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# Ethnoscience-Project-Based Learning (E-PjBL) Model for Biology Education: Content and Construct Validity Analysis

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**Abstract:** This study aims to analyze the content and construct validity of the Ethnoscience–Project-Based Learning (E-PjBL) model for biology education in higher education. The study employed a Research and Development (R&D) approach guided by Nieveen's educational design framework, focusing on the initial validation stage of model development. The validation process involved six expert validators with expertise in biology education, ethnoscience, instructional model development, and educational research. Research instruments consisted of content validity and construct validity validation sheets using a five-point Likert scale. The collected data were analyzed using descriptive quantitative analysis by calculating mean validity scores and inter-rater reliability using the percentage of agreement method. The results of the study indicate that: (1) the content validity of the E-PjBL model is categorized as very valid, with an overall mean score of 4.97, indicating that the model is developed based on actual learning needs and supported by state-of-the-art theoretical and empirical foundations; (2) the construct validity of the E-PjBL model is also classified as very valid, with an overall mean score of 4.91, demonstrating strong internal consistency among model components, including instructional syntax, learning objectives and impacts, as well as the learning environment and social system. These findings provide empirical evidence that the E-PjBL model is conceptually sound and theoretically feasible for further testing at the stages of practicality and effectiveness in higher education biology learning.

**Keywords:** Biology education; E-PjBL model; Validity analysis.

## Introduction

The twenty-first century is marked by rapid advancements in information technology and intensified global competition, which demand university graduates who are creative, innovative, adaptive, and capable of maintaining strong personal character grounded in cultural values (Ah-Nam & Osman, 2017). Digital transformation has reshaped patterns of communication, interaction, and decision-making (Illene et al., 2023; Oliver et al., 2019; Ness & Khinvasara, 2024), while extensive exposure to global digital culture has influenced students' cognitive orientations and social behaviors (Afandi et al., 2019). Although global connectivity facilitates knowledge exchange across cultures, it also poses challenges to the preservation of local cultural identity, as students increasingly adopt external cultural norms that may marginalize indigenous values and traditions (Leidner & Kayworth, 2006; Wallace et al., 2009; Torres et al., 2018; Huang, 2024). This condition represents a critical challenge for higher education institutions in sustaining national identity, cultural continuity, and character formation.

In response to this challenge, higher education is expected to strengthen character education and cultural literacy as integral components of learning. Cultural literacy enables students to understand, appreciate, and

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responsibly engage with their cultural heritage within a multicultural society (Hicks & Lloyd, 2016; Khairunnisa & Jannah, 2022; Oktafianti, 2024). It fosters identity awareness, tolerance, and social cohesion while supporting the preservation of local wisdom and cultural values (Rosala & Budiman, 2020; Warman et al., 2018; Haas, 2023). Through culturally grounded learning experiences, students develop empathy, inclusiveness, and a sense of responsibility toward sustaining indigenous knowledge systems (Lähdesmäki et al., 2022; Riggs et al., 2021; Bao, 2024).

The development of cultural literacy can be effectively supported through the integration of local knowledge and indigenous practices into science education. Ethnoscience-based learning enables students to connect scientific concepts with cultural experiences and traditional knowledge embedded in their communities (Rahayu et al., 2022; Hafizah & Nurhaliza, 2021; Wibowo & Ariyatun, 2020). However, previous studies indicate that although students express positive attitudes toward integrating local culture into learning, their depth of cultural understanding and appreciation remains limited (Muliadi, 2023). At the same time, contemporary demands on higher education emphasize the importance of developing creative thinking and higher-order cognitive skills to address complex real-world problems (Ananda, 2024; Rizaldi et al., 2020; Natuna et al., 2021).

In biology education, creative thinking and science process skills are essential competencies that support scientific inquiry, experimentation, and meaningful conceptual understanding. Science process skills enable students to observe phenomena, formulate hypotheses, design investigations, analyze data, and draw evidence-based conclusions (Mukaromah et al., 2022; Apeadido, 2024). Empirical evidence suggests that these skills not only enhance students' conceptual mastery but also strengthen their creative thinking and ability to relate scientific knowledge to real-life contexts (Putri et al., 2022; Hartati et al., 2022; Astalini et al., 2020). Therefore, biology learning requires pedagogical approaches that are inquiry-oriented, contextual, and culturally meaningful.

Project-Based Learning (PjBL) and ethnoscience-based approaches have been widely acknowledged as effective strategies for fostering these competencies through active, contextualized learning experiences (Suryaningsih & Nisa, 2021; Wijaya & Fajar, 2020; Kantina et al., 2022). Integrating projects with local cultural contexts allows students to engage in authentic scientific investigations while simultaneously connecting scientific concepts with indigenous practices and environmental values (Hartati et al., 2022). In the Lombok context, indigenous knowledge reflected in the construction of the Sasaknese traditional house (bale adat) embodies local wisdom related to material selection, environmental adaptation, and cultural symbolism (Arlinovita et al., 2015; Wahyudi, 2022; Juliani et al., 2020). Such indigenous practices provide rich, authentic contexts for culturally embedded science learning (Sudarmin et al., 2018).

Based on this rationale, the Ethnoscience–Project-Based Learning (E-PjBL) model was developed as an innovative instructional framework that integrates the principles of PjBL with ethnoscience rooted in local cultural traditions. The model seeks to address the limitations of conventional PjBL by embedding culturally relevant contexts across all phases of the learning process, including ethno-orientation, ethno-problem identification, ethno-project design, ethno-investigation, ethno-presentation, and ethno-reflection. Through this structure, the E-PjBL model is theoretically positioned to support inquiry-based learning that is culturally grounded, interdisciplinary, and meaningful for biology education in higher education settings.

Within the framework of Educational Design Research, the quality of a learning model is initially determined by its validity, which reflects the degree to which the model is theoretically sound and internally coherent (Nieveen, 1999). Content validity ensures that the model components are aligned with relevant learning theories, curriculum standards, and educational objectives, while construct validity examines the logical consistency and interrelationships among model elements. Establishing content and construct validity is a crucial preliminary step before examining practicality or effectiveness. Therefore, this study aims to analyze the content and construct validity of the Ethnoscience–Project-Based Learning (E-PjBL) model through expert judgment, providing empirical evidence of its conceptual soundness and theoretical feasibility for application in biology education at the higher education level.

## Method

This study employed a Research and Development (R&D) approach adapted from Borg and Gall (1983) and guided by Nieveen's (1999; 2007) educational product quality framework. In accordance with the focus of this article, the research was limited to the content and construct validity analysis of the Ethnoscience–Project-Based Learning (E-PjBL) model for biology education. Other development stages, including practicality testing and effectiveness evaluation, were conducted as part of a broader dissertation research program and are reported separately. Therefore, the findings presented in this article are derived exclusively from the expert validation phase.

The development procedure consisted of two main stages: (1) preliminary study and conceptual model planning, and (2) model development followed by expert validation. The preliminary stage involved a literature review, needs analysis, and theoretical synthesis related to project-based learning, ethnoscience, and biology education in higher education. Based on this analysis, a draft version of the E-PjBL model was designed, including its rationale, objectives, instructional syntax, social system, principles of reaction, support system, and expected instructional effects.

The draft E-PjBL model was subsequently subjected to expert validation by six validators with academic and professional expertise in biology education, instructional model development, and ethnoscience-based pedagogy. The validation process was designed to evaluate two main aspects, namely content validity and construct validity. Content validity aimed to examine the relevance and adequacy of the model components in relation to learning objectives, curriculum demands, and underlying theoretical foundations. Construct validity focused on assessing the internal consistency, logical structure, and coherence among the model components, including the alignment between the model's rationale, objectives, syntax, and expected learning outcomes.

Validation data were collected using structured validation instruments employing a five-point rating scale ranging from 1 (Very Poor) to 5 (Excellent). Validators assessed each indicator and were also encouraged to provide qualitative comments and suggestions for improving the conceptual design of the model. The level of validity (Va) was determined by calculating the mean scores of indicators and aspects assessed by each expert. The resulting mean scores were used to determine the validity level of the model and its supporting components, as presented in Table 1.

**Table 1.** Validity levels of the model and supporting components

| Interval | Category |
|---|---|
| Va > 4,21 | Very Valid |
| 3,40 < Va < 4,21 | Valid |
| 2,60 < Va < 3,40 | Fairly Valid |
| 1,79 < Va < 2,60 | Less Valid |
| Va < 1,79 | Invalid |

The E-PjBL model was considered to have met acceptable validity standards if it achieved at least the "Valid" category on all assessed components. To ensure the reliability of expert assessments, the percentage of agreement was calculated using Borich's formula, and validation results were categorized as reliable when the agreement value reached or exceeded 75%. In addition, the reliability of expert validation results was examined using the percentage of agreement formula (Formula 1).

$$\textit{Percentage of agreement } (R)\text{: } 1 - \frac{A-B}{A+B} x100\% \quad (1)$$

Notes:
R : Reliability
A : The frequency of observed behavioral aspects recorded by the observer who provided the higher frequency score
B : The frequency of observed behavioral aspects recorded by the observer who provided the lower frequency score

In addition to evaluating the conceptual structure of the E-PjBL model, the expert validators also reviewed a set of supporting components intended to operationalize the model in future implementation stages. These components included the learning scenario, student learning materials, student worksheets, and assessment instruments. The validation of supporting components was conducted using the same rating scale and interpretive criteria to ensure coherence between the theoretical model design and its planned instructional application. Qualitative feedback from the validators was analyzed descriptively and used as a basis for revising and refining the E-PjBL model during the validation cycle.

## Result and Discussion

*Content Validity of the E-PjBL Model*

According to Nieveen (1999; 2007), content validity reflects the extent to which a learning model is developed based on actual educational needs and supported by up-to-date theoretical and empirical knowledge. In this study, content validity was examined to ensure that the Ethnoscience–Project-Based Learning (E-PjBL) model is conceptually justified and relevant to the context of biology education in higher education. The results of expert validation indicate that the E-PjBL model demonstrates a very high level of content validity, as summarized in Table 2.

**Table 2.** Content validity results of the E-PjBL model

| Content Validity Aspect | Mean Score | Category | R | Category |
|---|---|---|---|---|
| Need for the development of the E-PjBL model | 5.0 | Very Valid | 100% | Reliable |
| Model design based on state-of-the-art knowledge | 4.94 | Very Valid | 89% | Reliable |
| Overall Mean | 4.97 | Very Valid | 94.5% | Reliable |

As shown in Table 1, the aspect concerning the need for developing the E-PjBL model achieved a mean score of 5.00, categorized as *very valid*, with perfect inter-rater reliability (R = 100%). This finding indicates strong consensus among experts that the integration of ethnoscience and project-based learning is urgently needed to address limitations of conventional biology instruction, particularly in fostering culturally responsive and contextual learning.

Similarly, the aspect assessing whether the model was designed based on state-of-the-art knowledge obtained a mean score of 4.94, also classified as *very valid*. The high reliability value (R = 89%) confirms that expert judgments were consistent. These results suggest that the E-PjBL model is firmly grounded in contemporary theories of ethnoscience-based learning, project-based learning, and competency-oriented science education. Overall, the content validity results (Va = 4.97; R = 94.5%) demonstrate that the E-PjBL model possesses a strong conceptual foundation and is well aligned with current educational needs and theoretical developments. From an educational design research perspective, this strong content validity constitutes an essential prerequisite for further model development and empirical testing.

*Construct Validity of the E-PjBL Model*

Construct validity emphasizes the internal coherence and logical consistency among the components of a learning model. In this study, construct validity was evaluated to determine whether the core elements of the E-PjBL model—such as instructional syntax, objectives, expected impacts, learning environment, and social system—are systematically interconnected and form an integrated instructional framework. The results of construct validity analysis are presented in Table 2.

**Table 2.** Construct validity results of the E-PjBL model

| Content Validity Aspect | Mean Score | Category | R | Category |
|---|---|---|---|---|
| E-PjBL instructional syntax | 5.00 | Very Valid | 100% | Reliable |
| Objectives and expected impacts of the E-PjBL model | 4.83 | Very Valid | 89% | Reliable |
| Learning environment and social system | 4.91 | Very Valid | 89% | Reliable |
| Overall Mean | 4.91 | Very Valid | 92.67% | Reliable |

As shown in Table 2, the instructional syntax of the E-PjBL model received the highest possible mean score (5.00), indicating that all validators perceived the six learning phases—ethno-orientation, ethno-problem, ethno-project design, ethno-project investigation, ethno-presentation, and ethno-reflection—as logically sequenced, pedagogically coherent, and theoretically sound. The perfect reliability score (R = 100%) further confirms the clarity and robustness of the instructional flow.

The aspect related to objectives and expected impacts achieved a mean score of 4.83 (*very valid*), with high reliability (R = 89%). Validators agreed that the model's objectives, particularly the development of creative thinking skills, science process skills, and cultural literacy, are consistently aligned with the instructional syntax and supported by relevant learning theories. The anticipated impacts, such as active engagement, collaboration, and contextual learning, were also considered coherent outcomes of the model design.

The learning environment and social system component attained a mean score of 4.91 (*very valid*) with strong reliability (R = 89%). Expert evaluations indicate that the E-PjBL model effectively conceptualizes a culturally responsive learning environment that encourages interaction, dialogue, collaboration, and inquiry-based learning rooted in local cultural contexts. Overall, the construct validity results (Va = 4.91; R = 92.67%) confirm that the E-PjBL model exhibits strong internal consistency and logical integration among its components, meeting the criteria for construct validity as proposed by Nieveen (1999).

The results of the content and construct validity analyses indicate that the Ethnoscience–Project-Based Learning (E-PjBL) model possesses a strong conceptual foundation and high internal coherence. These findings are highly relevant to the challenges of twenty-first-century higher education, which is characterized by rapid technological advancement and intensified global competition that demand graduates who are creative, adaptive, and capable of maintaining strong cultural character (Ah-Nam & Osman, 2017). In this context, the E-PjBL model responds to the growing concern that global digital exposure and cultural acculturation may weaken students' attachment to local values and indigenous knowledge systems (Leidner & Kayworth, 2006; Wallace et al., 2009; Torres et al., 2018; Huang, 2024).

The very high content validity score obtained by the E-PjBL model confirms expert consensus that biology education in higher education requires pedagogical innovation capable of integrating scientific learning with socio-cultural contexts. Digital transformation has reshaped students' ways of thinking, interacting, and learning, often distancing them from local cultural identities (Afandi et al., 2019; Illene et al., 2023; Oliver et al., 2019; Ness & Khinvasara, 2024). Consequently, strengthening cultural literacy has become a critical educational agenda. The E-PjBL model addresses this need by positioning ethnoscience as a core learning resource, thereby supporting students' understanding, appreciation, and responsible engagement with their cultural heritage (Hicks & Lloyd, 2016; Rosala & Budiman, 2020; Warman et al., 2018; Haas, 2023).

The strong content validity related to the use of state-of-the-art knowledge further indicates that the E-PjBL model is firmly grounded in contemporary theories of science education. Integrating indigenous knowledge into biology learning enables students to connect scientific concepts with lived cultural experiences and traditional practices embedded within their communities (Rahayu et al., 2022; Hafizah & Nurhaliza, 2021; Wibowo & Ariyatun, 2020). This is particularly important given previous findings showing that, despite positive attitudes toward cultural integration, students' depth of cultural understanding and appreciation often remains limited (Muliadi, 2023). By embedding ethnoscience throughout the learning process, the E-PjBL model has the potential to bridge this gap between attitude and meaningful cultural engagement.

From the perspective of construct validity, the consistently high scores across all model components demonstrate that the E-PjBL model is logically structured and internally coherent. The six instructional phases—*ethno-orientation, ethno-problem, ethno-project design, ethno-project investigation, ethno-presentation*, and *ethno-reflection*—form a systematic learning sequence that integrates the principles of Project-Based Learning with ethnoscience. Such coherence is essential in biology education, where inquiry, experimentation, and conceptual understanding must be carefully aligned to support meaningful learning (Mukaromah et al., 2022; Apeadido, 2024). Moreover, the integration of projects with local cultural contexts aligns with established evidence that Project-Based Learning is most effective when grounded in authentic and contextualized learning experiences (Suryaningsih & Nisa, 2021; Wijaya & Fajar, 2020; Kantina et al., 2022).

The alignment between the model's objectives, instructional syntax, and expected learning impacts reflects a goal-oriented instructional design. The targeted development of creative thinking skills, science process skills, and cultural literacy is not merely stated at a conceptual level, but operationalized through culturally grounded inquiry and project activities. This design is consistent with empirical studies indicating that science process skills enhance not only conceptual understanding but also creative thinking and students' ability to relate scientific knowledge to real-world contexts (Putri et al., 2022; Hartati et al., 2022; Astalini et al., 2020). Therefore, the E-PjBL model offers a holistic learning framework that supports both cognitive and cultural dimensions of biology education.

The learning environment and social system embedded within the E-PjBL model were also validated as highly appropriate. The model positions students as active participants engaged in collaboration, dialogue, and reflection, while lecturers function as facilitators and mediators of scientific and cultural knowledge. Such a learning environment is consistent with constructivist and sociocultural learning theories, which emphasize the role of social interaction and cultural context in knowledge construction. The incorporation of local indigenous practices, such as Sasaknese knowledge reflected in the construction of *bale adat*, provides authentic contexts for scientific inquiry and reinforces the relevance of biology learning to students' lived experiences (Arlinovita et al., 2015; Juliani et al., 2020; Wahyudi, 2022; Sudarmin et al., 2018).

The high reliability of the validation results further supports the robustness of the E-PjBL model. Strong inter-rater agreement among expert validators indicates that the model's quality was consistently recognized across different areas of expertise, including science education, project-based learning, educational design research, and ethnoscience. In addition, qualitative feedback from validators contributed significantly to refining the model, particularly in clarifying instructional syntax, strengthening the integration of science process skills, formalizing assessment mechanisms, and deepening the linkage between Sasaknese ethnoscience and project activities. This iterative refinement process reflects the core principles of Educational Design Research, in which expert validation serves as a reflective mechanism to enhance model quality (Nieveen, 1999).

Overall, the E-PjBL model meets the essential criteria of content and construct validity, indicating that it is theoretically sound, internally coherent, and contextually relevant. The model aligns with the demands of twenty-first-century education, the need to strengthen cultural literacy, and the characteristics of biology learning in higher education. By integrating ethnoscience with Project-Based Learning, the E-PjBL model represents a promising pedagogical alternative for improving science education quality while simultaneously supporting the preservation of local cultural identity. The strong validity evidence obtained in this study provides a solid foundation for subsequent investigations focusing on the practicality and effectiveness of the model in authentic classroom settings.

## Conclusion

Based on the results of the research above, it can be concluded that: (1) the content validity of the Ethnoscience–Project-Based Learning (E-PjBL) model for biology education is classified as very valid, as indicated by an overall mean score of 4.97, demonstrating that the model is developed based on actual learning needs and supported by state-of-the-art theoretical and empirical foundations in ethnoscience, Project-Based Learning, and twenty-first-century science education; (2) the construct validity of the E-PjBL model is also categorized as very valid, with an overall mean score of 4.91, indicating strong internal consistency and logical coherence among the model components, including instructional syntax, learning objectives and impacts, as well as the learning environment and social system.

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**Author Contributions**
Agus Muliadi: Developing the literature study topics, defining the literature analysis methodology, drafting the manuscript, and conducting revisions and final editing of the article.
Joni Rokhmat, Aliefman Hakim, and AA Sukarso: Analyzing and reviewing the literature relevant to the study topics and provided academic guidance to strengthen the conceptual and theoretical foundations of the manuscript.

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The authors declare no conflict of interest.

## References

Afandi, A., Sajidan, S., Akhyar, M., & Suryani, N. (2019). Development frameworks of the Indonesian partnership 21st-century skills standards for prospective science teachers: A Delphi study. *Jurnal Pendidikan IPA Indonesia, 8*(1), 89–100. https://doi.org/10.15294/jpii.v8i1.11647

Ah-Nam, L., & Osman, K. (2017). Developing 21st century skills through a constructivist–constructionist learning environment. *Journal of Educational Technology & Society, 20*(2), 205–216. Retrieved from https://www.learntechlib.org/p/209542/

Apeadido, M. (2024). Science process skills as a foundation of inquiry-based science learning. *Journal of Science Learning, 7*(1), 1–10.

Arlinovita, R., Prasetyo, Z. K., & Sudarmin. (2015). Indigenous knowledge in traditional house construction as a context for science learning. *Jurnal Pendidikan IPA Indonesia, 4*(2), 152–160.

Astalini, A., Kurniawan, D. A., & Darmaji, D. (2020). Students' science process skills and conceptual understanding in science learning. *International Journal of Instruction, 13*(2), 83–96.

Bao, Y. (2024). Cultural literacy and identity formation in higher education. *Journal of Cultural Education, 18*(1), 55–69.

Haas, B. (2023). Cultural literacy, identity, and social cohesion in education. *Educational Review, 75*(3), 401–417.

Hafizah, D., & Nurhaliza, S. (2021). Ethnoscience-based learning in biology education. *Jurnal Pendidikan Biologi, 13*(2), 89–98.

Hartati, R., Setiono, S., & Astuti, R. (2022). Project-based learning to enhance science process skills and creative thinking. *Journal of Science Education Research, 6*(3), 210–221.

Hebert, S. L., & Cotner, S. (2019). A comparison of majors' and non-majors' incoming science process skills. *The American Biology Teacher, 81*(8), 554–560. https://doi.org/10.1525/abt.2019.81.8.554

Hicks, A., & Lloyd, A. (2016). It takes a community to build a framework: Information literacy within intercultural settings. *Journal of Information Science, 42*(3), 334–343. https://doi.org/10.1177/0165551516630219

Huang, M. (2024). Cultural acculturation and identity challenges in the digital era. *Journal of Global Education, 12*(1), 22–34.

Illene, S., Robertson, J., & Walsh, K. (2023). Digital transformation and learning innovation in higher education. *Computers & Education, 190*, 104601.

Juliani, J., Juliana, J., Komalasari, F. D., Hamdani, H., Umar, H., & Tahir, M. (2020). Nilai kearifan lokal dalam rumah adat Limbungan suku Sasak. *Jurnal Dinamika Sosial Budaya, 22*(2), 158–167. https://doi.org/10.26623/jdsb.v22i2.2832

Kantina, N., Suryaningsih, E., & Nisa, A. (2022). Effectiveness of project-based learning in science education. *Journal of Science and Science Education, 6*(2), 97–108.

Khairunnisa, A., & Jannah, R. (2022). Cultural literacy development in higher education learning. *Journal of Social Education, 10*(2), 144–156.

Kokotsaki, D., Menzies, V., & Wiggins, A. (2016). Project-based learning: A review of the literature. *Improving Schools, 19*(3), 267–277. https://doi.org/10.1177/1365480216659733

Lähdesmäki, T., Baranova, J., Ylönen, S. C., Koistinen, A., Mäkinen, K., Juškienė, V., & Zaleskienė, I. (2022). *Learning cultural literacy through creative practices*. Springer. https://doi.org/10.1007/978-3-030-89236-4

Leidner, D. E., & Kayworth, T. (2006). A review of culture in information systems research. *MIS Quarterly, 30*(2), 357–399.

Mukaromah, A., Sriyati, S., & Rustaman, N. Y. (2022). Science process skills in biology learning. *Jurnal Pendidikan IPA, 11*(1), 12–23.

Muliadi, A. (2023). Students' perceptions of ethnoscience integration in science learning. *Journal of Science Education, 8*(1), 55–66.

Ness, J., & Khinvasara, T. (2024). Digital decision-making and learning behavior in higher education. *Educational Technology Research and Development, 72*(1), 89–104.

Nieveen, N. (1999). Prototyping to reach product quality. In J. van den Akker et al. (Eds.), *Design approaches and tools in education and training* (pp. 125–135). Springer.

Nieveen, N. (2007). Formative evaluation in educational design research. In T. Plomp & N. Nieveen (Eds.), *An introduction to educational design research* (pp. 89–102). SLO.

Oliver, M., Kellogg, S., & Patel, R. (2019). Learning technologies and higher education: Challenges and opportunities. *British Journal of Educational Technology, 50*(6), 2891–2904.

Putri, R. D., Hartono, H., & Astuti, D. (2022). Science process skills and creative thinking in science learning. *Journal of Science Learning, 5*(2), 98–107.

Rahayu, R., & Ismawati, R. (2022). Efektivitas online project-based learning berbasis etnosains terhadap keterampilan proses sains mahasiswa. *Jurnal Pendidikan MIPA, 12*(4), 1065–1071. https://doi.org/10.37630/jpm.v12i4.738

Rahayu, S., Sudarmin, S., & Sumarni, W. (2022). Integrating ethnoscience into science education: A cultural approach. *Journal of Science Education, 14*(2), 120–131.

Riggs, E., Brown, S., Szwarc, J., Nesvadba, N., & Yelland, J. (2021). Teach-back and cultural understanding in higher education. *Health Literacy Research and Practice, 5*(3), e199–e207. https://doi.org/10.3928/24748307-20210811-01

Rosala, D., & Budiman, A. (2020). Local wisdom-based learning and character education. *Mimbar Sekolah Dasar, 7*(3), 304–326. https://doi.org/10.17509/mimbar-sd.v7i3.28185

Sudarmin, S., Zahro, L., Pujiastuti, S. E., & Asyhar, R. (2018). The development of ethnoscience-based science learning. *Journal of Physics: Conference Series, 983*, 012191. https://doi.org/10.1088/1742-6596/983/1/012191

Suryaningsih, E., & Nisa, A. (2021). Project-based learning in science classrooms: A contextual approach. *Journal of Science Education, 9*(2), 75–86.

Torres, V., Jones, S. R., & Renn, K. A. (2018). Student development in a global context. *Journal of College Student Development, 59*(4), 437–454.

Wallace, L., Etzkowitz, H., & Evans, J. (2009). Cultural identity in globalized education. *Educational Researcher, 38*(1), 47–57.

Wahyudi, W. (2022). Environmental adaptation in traditional architecture. *Journal of Environmental Education, 14*(2), 101–112.

Warman, W., Suyanto, S., & Budiman, A. (2018). Cultural values and education in multicultural contexts. *Journal of Social Studies Education, 12*(3), 211–220.

Wibowo, A., & Ariyatun, A. (2020). Ethnoscience as a learning resource in science education. *Jurnal Pendidikan IPA, 9*(3), 233–242.

Wijaya, M., & Fajar, A. (2020). Project-based learning and student engagement in science education. *International Journal of Instruction, 13*(4), 55–70.