Enhancing Language Learning Through Ethnopedagogical Blended STEM: Effects on Students' Creative and Problem-Solving Competencies

[1*]Everhard Markiano Solissa, [2]Sukini, [3]Burhan Efendi, [4]Tomi Apra Santosa, [5]Hasyim Mahmud Wantu, [6] Unpris Yastanti

[1]Faculty of Teacher Training and Educations, Universitas Pattimura, Indonesia
[2]Faculty of Teacher Training and Education, Universitas Widya Dharma Klaten, Indonesia
[3]Universitas Muhammadiyah Karanganyar, Indonesia
[4] Akademi Teknik Adikarya, Indonesia
[5] Faculty of Teacher Training and Education, IAIN Sultan Amai Gorontalo, Indonesia
[6]Universitas Bina Sarana Informatika, Indonesia

*Corresponding Author e-mail: eversolissa@yahoo.com

Abstract

This study aims to investigate the effectiveness of ethnopedagogical mixed STEM approaches in improving students' creative thinking and problem-solving skills in the context of language learning. Using 24 empirical studies published between 2020 and 2024, the study synthesized quantitative findings to determine the overall effect size and identify moderator variables that could influence learning outcomes. The data encoding follows PRISMA guidelines, and statistical analysis is performed using JASP software. The analysis yielded a significant overall effect measure (Hedges' g = 0.78, p <0.001), which demonstrated a strong positive impact of ethnopedagogically blended STEM learning on creative skills and problem-solving in language education. The moderator analysis showed that education level and duration of learning significantly moderated the effect size, while the year of publication and geographic region did not show significant moderation. These findings support the integration of culturally responsive STEM-based pedagogy in language teaching and highlight the importance of contextual-based learning models for fostering 21st-century skills.

Keywords: Ethnopedagogy, Blended STEM, Language Education, Creative Thinking, Problem Solving

INTRODUCTION

Language mastery is one of the fundamental skills that is very crucial in the context of education and individual development, especially in the current era of globalization (Bagus et al., 2020). Language not only serves as a means of communication, but also as a primary medium for acquiring knowledge, developing critical thinking, and building effective social interactions. In the world of education, good language skills allow students to understand the learning material in depth and convey ideas clearly and systematically (Shadiev & Yang, 2020; Zhou & Wei, 2018). In addition, mastery of foreign languages—especially international languages such as English—is the key to access global academic resources and international career opportunities. Therefore, improving language competence is a strategic priority in an effort to produce a superior generation that is able to compete at the national and international levels (Nurwidodo et al., 2023).

In the era of globalization marked by advances in information technology and cross-border human mobility, language skills are increasingly becoming an important capital for

individuals to adjust to the socio-cultural and economic dynamics of the world(Žižanović et al., 2021). Language mastery opens the door to cross-cultural exchange of ideas and collaboration between countries in various fields such as science, technology, business, and diplomacy. Furthermore, language skills support the development of creativity and problem-solving abilities through multidisciplinary interactions that are rich in different perspectives(Sugiarto et al., 2025; Rohmantika & Kurniawan, 2021). Thus, investing in language learning not only strengthens students' academic capacity but also prepares them for the complex challenges in the global society of the future. One of the main challenges in language learning today is the tendency for approaches that are theoretical and less contextual(Kessler, 2018; Parmaxi, 2023). The material presented is often limited to grammatical and structural aspects, thus ignoring the social, cultural, and functional dimensions of the use of language in real life. As a result, students have difficulty in connecting learning with authentic communication situations. The lack of integration of the context of daily life and local culture makes learning feel abstract and irrelevant, reducing students' motivation and ability to apply language effectively in a variety of situations (Zhang, 2022).

In addition, language learning in general has not fully integrated 21st-century skills such as critical thinking, creativity, collaboration, and digital literacy(Nurwidodo et al., 2023; Žižanović et al., 2021). A curriculum that is linear and focused on memorization is not enough to facilitate the development of complex competencies needed in an era of globalization and technological disruption (Ashidiq et al., 2024). This has an impact on students' low readiness to face real-world challenges that require cross-cultural communication skills, independent problem-solving, and adaptation to the digital environment. Therefore, language learning needs to be redesigned with a more holistic, interdisciplinary, and responsive approach to the needs of the times (Łubiarz & Kościńska, 2024).

In an era of globalization characterized by high mobility, information, technology, and people, individuals are required to have skills that go beyond basic academic abilities. Two of the main competencies that are highlighted in 21st-century skills are creativity and problem-solving skills(Rediani et al., 2024; Oktarina et al., 2018; Winiasri et al., 2023). Creativity allows individuals to generate new and original ideas in the face of complex challenges, while problem-solving skills are required to identify issues, analyze situations, and design effective solutions. In a global context, these two competencies are determinants of individual success in the world of work, education, and social life, where change and uncertainty are an integral part (Andrianto et al., 2023).

In response, today's education needs to design a learning strategy that focuses not only on content mastery, but also on developing high-level thinking skills(Nursima et al., 2022; Putri & Turaqulov, 2022). In the context of language learning, this can be done through integrative and innovative approaches, such as the use of problem-based projects, the use of interactive digital media, and the application of real-context-based collaborative learning models(Kasi et al., 2021). This strategy not only helps students understand language as a communication tool, but also as a means to express creative ideas and solve problems in daily life. Thus, language learning is not only cognitive, but also oriented towards the development of competencies relevant to global needs (Babalola & Keku, 2024; Rohmantika & Kurniawan, 2021).

The ethnopedagogy approach is an educational paradigm that places local cultural values as the main foundation in the learning process (Defi, 2025; Rexhepi & Bajrami, 2025);. This concept developed in response to the need to adapt teaching methods to be more relevant to the social and cultural context of learners. By integrating local wisdom, traditions, and cultural practices of the local community, ethnopedagogy not only enriches the learning experience but also increases students' emotional engagement and motivation (Sudarmin et al., 2025). This approach allows for more meaningful knowledge transfer because learning materials are delivered through a cultural lens that is already familiar to students, making it easier to understand and apply academic concepts in daily life.

The integration of ethnopedagogy approaches with modern learning models such as STEM-based blended learning offers an innovative strategy that is able to answer contemporary educational challenges (Wantu et al., 2024). Blended learning, which combines in-person and online learning methods, provides greater flexibility and accessibility for students to learn actively and independently (Sakti et al., 2024). When combined with local cultural values through ethnopedagogy, this approach not only enriches academic content but also fosters a sense of emotional attachment and cultural identity in learners. This approach allows students to apply STEM concepts in culturally relevant real-life contexts, thereby enhancing their conceptual understanding as well as creativity (Dewanto et al., 2023; Uluk et al., 2024).

The application of STEM-based blended learning in an ethnopedagogical framework also supports the development of 21st-century competencies such as critical thinking skills, collaboration, and creative problem-solving (Arar et al., 2023). By utilizing digital technology as a learning medium while incorporating elements of local culture as a source of inspiration and context for the application of science, this model creates a holistic and contextual learning environment(Sugiarto et al., 2025; Lazo, 2024). Various empirical studies show that the integration of these two approaches can improve students' motivation to learn as well as academic outcomes in the fields of language and science. Therefore, the combination of ethnopedagogy and blended STEM is a strategic alternative to build an inclusive education system that is responsive to socio-cultural needs as well as the demands of global technological development (Abdurrahman et al., 2020; Łubiarz & Kościńska, 2024).

Some previous research has shown that STEM-based learning approaches have a significant contribution to improving higher-level thinking skills, such as creativity and problem-solving abilities. Research by Becker & Park (2011) shows that the integration of STEM in primary and secondary education can simultaneously improve students' divergent and logical thinking skills. In the context of language learning, the STEM approach provides a space for students to relate language learning to the real world through contextual problem-solving, phenomenon observation, and collaborative exploration(Suherman et al., 2021). This not only strengthens the linguistic aspect, but also expands the way students think in expressing ideas creatively and logically.

Research by Sulastri et al. (2020) concluded that ethnopedagogy is able to develop students' cognitive and affective skills through the internalization of local cultural values into learning materials. When ethnopedagogy is combined with a blended STEM approach, there is a synergistic potential to create language learning that is not only innovative and meaningful, but also contextual and rooted in the cultural identity of learners. Therefore, a meta-analysis study of the effectiveness of the Ethnopedagogical Blended STEM approach in language learning is relevant and important to provide stronger empirical evidence.

In the face of various empirical findings that are scattered about the influence of ethnopedagogical blended STEM on students' creative competence and problem-solving, scientific synthesis through meta-analysis is very important to obtain a more comprehensive and valid picture. Meta-analysis allows the incorporation of quantitative data from various independent studies so as to identify general patterns, effect strengths, and moderator variables that influence learning outcomes. With this approach, the limitations of each individual study such as small sample sizes or methodological variations can be minimized, resulting in stronger conclusions and broader generalizations. Therefore, meta-analysis not only strengthens the scientific evidence base but also provides strategic direction for the effective development of ethnopedagogy and STEM-based education policies and learning practices. Based on this, this study aims to investigate the effectiveness of the ethnopedagogical mixed STEM approach in improving students' creative thinking and problem-solving skills in the context of language learning.

METHOD

This study uses a quantitative meta-analysis approach to evaluate the effectiveness of the *Ethnopedagogical Blended STEM approach* on students' creative competence and problem-solving in language learning. Meta-analysis was chosen because it is able to integrate and synthesize the results of various relevant empirical studies in order to obtain more generalizable and accurate conclusions. The analyzed studies were obtained through systematic searches in several scientific databases such as Scopus, Web of Science, ERIC, and Google Scholar. Inclusion criteria include publications that empirically test the effects of STEM-based ethnopedagogical approaches and blended learning in the context of language learning, as well as reporting quantitative data relevant to effect size calculations, such as mean values, standard deviations, and sample sizes. The results of the data selection were obtained from 18 relevant studies.

The data analysis process was carried out using the latest version of JASP software . This analysis included standard effect size calculations (Cohen's d or Hedges' g), heterogeneity testing between studies using Q-statistic and I^2, and moderator analysis to identify variables that affect the effectiveness of the intervention, such as education level, duration of intervention, and cultural context. In addition, publication bias tests were also carried out through *funnel plots* and *Egger's test*. The use of JASP allows for transparent and easily replicated statistical analysis, as well as supports informative data visualization, thus strengthening the validity and reliability of the findings of this study. Calculate the value of effect size and standard error using the following formula:

$$z = 0.5 \; x \; In \; \frac{1+r}{1-r}$$

Equatian 1. Effect Size

$$V_z = \frac{1}{N-3}$$
$$SE_{X=} \sqrt{V_z}$$

Equatian 2. Standar error

Interpretation of effect size value data with the help of JASP serves to obtain data on the existence or absence of publication bias. The effect size value criteria in this study can be seen in Table 1.

Tabel 1. Kriteria Nilai Effect Size

Effect Size	Kriteria
$0.0 \leq$ Effect Size ≤ 0.20	Poor
$0.21 \leq$ Effect Size ≤ 0.50	Small
$0.51 \leq$ Effect Size ≤ 0.10	Medium
$1,11 \geq$ Effect size	Strong

Source:(Ayaz & Söylemez, 2015; Zulyusri et al., 2023)

Data on research samples, effect size, standard errors, heterogeneity tests and publication bias are presented in the form of a table. The publication bias test uses a p-value of > 0.05 by conducting a funnel plot analysis and an egger's test. If the results of the funnel plot analysis and egger's test > 0.05, it means that there is no publication bias.

RESULTS AND DISCUSSION

Based on the results of data search through the database, 18 studies/articles met the inclusion criteria. The effect size and error standard can be seen in Table 2.

Table 2. Effect Size and Standard Error Every Research

Code Journal	Country	Vz	Z	SEz
JA1	Indonesia	0.00678	1.08	0.34
JA 2	Indonesia	0.02451	2.11	0.28
JA 3	Malaysia	0.06712	0.21	0.10
JA 4	Malaysia	0.02831	0.96	0.30
JA 5	Thailand	0.00216	1.17	0.44
JA 6	Indonesia	0.00781	0.91	0.28
JA 7	Mesir	0.06236	0.44	0.15
JA 8	China	0.06181	0.34	0.06
JA 9	China	0.05611	1.45	0.27
JA 10	Pakistan	0.04265	1.27	0.33
JA 11	Pakistan	0.00502	1.30	0.30
JA 12	Inggris	0.01182	0.57	0.20
JA 13	Indonesia	0.09022	0.91	0.22
JA 14	Amerika	0.00701	1.82	0.35
JA15	Amerika	0.06113	0.78	0.29
JA 16	China	0.00531	2.15	0.30
JA 17	Indonesia	0.00470	0.29	0.10
JA 18	Indonesia	0.02671	0.79	0.21

Based on Table 2, the effect size value of the 18 studies ranged from 0.21 to 2.15. According to Borenstein et al., (2007) of the 4 (22.2%) small criteria effect size, 3 (16.6%) studies had medium criteria effect sizes and 11 (61. 2 %) studies had high criteria effect size values. Based on the results of the data test based on JASP outputs, the following results were obtained:

Heterogeneity Test

Furthermore, analyze the heterogeneity test of the ten analyzed studies which can be seen in Table 3.

Table 3. *Resiadual Heteroneity test*

Q$_c$	df	P
38.138	17	< 0.001

Based on Table 3. The results of the heterogeneity test analysis showed that 10 researchers had a heterogeneous distribution (QC = 38.138 ; P < 0.001). With this, random effect size is effective to estimate the average effect size of the 10 studies analyzed. The results of the the strong positive impact of ethnopedagogical mixed STEM learning on creative skills and problem-solving in Language education.

Hypothesis Test

Next, calculate the p-value to test the hypothesis through the random effect model. The results of the summary effect model analysis with the random effect model can be seen in Table 4.

Tabel 4. *Pooled Effect Size Test*

Estimate	Standard error	t	df	P
0.983	0.139	7.063	17	< 0.001

Table 4. The results of the analysis of the average value of effect size with the random effect model showed that there was the presence of a strong positive impact of ethnopedagogical mixed STEM learning on creative skills and problem-solving in language education compared to conventional models (t = 7.063; p< 0.001).

Publication Bias

Checking publication bias through funnel plot analysis and Rosenthal fail safe N (FSN) test (Tamur et al., 2020; Badawi et al., 2022; Ichsan et al., 2023b; Borenstein et al., 2007). The results of checking publication bias with funnel plot can be seen in Figure 1
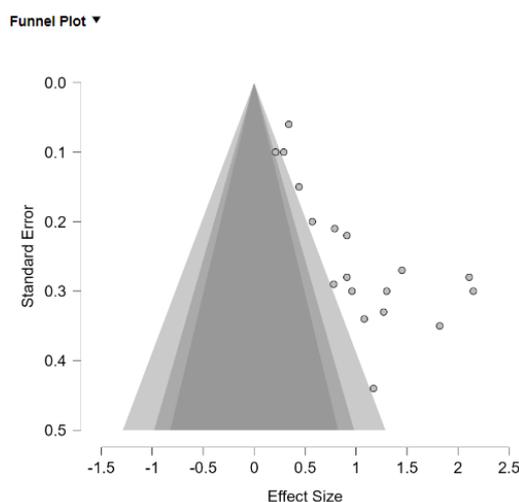

Figure 1. Funnel Plot

Based on Figure 1, the analysis of the funnel plot is not yet known whether it is symmetrical or asymmetrical, so it is necessary to conduct a Egger's test. The results of the Egger's test calculation can be seen in Table 5.

Tabel 5. Egger's Test

	z	p
Sei	2.150	0.124

Based on Table 5, the Z value is 2.150 and the p-value is 0.124 more than the sig value. 0.05 means that there is no publication bias in this study. Next, the forest plot analysis can be seen in figure 2.
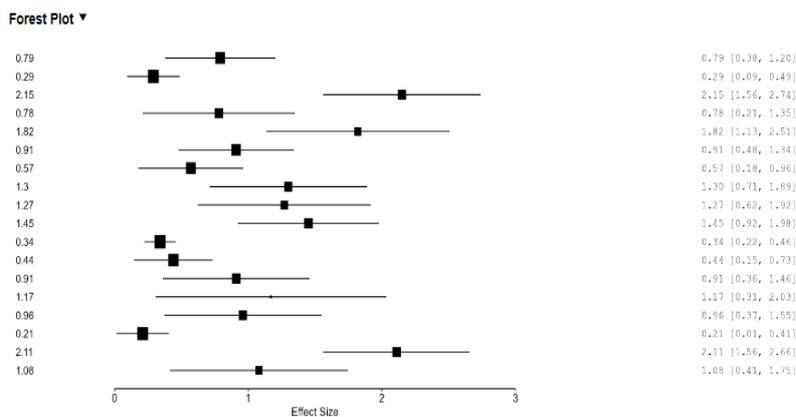

Figure 2. Forest Plot

Based on the forest plot analysis, it can be observed that the analyzed articles have values that vary between 0.21 to 2.15 with a summary effect size value of 0.692. This finding the strong positive impact of ethnopedagogical mixed STEM learning on creative skills and problem-solving in Language education. This approach combines local cultural values (ethnopedagogy) with an interdisciplinary approach based on STEM and technological support in a blended learning model(Defi, 2025). Research shows that ethnopedagogy can increase the relevance of learning to students' lives, while blended STEM reinforces the linkages between language concepts, science, and real-world contexts (Khasanah & Hakim, 2022; Sutrisna et al., 2021). This creates a learning ecosystem that not only fosters language skills, but also cultural awareness and cross-disciplinary thinking skills (Erfan et al., 2024; Quiao et al., 2024).

Ethnopedagogical blended STEM based language learning has a significant impact on increasing student creativity. Learning activities that emphasize cultural exploration, problem-solving, and project-based product creation encourage students to think originally and reflectively (Nugroho et al., 2023). Creativity in this context is not only seen in the linguistic products produced, but also in the way students integrate elements of language with scientific and cultural knowledge in conveying ideas. Thus, language learning is not only reproductive, but also productive and transformative (Shadiev & Yang, 2020). Ethno-STEM in language learning contributes to strengthening problem-solving competencies because this approach invites students to analyze real-world situations related to their local culture and formulate solutions through the medium of language. Studies show that involvement in problem-based cross-disciplinary projects improves students' ability to think critically, connect information, and convey solutions in effective language (Hidayati et al., 2021; Widodo, 2020; Putri & Turaqulov, 2022). Language learning with this approach changes the role of language from just a means of communication to a means of thinking and acting in solving problems.

The blended learning model allows for flexibility and sustainability of learning in and out of the classroom. In the context of ethnopedagogy-STEM, digital technology facilitates access to diverse cultural and scientific resources, enriching students' learning experiences (Rahmawati & Sari, 2022). Digital media allows students to document local cultural narratives, create multimedia products, and engage in cross-cultural discussions (Sakti et al., 2024; Quiñonez & Mendoza, 2024). This integration enhances learning engagement and enables personalized learning that is adaptive to students' needs and interests, including in the context of language proficiency. The importance of reformulating the language curriculum to be more adaptive to the times. Ethnopedagogical blended STEM curriculum can be an alternative to answer the challenges of competency-based education and values (Parmaxi, 2023; Zhang, 2022). In addition to emphasizing linguistic skills, this curriculum must also encourage character strengthening, collaboration, and the integration of knowledge with local culture (Suryana & Munandar, 2022). Thus, students are not only competent cognitively, but also has strong roots of identity and cultural sensitivity.

CONCLUSION

From the results of this study, it can be concluded that there is a strong positive impact of ethnopedagogical mixed STEM learning on creative skills and problem-solving in language education. The moderator analysis showed that education level and duration of learning significantly moderated the effect size, while the year of publication and geographic region did not show significant moderation. These findings support the integration of culturally responsive STEM-based pedagogy in language teaching and highlight the importance of contextual-based learning models for fostering 21st-century skills. The integration of local cultural values through ethnopedagogy with technology-supported STEM interdisciplinary approaches in blended learning creates a contextual, collaborative, and innovative learning ecosystem. This approach not only enriches the language learning experience, but also encourages students to think critically, creatively, and reflective of real problems in their

environment. Thus, this model deserves to be considered as an effective pedagogical strategy in strengthening students' 21st century skills, especially in the context of cultural- and technology-based language education.

RECOMMENDATION

Based on the findings of the research Enhancing Language Learning Through Ethnopedagogical Blended STEM: Effects on Students' Creative and Problem-Solving Competencies, it is suggested that the Ethnopedagogical Blended STEM-based learning model be applied more widely in the language learning process, especially at the secondary and higher education levels. This model has been proven to be able to improve students' creative competence and problem-solving through the integration of local wisdom values, scientific approaches, and the use of technology. Researchers are further advised to explore the adaptation of this model in cultural contexts and other subjects in order to identify the extent of its flexibility and effectiveness in strengthening 21st century competencies holistically.

ACKNOWLEDGMENT

FUNDING INFORMATION

AUTHOR CONTRIBUTIONS STATEMENT

Name of Author	C	M	So	Va	Fo	I	R	D	O	E	Vi	Su	P	Fu
Everhard Markiano S	✓	✓	✓	✓	✓	✓		✓	✓	✓			✓	
Sukini		✓				✓	✓	✓	✓	✓	✓	✓		
Burhan Efendi	✓		✓	✓			✓		✓	✓	✓		✓	✓
Tomi Apra Santosa					✓		✓		✓			✓		✓
Hasyim Mahmud W														
Unpris Yastanti														

CONFLICT OF INTEREST STATEMENT

Authors state no conflict of interest.

REFERENCES

Abdurrahman, Ariyani, F., Nurulsari, N., Maulina, H., & Sukamto, I. (2020). The prospective ethnopedagogy-integrated STEM learning approach: Science teacher perceptions and experiences. *Journal of Physics: Conference Series*, *1572*(1). https://doi.org/10.1088/1742-6596/1572/1/012082

Andrianto, T., Susanto, E., Syukri, M. Y., Sulistiana, O., & Irawan, C. (2023). *Formulating Character Development Policy in Vocational Higher Education : A Qualitative Study and the V-CODE Model*. *3*(1), 57–73. https://doi.org/10.58229/jissbd.v3i1.321

Arar, K., Sawalhi, R., DeCuir, A., & Amatullah, T. (2023). Islamic-Based Educational Leadership, Administration and Management. In *Islamic-Based Educational Leadership, Administration and Management*. https://doi.org/10.4324/9781003360070

Ashidiq, R. M., Winarno, N., Prima, E. C., Widodo, A., & Chang, C. (2024). *Investigating the Impact of STEM Learning on Students ' Critical Thinking Skills through Hand-Made Projector Activity*. *7*(August 2023). https://doi.org/10.17509/jsl.v7i2.61549

Ayaz, M. F., & Söylemez, M. (2015). The effect of the project-based learning approach on the academic achievements of the students in science classes in Turkey: A meta-analysis study. *Egitim ve Bilim*, *40*(178), 255–283. https://doi.org/10.15390/EB.2015.4000

Babalola, E. O., & Keku, E. (2024). Ethno-STEM Integrated Project-Based Learning to Improve Students' Creative Thinking Skills. *International Journal of Ethnoscience and Technology in Education*, *1*(2), 116. https://doi.org/10.33394/ijete.v1i2.11308

Badawi et al. (2023). Integration of Blended Learning and Project-Based Learning (BPjBL) on Achievement of Students' learning goals: A Meta-analysis study. *Pegem Journal of Education and Instruction*, *13*(4). https://doi.org/10.47750/pegegog.13.04.32

Bagus, I., Wisnu, M., Ayu, I., & Purnami, P. (2020). *Ethnopedagogical study in audio-visual learning media based on the transformation of satua tong*. 614–621.

Borenstein, M., Hedges, L., & Rothstein, H. (2007). *Introduction to Meta-Analysis*. www.Meta-Analysis.com

Defi, A. M. (2025). *The Internalization of Moral Values in Wayang Kulit : The Tale of Begawan Among Raga (An Ethnopedagogical Perspective)*. *5*(1), 130–137. https://doi.org/10.58737/jpled.v5i1.399

Dewanto, D., Wantu, H. M., Dwihapsari, Y., Santosa, T. A., & Agustina, I. (2023). Effectiveness of The Internet of Things (IoT)-Based Jigsaw Learning Model on Students' Creative Thinking Skills: A- Meta-Analysis. *Jurnal Penelitian Pendidikan IPA*, *9*(10), 912–920. https://doi.org/10.29303/jppipa.v9i10.4964

Erfan, M., Suranti, N. M. Y., & Ibrahim, I. (2024). Development of an Ethnopedagogical LMS to Enhance the Creativity of Elementary School Teacher Candidates in Learning Science Course. *Jurnal Penelitian Pendidikan IPA*, *10*(2), 886–895. https://doi.org/10.29303/jppipa.v10i2.6265

Ichsan, I., Suharyat, Y., Santosa, T. A., & Satria, E. (2023). Effectiveness of STEM-Based Learning in Teaching 21 st Century Skills in Generation Z Student in Science Learning: A Meta-Analysis. *Jurnal Penelitian Pendidikan IPA*, *9*(1), 150–166. https://doi.org/10.29303/jppipa.v9i1.2517

Kasi, Y. F., Samsudin, A., Widodo, A., & Riandi, R. (2021). A Thematic Review on Exploring Ethnoscience in Science Education: A Case in Indonesia. *Tadris: Jurnal Keguruan Dan Ilmu Tarbiyah*, *6*(2), 229–241. https://doi.org/10.24042/tadris.v6i2.9509

Kessler, G. (2018). Technology and the future of language teaching. *Foreign Language Annals*, *51*(1), 205–218. https://doi.org/10.1111/flan.12318

Lazo, A. (2024). *UNCOpen Analyzing the Influence of Faculty Diversity on Dance Education in Texas High Schools : A Case Study of Representation in Dance Programs*.

Łubiarz, M., & Kościńska, A. (2024). Webquest for Academic Purposes — a Strategy for Developing Students' EAP Skills. *Bellaterra Journal of Teaching and Learning Language and Literature*, *17*(2). https://doi.org/10.5565/rev/jtl3.1096

Nursima, I., Lah, Y. C., & Duong, N. A. T. (2022). Ethnopedagogy in Primary Schools: Ethnographic Study in Thematic Learning at Ma'arif Setono Jenangan Ponorogo. *Journal of Basic Education Research*, *3*(3), 106–116. https://doi.org/10.37251/jber.v3i3.896

Nurwidodo, N., Ibrohim, I., Sueb, S., & Husamah, H. (2023). "Let's transform!": A systematic literature review of science learning in COVID-19 pandemic era. *Eurasia Journal of Mathematics, Science and Technology Education*, *19*(2). https://doi.org/10.29333/ejmste/12875

Oktarina, K., Lufri, L., & Chatri, M. (2018). Validity of Learning Module Natural Sciences Oriented Constructivism with the Contain of Character Education for Students of Class VIII at Yunior Hight School. *IOP Conference Series: Materials Science and Engineering*, *335*(1), 0–10. https://doi.org/10.1088/1757-899X/335/1/012091

Parmaxi, A. (2023). Virtual reality in language learning: a systematic review and implications for research and practice. *Interactive Learning Environments*, *31*(1), 172–184. https://doi.org/10.1080/10494820.2020.1765392

Putri, D. S. I., & Turaqulov, B. T. (2022). Harmonizing Tradition, Science, and STEM Learning: Empowering Students' Creative Minds with Sound Waves and Local Wisdom. *Schrödinger: Journal of Physics Education*, *3*(4), 90–98. https://doi.org/10.37251/sjpe.v3i4.916

Quiao, M. A. D., Apdian, F. B., Pontillo, H. R. P., Won, M. E. Q., & Oledan, A. M. B. (2024).

Exploring Ethnocultural Education on Students ' Science Academic Achievement : A Meta-Analysis. *June*, 308–317. https://doi.org/10.51386/25815946/ijsms-v7i3p122

Quiñonez, H. A. S., & Mendoza, C. A. S. (2024). Ethnoeducation As an Instrument for the Promotion of Sustainable Development. an Analysis From Scientometrics. *Granja*, *39*(1), 11–28. https://doi.org/10.17163/LGR.N39.2024.01

Rediani, N. N., Palittin, I. D., & Kaize, B. R. (2024). Project Based Learning: Enhancing Character and Creative Thinking Skills through Activity-Based Projects in Numeracy Literacy Courses. *Indonesian Values and Character Education Journal*, *7*(1), 88–100. https://doi.org/10.23887/ivcej.v7i1.80139

Rexhepi, B., & Bajrami, A. (2025). *Ethno-Pedagogical Module : A Theoretical Exploration of Knowledge Transmission in Ethnobiological Systems*. *7*(1), 1–12.

Rohmantika, N., & Kurniawan, E. S. (2021). Using of Ethno-STEM Based Teaching Materials to Increase the Creativity of Students in Learning Physics. *Jurnal Geliga Sains: Jurnal Pendidikan Fisika*, *9*(2), 129. https://doi.org/10.31258/jgs.9.2.129-138

Sakti, S. A., Endraswara, S., & Rohman, A. (2024). Revitalizing local wisdom within character education through ethnopedagogy apporach: A case study on a preschool in Yogyakarta. *Heliyon*, *10*(10), e31370. https://doi.org/10.1016/j.heliyon.2024.e31370

Shadiev, R., & Yang, M. (2020). Review of studies on technology-enhanced language learning and teaching. *Sustainability (Switzerland)*, *12*(2). https://doi.org/10.3390/su12020524

Sudarmin, Ariyatun, Rahayu, S., Yamtinah, S., Pujiastuti, S. E., Munzil, & Winarto. (2025). How to increase student sustainable attitudes: A study effect of the education for sustainable development ethno-pedagogy learning model (EP-ESD). *Multidisciplinary Science Journal*, *7*(5). https://doi.org/10.31893/multiscience.2025252

Sugiarto, E., Syarif, M. I., Mulyono, K. B., bin Othman, A. N., & Krisnawati, M. (2025). How is ethnopedagogy-based education implemented? (A case study on the heritage of batik in Indonesia). *Cogent Education*, *12*(1). https://doi.org/10.1080/2331186X.2025.2466245

Suherman, Vidákovich, T., & Komarudin. (2021). STEM-E: Fostering mathematical creative thinking ability in the 21st Century. *Journal of Physics: Conference Series*, *1882*(1). https://doi.org/10.1088/1742-6596/1882/1/012164

Tamur, M., Juandi, D., & Kusumah, Y. S. (2020). The effectiveness of the application of mathematical software in indonesia; a meta-analysis study. *International Journal of Instruction*, *13*(4), 867–884. https://doi.org/10.29333/iji.2020.13453a

Uluk, E., Masruchiyah, N., Nurhayati, R., Agustina, I., Sari, W. D., Santosa, T. A., Widya, U., Klaten, D., & Yogyakarta, U. N. (2024). Effectiveness of Blended Learning Model Assisted By Scholoogy to Improve Language Skills of Early Childhood Education Teachers. *Jurnal Obsesi: Jurnal Pendidikan Anak Usia Dini*, *8*(6), 1363–1374. https://doi.org/10.31004/obsesi.v8i6.6226

Wantu, H. M., Muis, A., Zain, A., Hiola, S. F., Agustina, I., Santosa, T. A., Yastanti, U., & Nugraha, A. R. (2024). Effectiveness of Think-Pair-Share and STEM Models on Critical Thinking in Early Childhood Education. *Jurnal Obsesi: Jurnal Pendidikan Anak Usia Dini*, *8*(5), 1320–1330. https://doi.org/10.31004/obsesi.v8i5.6202

Winiasri, L., Santosa, T. A., Yohandri, Y., Razak, A., Festiyed, F., & Zulyusri, Z. (2023). Ethno-Biology Learning Model Based on Design Thinking to Improve Students' Critical Thinking Skills. *Jurnal Penelitian Pendidikan IPA*, *9*(9), 7767–7774. https://doi.org/10.29303/jppipa.v9i9.4213

Zhang, W. (2022). The Role of Technology-Based Education and Teacher Professional Development in English as a Foreign Language Classes. *Frontiers in Psychology*, *13*(June). https://doi.org/10.3389/fpsyg.2022.910315

Zhou, Y., & Wei, M. (2018). Strategies in technology-enhanced language learning. *Studies in Second Language Learning and Teaching*, *8*(2 Special Issue), 471–495. https://doi.org/10.14746/ssllt.2018.8.2.13

Žižanović, S., Pranjić, S. S., & Radovanović, M. (2021). *Educational Challenges of Emergency Remote Teaching and Learning During the Coronavirus Crisis*. February. https://doi.org/10.51508/intcess.2021168

Zulyusri, Z., Santosa, T. A., Festiyed, F., Yerimadesi, Y., Yohandri, Y., Razak, A., & Sofianora, A. (2023). Effectiveness of STEM Learning Based on Design Thinking in Improving Critical Thinking Skills in Science Learning: A Meta-Analysis. *Jurnal Penelitian Pendidikan IPA*, *9*(6), 112–119. https://doi.org/10.29303/jppipa.v9i6.3709