Journal of Engineering Science and Technology
Special Issue on ISCoE2024 Vol. 20 No. 3 (2025) 145 - 152

INTEGRATION OF ETHNOZOOLOGY AND TECHNOLOGY IN E-MODULE DEVELOPMENT FOR ANIMAL STRUCTURE COURSES

SIROJJUDDIN SIROJJUDDIN[1,*], RATNA PRABAWATI[1], JAHARUDIN JAHARUDIN[1], FEBRIAN ANDI HIDAYAT[1,2], SITI WARDANIA MALAWAT[1]

[1]Universitas Pendidikan Muhammadiyah Sorong, Sorong, Indonesia
[2]Universitas Pendidikan Indonesia, Bandung, Indonesia
*Corresponding author: sirojjuddin@unimudasorong.ac.id

Abstract

This study developed an ethnozoology-based e-module that integrates educational technology to enhance students' understanding of animal structures by linking zoological concepts with cultural knowledge, particularly in the Moi indigenous community in Greater Sorong, Indonesia. We used a Design-Based Research (DBR) approach, consisting of analysis, design, development, and reflection stages. We created an e-module. Then, the e-module was validated by material and media experts and subsequently implemented in the classroom. The results demonstrated an improvement in students' collaborative ability from 2.1 to 3.57 and cognitive ability with an N-Gain score of 0.5 (medium category). Expert validation confirmed its feasibility, with a material validity score of 3.72 and a media validity score of 3.57, indicating that the e-module is suitable for learning. The increase in student engagement occurred because the e-module integrated scientific concepts with cultural narratives, enabling students to understand animal structures in a real-world context through reflective questions, case studies, and interactive digital simulations. Its effectiveness in improving cognitive understanding was observed because its design facilitates in-depth exploration by combining cultural perspectives with technology-enhanced learning. The integration of ethnozoology and technology in the e-module creates a more interactive, culturally relevant, and accessible learning experience, while also contributing to cultural preservation and biodiversity conservation. This ensures that traditional knowledge remains relevant in modern science education.

Keywords: Animal structure courses, Educational technology, E-module, Ethnozoology, Indigeneous knowledge.

1. Introduction

Integrating ethnozoology and technology in e-modules for Animal Structure courses connects scientific concepts with cultural contexts. Indonesia, one of the world's most biodiverse nations, hosts numerous endemic species across 17,000 islands [1, 2]. In Sorong, West Papua, Indonesia, indigenous groups like the Moi, Tehit, and Maya have long utilized local fauna for economic, spiritual, and cultural purposes [3, 4]. However, urbanization and globalization threaten the transmission of ethnozoological knowledge, especially among younger generations [5]. Traditional zoological education often isolates animal structures from real-world contexts, limiting students' understanding of their practical and cultural significance [6, 7].

Previous studies reported integrating cultural knowledge into zoological education to help students a deeper understanding of animal structures in ecological and social contexts [8]. Additional technology is effective in improving more [9-14]. Interactive e-modules, digital simulations, virtual reality (VR), and augmented reality (AR) have been proven to increase student engagement and improve learning accessibility [15, 16]. Research also indicates that technology-enhanced learning enables better visualization of complex anatomical structures and fosters a more interactive and immersive learning experience [17-20]. However, despite the increasing integration of technology in science education, few studies have explicitly combined ethnozoology [21] with digital learning tools in teaching animal structure courses, particularly within the West Papua context.

This study developed an ethnozoology-based e-module that integrates educational technology to enhance students' understanding of animal structures. It employs a Design-Based Research (DBR) approach. Unlike previous studies that examined cultural knowledge and educational technology separately, this study explicitly combines both aspects to create a more contextualized and inclusive zoology learning model. The novelty of this study includes: (i) integrating ethnozoology and educational technology in a digital e-module that enhances student understanding through interactive content, (ii) adopting an interdisciplinary approach that merges cultural knowledge and digital tools, fostering a more inclusive zoology learning model, and (iii) contributing both to the documentation and preservation of Moi indigenous knowledge and biodiversity conservation through technology-based education.

2. Literature Review

Figure 1 illustrates the e-module structure, consisting of initial, core, and supporting components for effective learning. The initial component includes identity, cover, concept map, and usage guide [22]. The core component features references (author profile, bibliography, glossary) and learning materials (content, activities, evaluations, quizzes, and reflections) to enhance understanding [23]. AR- and VR-based e-modules improve zoological comprehension, while problem-based learning (PBL) and project-based learning (PjBL) strengthen critical thinking, making learning more engaging [24]. Integrating ethnozoology and technology connects scientific concepts with cultural practices and supports biodiversity conservation [21, 25]. E-modules with AR/VR enhance interactive learning, benefiting remote students and enabling ethical virtual dissection [26]. An interdisciplinary approach is essential for linking zoology with cultural heritage

[27]. While VR aids 3D exploration, PBL and PjBL-based e-modules develop critical thinking, and STEM integration fosters a holistic zoological understanding [28]. Ethnozoology-based e-modules enhance learning while preserving traditional ecological knowledge.

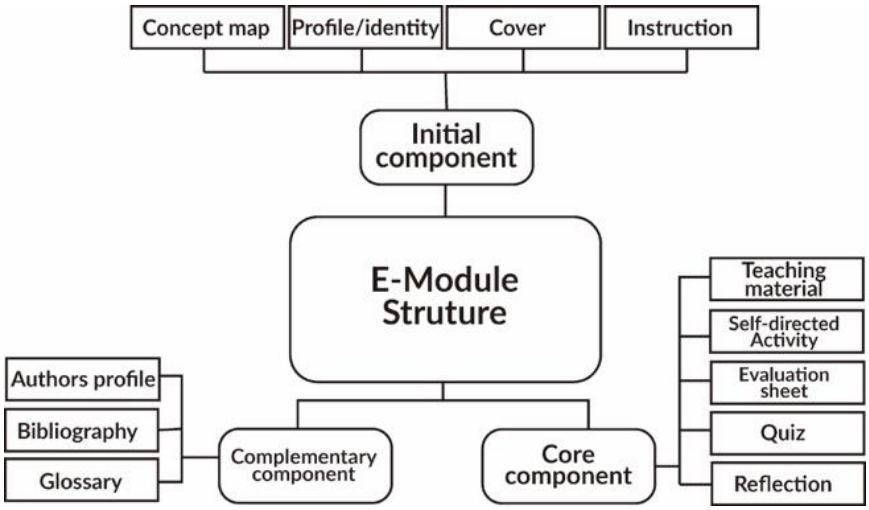

Fig. 1. Digital based e-module component structure.

3.Method

This study used a DBR approach with four stages: analysis, design, development, and reflection. It involved local communities in Greater Sorong and 30 biology education students from Southwest Papua, Indonesia. Data were collected through questionnaires, field notes, literature reviews, expert validation sheets, and cognitive tests to assess the e-modules' effectiveness. Statistical analysis was conducted using SPSS using previous reports [29-31].

4.Results and Discussion

Figure 2 illustrates the interactive learning flow in the e-module, where users progress through initial access, activities, evaluation, and reflection. Students engage with the material, participate in interactive tasks, and undergo evaluation. If understanding is insufficient, they repeat the process until mastery is achieved. Progression to reflection occurs only after meeting evaluation standards, ensuring adaptive learning through repetition and engagement.

Figure 3 presents the core design of the ethnozoology-based e-module for the Animal Structure course, integrating zoological concepts with local cultural practices and conservation issues. It incorporates 5W1H-based reflective questions to deepen students' critical understanding of animal structures and cultural significance. The content is interactive, promoting independent engagement through case studies and ethnozoological practice analysis, providing both theoretical and practical insights. Additional components include a bibliography and author profile, enhancing credibility and ensuring the e-module’s relevance as a contextual educational resource.

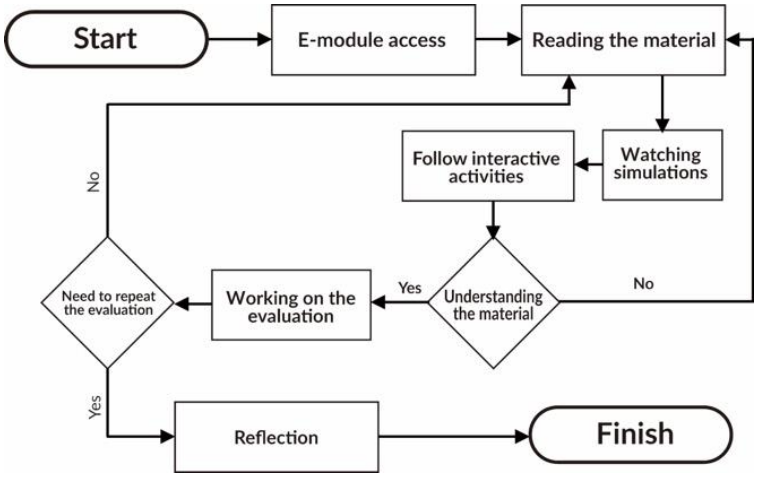

Fig. 2. Flowchart of interactive learning process in e-module.

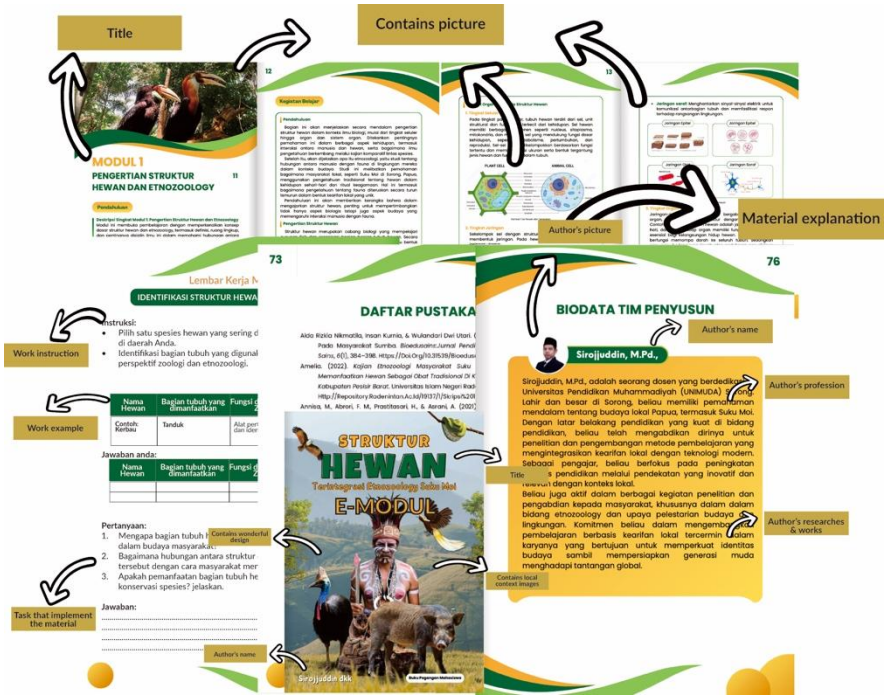

Fig. 3. Teaching material, student activity, evaluation, bibliography, and curriculum vitae design.

Table 1 presents the validation results (RTVTK) of ethnozoology-based teaching materials for the Animal Structure course, incorporating Moi Tribe knowledge [32, 33]. A feasibility test by two material experts yielded an average score of 3.72, and the media feasibility test scored 3.57, both falling within the valid category. Testing with 30 Biology Education students confirmed the materials' relevance, with RTVTK at 3.565873 and lecturer validation at 3.930556, ensuring

validity and feasibility. Field observations showed that a local context-based interactive approach boosted student engagement, evidenced by active participation in discussions and group assignments.

The evaluation results indicated positive impacts on collaboration and cognitive abilities. Collaboration skills improved from 2.1 (Level 1) to 3.57 (Level 3), aligning with research linking cultural knowledge integration to higher student interaction [34, 35]. Cognitive ability, measured via *N-Gain* (0.5, medium category) and *T-test*, showed significant improvement, supporting findings that culturally integrated, digital-based learning enhances conceptual understanding and retention [20, 24, 28]. These results confirm the effectiveness of combining local knowledge with modern education to improve student learning outcomes.

Table 1. The results of subject lecture's responses to e-module.

Aspect	Average of each criterion		Average of each the aspect	
	Student	**Lecture**	**Student**	**Lecture**
Quality	21.27	23	3.544444	3.833333
Learning	24.96	35	3.566667	3.888889
Function	7.2	12	3.6	4
Layout	24.86	28	3.552381	4
Average of each response validation (RTVTK)			3.565873	3.930556

5. Conclusion

This study shows that ethnozoology-based e-modules are effective in improving the understanding of 30 students in the Animal Structure course by connecting zoology and local wisdom of the Moi Tribe. Using the DBR approach, this e-module was validated with a material score of 3.72 and media of 3.57, as well as improving collaborative ability from 2.1 to 3.57 and a cognitive N-Gain of 0.5. The improvement occurred because the e-module integrates scientific concepts with culture, creates interactive, relevant, and technology-based learning, and supports cultural preservation and biodiversity conservation.

Acknowledgments

We would like to thank DRTPM (Directorate of Research, Technology and Community Service) of the Ministry of Education, Culture, Research and Technology of the Republic of Indonesia and Universitas Pendidikan Muhammadiyah (UNIMUDA) Sorong for providing support in this research.

References

1. Wiyanarti, E.; Holilah, M.I.N.A.; Zahra, T.F.; and Dahalan, S.C. (2024). Development of an e-module based on local wisdom ethnoastronomy in the digital era to strengthen the pedagogical competence of social studies teachers. *Journal of Engineering Science and Technology*, 19(4), 1280-1301.
2. Setiawan, A. (2022). Keanekaragaman hayati Indonesia: Masalah dan upaya konservasinya. *Indonesian Journal of Conservation*, 11(1), 13-21.

3. Pattiselanno, F.; Apituley, J.R.; Arobaya, A.Y.; and Koibur, J.F. (2019). Using wildlife for local livelihood-experiences from the Bird's Head Peninsula, West Papua, Indonesia. *Biodiversitas Journal of Biological Diversity*, 20(7). 1839-1845.
4. Sutarno, S.; Qayim, I.; Muhadiono, I.; Purwanto, Y.; and Zuhud, E.A. (2017). Traditional knowledge on the animal utilization by the Hatam tribe of Manokwari, West Papua Province. *Biosaintifika*: *Journal of Biology and Biology Education*, 9(3), 451-459.
5. Nahak, H.M. (2019). Upaya melestarikan budaya Indonesia di era globalisasi. *Jurnal Sosiologi Nusantara*, 5(1), 65-76.
6. Ulicsni, V.; Babai, D.; Vadász, C.; Vadász-Besnyői, V.; Báldi, A.; and Molnár, Z. (2019). Bridging conservation science and traditional knowledge of wild animals: The need for expert guidance and inclusion of local knowledge holders. *Ambio*, 48, 769-778.
7. Stocklmayer, S.M.; Rennie, L.J.; and Gilbert, J.K. (2010). The roles of the formal and informal sectors in the provision of effective science education. *Studies in Science Education*, 46(1), 1-44.
8. Kerans, G.; Sanjaya, Y.; Liliasari, L.; Pamungkas, J.; and Ate, G.Y. (2024). Effect of substrate and water on cultivation of Sumba seaworm (nyale) and experimental practicum design for improving critical and creative thinking skills of prospective science teacher in biology and supporting sustainable development goals (SDGs). *ASEAN Journal of Science and Engineering*, 4(3), 383-404.
9. Susilawati, A.; Al-Obaidi, A.S.M.; Abduh, A.; Irwansyah, F.S.; and Nandiyanto, A.B.D. (2025). How to do research methodology: From literature review, bibliometric, step-by-step research stages, to practical examples in science and engineering education. *Indonesian Journal of Science and Technology*, 10(1), 1-40.
10. Al Husaeni, D.F.; Al Husaeni, D.N.; Nandiyanto, A.B.D.; Rokhman, M.; Chalim, S.; Chano, J.; Al-Obaidi, A.S.M.; and Roestamy, M. (2024). How technology can change educational research? Definition, factors for improving quality of education and computational bibliometric analysis. *ASEAN Journal of Science and Engineering*, 4(2), 127-166.
11. Suherman, I. (2023). How to improve student understanding in learning science by regulating strategy in language education? Definition, factors for enhancing students comprehension, and computational bibliometric review analysis. *International Journal of Language Education*, 7(3), 527-562.
12. Fauziah, S.P.; Suherman, I.; Sya, M.F.; Roestamy, M.; Abduh, A.; and Nandiyanto, A.B.D. (2021). Strategies in language education to improve science student understanding during practicum in laboratory: Review and computational bibliometric analysis. *International Journal of Language Education*, 5(4), 409-425.
13. Al Husaeni, D.F.; Al Husaeni, D.N.; Ragadhita, R.; Bilad, M.R.; Al-Obaidi, A.S.M.; Abduh, A.; and Nandiyanto, A.B.D. (2022). How language and technology can improve student learning quality in engineering? Definition, factors for enhancing students comprehension, and computational bibliometric analysis. *International Journal of Language Education*, 6(4), 445-476.

14. Ismail, I.; Riandi, R.; Kaniawati, I.; Sopandi, W.; Supriyadi, S.; Suhendar, S.; and Hidayat, F.A. (2024). Gender roles in understanding and implementing green energy technology in Indonesian schools: Rasch analysis. *Qubahan Academic Journal*, 4(3), 298-314.
15. Trinoviorar, S. (2024). Interactive learning innovation in archival material through the development of augmented reality-based e-modules. *Jurnal Ilmiah Pendidikan Profesi Guru*, 7(3), 656-669.
16. Al-Kamzari, F.; and Alias, N. (2024). The essential technology implementations for developing a hybrid module for high school physics in the Sultanate of Oman. *International Journal of Instruction*, 17(3), 617-634.
17. Richards, S. (2023). Student engagement using hololens mixed-reality technology in human anatomy laboratories for osteopathic medical students: an instructional model. *Medical Science Educator*, 33(1), 223-231.
18. Cabero-Almenara, J.; De-La-Portilla-De-Juan, F.; Barroso-Osuna, J.; and Palacios-Rodriguez, A. (2023). Technology-enhanced learning in health sciences: Improving the motivation and performance of medical students with immersive reality. *Applied Sciences*, 13(14), 8420.
19. Heather, A.; Chinnah, T.; and Devaraj, V. (2019). The use of virtual and augmented reality in anatomy teaching. *MedEdPublish*, 8(77), 1-13.
20. Kade, A.; Supriyatman, S.; Kamaruddin, A.; Novia, N.; Supriyadi, S.; and Husain, S. (2024). Exploring technology-driven simulations in practical physics: Insights into mechanical measurements concept. *ASEAN Journal of Science and Engineering*, 4(3), 429-444.
21. Zukmadini, A.Y.; Rohman, F.; Dharmawan, A.; Sari, M.S.; Rochman, S.; and Razak, S.A. (2024). Potential biodiversity from ethnozoology of Enggano Island: Utilization, a quantitative analysis, list of animals conserved by local people, and application of research findings empowering species literacy in biology student teachers. *Indonesian Journal of Science and Technology*, 9(2), 463-496.
22. Dewi, F.; Lengkanawati, N.; and Purnawarman, P. (2019). Teachers' consideration in technology-integrated lesson design: A case of Indonesian EFL teachers. *International Journal of Emerging Technologies in Learning* (*IJET*), 14(18), 92-107.
23. Kurniati, R.D.; Andra, D.; and Distrik, I.W. (2021). E-module development based on PBL integrated STEM assisted by social media to improve critical thinking skill: A preliminary study. *Journal of Physics*: *Conference Series*, 1796(1), 012077.
24. Ahmad, Z.; Gani, H.; and Haling, A. (2024). Use of virtual reality learning media in the animal developmental structure course-lecturer and student responses. *Asian Journal of Education and Social Studies*, 50(8), 547-555.
25. Alves, R.R.N. (2012). Relationships between fauna and people and the role of ethnozoology in animal conservation. *Ethnobiology and Conservation*, 1(2), 1-70.
26. Sadler, T.D.; and Zeidler, D.L. (2022). The role of technology in promoting multicultural science education. *Journal of Science Education*, 35(2), 85-102.
27. Caetano, J.M.V.; and Ponciano, L.C.M.D.O. (2021). Cultural geology, cultural biology, cultural taxonomy, and the intangible geoheritage as new strategies for geoconservation. *Geoheritage*, 13(79), 1-21.

28. Kurniati, R.; Andra, D.; and Distrik, I. (2021). E-module development based on PBL integrated STEM assisted by social media to improve critical thinking skill: A preliminary study. *Journal of Physics Conference Series*, 1796(1), 012077.
29. Fiandini, M.; Nandiyanto, A.B.D.; Al Husaeni, D.F.; Al Husaeni, D.N.; and Mushiban, M. (2024). How to calculate statistics for significant difference test using SPSS: Understanding students comprehension on the concept of steam engines as power plant. *Indonesian Journal of Science and Technology*, 9(1), 45-108.
30. Rahayu, N.I.; Muktiarni, M.; and Hidayat, Y. (2024). An application of statistical testing: A guide to basic parametric statistics in educational research using SPSS. *ASEAN Journal of Science and Engineering*, 4(3), 569-582.
31. Afifah, S.; Mudzakir, A.; and Nandiyanto, A.B.D. (2022). How to calculate paired sample t-test using SPSS software: From step-by-step processing for users to the practical examples in the analysis of the effect of application anti-fire bamboo teaching materials on student learning outcomes. *Indonesian Journal of Teaching in Science*, 2(1), 81-92.
32. Blesia, J.U.; and Ratang, W. (2016). Indigenous wisdom for developing economic life case of Yokari people, West Papua. *Komunitas*, 8(2), 275-284.
33. Indrawan, M.; Sumule, A.; Wijaya, A.; Kapisa, N.; Wanggai, F.; Ahmad, M.; Mambai, B.V. and Heatubun, C.D. (2019). A time for locally driven development in Papua and West Papua. *Development in Practice*, 29(6), 817-823.
34. Salas, E.; Grossman, R.; Hughes, A.M.; and Coultas, C.W. (2020). Enhancing the power of culture in education: The role of collaboration and engagement. *Educational Review*, 72(3), 289-305.
35. Johnson, D.W.; and Johnson, R.T. (2019). Cooperative learning: The impact on student engagement and interaction. *Journal of Educational Psychology*, 111(4), 657-672.