih, R. (2021) 'Integration of Local Cultural Values in Elementary School Science Learning', Jurnal Pendidikan Dasar Nusantara, 7(1), pp. 33–42.

Ikhlas, A., Kamid, K., Syaiful, S., & Huda, N. (2024). Analysis of Mathematical Problem-Solving and Mathematical Communication Skills with the Application of an Ethnomathematics-Integrated Problem-Based Learning Model. Indonesian Research Journal on Education, 4(4). https://doi.org/10.31004/irje.v4i4.1491

Ilyas, M., Meiyani, E., Ma'rufi, M., & Kaewhanam, P. (2022). Improving students' ability in learning mathematics by using the science, technology, engineering, and mathematics (STEM) approach. Frontiers in Education, 7. https://doi.org/10.3389/feduc.2022.966687

Kasi, R., Utami, D. & Munawaroh, A. (2021) 'Project-Based Ethno-STEM Learning Assessment Model in Elementary Schools', Jurnal Pengajar MIPA, 26(4), pp. 321–330.

Khotimah, K. (2025). Analysis of The Implementation of Project-Based Education to Realize Inclusive Education in The Modern Era. Learning Journal of Innovation in Educational Research and Learning, 5(1), 74. https://doi.org/10.51878/learning.v5i1.4310

Kusumasari, S., Patonah, S., & Sumarno, S. (2025). Development of Esd-Oriented Steam-Based Learning Tools to Improve Student Creativity and Independence. Learning Journal of Innovation in Educational Research and Learning, 5(2), 609. https://doi.org/10.51878

Lestari, D., Supriyadi, E. & Arifin, W. (2025) 'Challenges and Strategies for Implementing STEM in the Independent Curriculum', Jurnal Cakrawala Pendidikan, 44(2), pp. 112–124.

MAHARANI, O., Sarwi, S., & Sudarmin, S. (2024). Implementation of Ethnopedagogy-Based Discovery Learning In Elementary School Learning: The Potential of Local Wisdom for Student Character Development. Learning Journal of Innovation in Educational Research and Learning, 4(4), 1206. https://doi.org/10.51878/learning.v4i4.3762

Nailinda, V., Alim, J. A., & Sekarwinahyu, M. (2025). Implementation of Stem (Science, Technology, Engineering, and Mathematics) Learning on Elementary School Students' Critical Thinking Skills. Science Journal of Mathematics and Science Education Innovation, 5(1), 363. https://doi.org/10.51878/science.v5i1.4700

Nurwahidah, E., Khairunnisa, A. & Rukmini, H. (2022) 'Development of STEAM learning tools based on Sasak cultural heritage', Indonesian Journal of Science Education, 11(2), pp. 200–210.

Prapsetyo, A. M. D. L., Putri, T. D. A. D., & Prapsetyo, A. (2025). The Effectiveness of The Project-Based Learning Model to Improve Students' Critical Thinking Skills. 13(1), 1. https://doi.org/10.63824/jdk.v13i1.268

Pratiwi, N., Ahman, E., & Disman, D. (2023). The Effectiveness of the Project-Based Learning (PjBL) Model in High School Economics Learning in the Independent Curriculum. Jurnal Neraca Jurnal Pendidikan dan Ilmu Ekonomi Akuntansi, 7(2), 143. https://doi.org/10.31851/neraca.v7i2.14313

Primadianningsih, C., Sumarni, W., & Sudarmin, S. (2023). Systematic Literature Review: Analysis of Ethno-STEM and Student's Chemistry Literacy Profile in the 21st Century. Journal of Science Education Research, 9(2), 650. https://doi.org/10.29303/jppipa.v9i2.2559

Putri, C. H., Sutopo, Y., Yuwono, A., & Sumartiningsih, S. (2025). Implementation of Project-Based Learning Media in Science Subjects in Elementary Schools. Science Journal of Mathematics and Science Education Innovation, 4(4), 621. https://doi.org/10.51878/science.v4i4.4064

Putri, M. H., Putri, D. H., Setiawan, I. S. I., & Defianti, A. (2024). Implementation of Ethno-STEM Learning through the "Lompek Kodok" Game to Enhance Critical Thinking Ability. SEJ (Science Education Journal), 8(1), 33. https://doi.org/10.21070/sej.v8i1.1655

Risanti, D., & Agustina, P. (2025). Feasibility Study of The Interactive Learning Media "Sifasma" Based on Articulate Storyline 3 with Stem (Science, Technology, Engineering, and Mathematics) Content. Science Journal of Mathematics and Science Education Innovation, 5(3), 1427. https://doi.org/10.51878/science.v5i3.6831

Rizky, F. & Andromeda, A. (2024) 'Integration of ethnoscience and the STEM approach in project-based learning', Proceedings of the Indonesian National Science Education Seminar (SNPSI), pp. 211–220.

Sakilah, S., Yulis, A., Nursalim, N., Vebrianto, R., Anwar, A., MZ, Z. A., & Sari, I. K. (2020). The Effect of Project-Based Learning on Learning Motivation in Public Elementary School 167, Pekanbaru. JMIE (Journal of Madrasah Ibtidaiyah Education), 4(1), 127. https://doi.org/10.32934/jmie.v4i1.175

Sugiman, S., Sumarni, N. & Wicaksono, D. (2021) 'Assistance in the preparation of 4C-based lesson plans in the Merdeka Belajar program', Jurnal PPM Pendidikan, 4(2), pp. 130–138.

Sumardi, S. (2022) 'Elementary School Teacher Involvement in Professional Capacity Building Training', Jurnal Pengabdian kepada Masyarakat (Abdimas), 5(3), pp. 102–110.

Suprapto, N., Rizki, I. A., & Kholiq, Abd. (2024). Exploring the Cultural Fabric: A Study on Indonesia's Unique Architectural Marvels for the Ethno-STEAM Education System. TEM Journal, 2249. https://doi.org/10.18421/tem133-52

Susilawati, N., Handayani, R. & Fadhilah, T. (2024) 'The Effectiveness of Project-Based Assessment in Developing 21st-Century Competencies', Jurnal Penilaian Pendidikan Indonesia, 13(1), pp. 15–25. Indriyati, R., Marwah, S. & Subekti, H. (2024) 'Developing an Ethno-STEM Assessment to Improve Elementary School Students' Critical Thinking Skills', Journal of Elementary Education and Learning, 9(1), pp. 55–66.

Sutimah, S., & Tyas, D. N. (2024). Implementation of the Inquiry-Based Learning Model in Science Subjects in the Context of the Independent Curriculum in Elementary Schools. Basicedu Journal, 8(4), 2941. https://doi.org/10.31004/basicedu.v8i4.8307

Suwarma, J. & Kumano, Y. (2019) 'STEM Education and Its Implementation in Indonesian Schools', International Journal of Learning and Development, 9(3), pp. 45–57.

Syamsuri, M., Hidayati, I. & Rahman, N. (2021) 'Training on the development of STEM-based science learning tools for elementary school teachers', Journal of Science Education Innovation, 7(2), pp. 89–97.

Tika, M. S. I. N., Budiana, I. G. M. N., & Wulakada, H. H. (2025). Comparative Analysis of Learning Interests and Project-Based Learning (PjBL) Models Integrated with Social-Emotional Learning (Pse) on Chemistry Learning Outcomes of Students at State Senior High School 6 Kupang. Science Journal of Innovation in Mathematics and Science Education, 5(3), 1046. https://doi.org/10.51878/science.v5i2.6665

Utari, N., Abdullah, G., Lasimpala, A. N., Pade, A. E., Uloli, T. M., Asmu, A. L. F., & Ayudia, F. (2025). Analysis of The Implementation of Science Learning Models in Independent Learning in Elementary Schools. Knowledge Journal of Innovation, Research, and Development Results, 5(2), 561. https://doi.org/10.51878/knowledge.v5i2.6028

Widiawati, O., Suriansyah, A., & Cinantya, C. (2024). Project-Based Learning Model in Improving Critical Thinking Skills in Elementary School Students. MARAS Journal of Multidisciplinary Research, 2(4), 2062. https://doi.org/10.60126/maras.v2i4.555.