Jurnal Paedagogy:
Jurnal Penelitian dan Pengembangan Pendidikan
https://e-journal.undikma.ac.id/index.php/pedagogy/index
Email:paedagogy@undikma.ac.id

Vol. 12 No. 3 : July 2025
E-ISSN: 2722-4627
pp. 648-655

Development of E-Module of Science Based on Bondowoso Ethnoscience on Vibration and Wave Material

Silvia Qaulina Damayanti, Supeno*, Iis Nur Asyiah
Master of Science Education Study Program, Faculty of Teacher Training and Education, Universitas Jember, Indonesia
*Corresponding Author. Email: supeno.fkip@unej.ac.id

Abstract: This study aims to produce Bondowoso ethnoscience-based science e-modules on vibration and wave materials suitable for use in learning activities. The development research uses a 4D model to define, design, develop, and disseminate. Data collection is done through observation, interviews, and expert validation. Interviews were conducted with 8th-grade science teachers and Bondowoso art activists. Validation was carried out by providing validation sheets and developing products for validators. The results of this study indicate that the Bondowoso ethnoscience-based science e-module has a high feasibility level, as evidenced by the average validation score of 89.5%, and the interpretation of validity is very valid. The validity of media feasibility is 87.5%, the validity of material feasibility is 91.7%, and the validity of language feasibility is 89.3%. Based on these results, it can be concluded that the Bondowoso ethnoscience-based science e-module on vibration and wave material is very feasible to use in learning.

Article History
Received: 21-04-2025
Revised: 25-05-2025
Accepted: 18-06-2025
Published: 25-07-2025

Key Words:
E-Modules; Science Learning; Bondowoso Ethnoscience.

How to Cite: Damayanti, S., Supeno, S., & Asyiah, I. (2025). Development of E-Module of Science Based on Bondowoso Ethnoscience on Vibration and Wave Material. *Jurnal Paedagogy, 12*(3), 648-655. doi:https://doi.org/10.33394/jp.v12i3.15315

https://doi.org/10.33394/jp.v12i3.15315

Introduction

Science is a konowledge that deals with nature. Science includes a science that examines everything in nature and studies events that occur in nature. Studying science is not only learning declarative forms of knowledge, both concepts, laws, principles, and facts but studying science is also learning the process of getting reports in science, which will improve critical thinking skills and logical reasoning and can solve problems creatively (Mutmainnah et al., 2021). Critical thinking skills need to be developed in science learning because these skills can train students to solve problems based on scientific thinking (Handayani et al., 2022; Muhasabah et al., 2025). Critical thinking is a process of intellectual discipline actively and skillfully conceptualizing, applying, analyzing, synthesizing, and evaluating information obtained from observation, experience, reflection, reasoning, and communication that guides beliefs and actions (Akihary et al., 2023). Critical thinking skills will help students reason, develop analytical and decision-making skills when facing many choices, and comprehensively connect and evaluate all aspects of the problem (Fatmawati et al., 2024; Putri et al., 2023). Critical thinking raises caution and anticipates every possibility that might occur in the future (Adri et al., 2022).

Learning in the 21st century requires students to develop their thinking skills. However, the state of education and student competence is contrary to the needs of the 21st century (Rachmawati et al., 2023). The field's reality shows that students' critical thinking skills are still relatively low. Based on the Indonesian education report card of Bondowoso district in 2024, the literacy skills of junior high school students in Bondowoso district are in

Vol. 12 No. 3 : July 2025
E-ISSN: 2722-4627
pp. 648-655

the medium category, namely 40.00% - 70.00% of students reach the minimum literacy competency. Literacy skills are essential for students in the school environment and society as a basis for knowledge, developing critical and analytical thinking skills, and providing competitiveness in globalization and technology (Kemdikbud, 2024). One of the contributing factors is the unavailability of teaching materials that can train critical thinking skills (Rianti et al., 2021). The knowledge presented in the teaching materials is limited to science concepts and less associated with daily life events (Hidayati et al., 2023).

One solution that can be applied to improving students' critical thinking skills is the development of ethnoscience-based science e-modules. Modules are teaching materials in the form of books that aim to enable students to learn independently without or with teacher guidance (Febriati et al., 2021). Along with the times and technology, modules can be presented in a different format, namely digitally packaged or e-modules. E-modules are modules accessed and used through electronic devices such as laptops, computers, tablets or smartphones (Permana et al., 2023). Ethnoscience is a strategy for creating a learning environment by integrating culture into the science learning process. Learning science by using ethnoscience-based teaching materials will make students more interested and enthusiastic about learning (Mardianti et al., 2020). Students can develop critical, creative, and innovative thinking skills by studying and understanding the local wisdom contained in ethnoscience. They can learn how traditional communities observe, understand, and utilize the natural phenomena around them and how this knowledge can be translated into scientific concepts and principles (Ismail et al., 2024).

Several studies have been conducted to improve students' critical thinking skills. Saputra & Salim's (2020) research on applying teaching materials based on critical thinking skills in Pasarwajo State High School grade XI students. Another research is developing science teaching materials oriented to the discovery learning model (Luqmanto et al., 2024). However, the teaching materials used in the study still used printed teaching materials. Technology is essential for introducing and developing critical thinking skills in the digital era. In addition, the study has not connected learning with local culture or ethnoscience. One of the best ways to improve students' critical thinking skills is to connect what they learn with their culture, community, and life (Nur et al., 2023).

One of Bondowoso's ethnosciences is the traditional music art of Kentrung. The character of Bondowoso Kentrung is related to one of the science materials, namely vibrations and waves. Vibration and wave events occur when the Kentrung Trebeng is hit or beaten, and it will make a sound. The vibrating Trebeng Kentrung causes the sound. The particles in the Trebeng Kentrung that vibrate make the surrounding air vibrate until they are heard in the human eardrum. Sound reaches the ear and propagates through waves (Kemendikbud, 2017). Other Bondowoso ethnosciences include Kona Mask Dance, Singo Ulung, Wayang Kattok, Ojung Dance, Macapat, and Bondowoso Batik. The movements of the dances, the sounds produced, and the dripping of the night during batik-making can also be related to vibrations and waves. Vibration and wave materials are physics materials pertaining to everyday life. The material can train students' critical thinking skills (Khumairok et al., 2021).

The purpose of this research is to produce Bondowoso ethnoscience-based science e-modules on vibration and wave material that are suitable for use in learning activities so that they can improve student's critical thinking skills. Students learn science through contextual events about art related to science concepts. Students can analyze each part of the art and

Jurnal Paedagogy:
Jurnal Penelitian dan Pengembangan Pendidikan
https://e-journal.undikma.ac.id/index.php/pedagogy/index
Email:paedagogy@undikma.ac.id

Vol. 12 No. 3 : July 2025
E-ISSN: 2722-4627
pp. 648-655

relate it to the topic of vibration and waves so that critical thinking skills are expected to improve.

Research Method

This development research uses Thiagarajan's (1974) 4D model with the stages of defining, designing, developing, and disseminating. The development of Bondowoso ethnoscience-based science e-modules is based on the 4D development model stages. The first stage defines conducting needs analysis activities to determine the media or teaching materials used, conditions or learning processes, and student characteristics. The second stage is design, which involves designing Bondowoso ethnoscience-based science e-modules and compiling the instruments used. The third stage is development, which consists of conducting validation activities with two lecturers and one science master teacher.

The needs analysis data collection technique was obtained through interviews with 8th-grade science teachers in Bondowoso Regency and Bondowoso Kentrung art activists (GAS) using interview guidelines. Validation data was collected by providing validation sheets and developing products for validators. Validators can also offer comments and suggestions about the products that have been created.

The results of the data analysis of the feasibility validation of Bondowoso ethnoscience-based science e-modules obtained from the validation sheet given to the validator using the following formula:

$$V = \frac{Tse}{Tsh} \times 100\%$$

Description:
V = Validation Percentage
Tse = Total empirical score obtained
Tsh = Maximum expected total

The analysis was continued using the combined validation calculation

$$V = \frac{Vah1 + Vah2 + Vah3}{3}$$

Description:
V = Validation (Combined)
Vah1 = expert validation 1
Vah2 = expert validation 2
Vah3 = expert validation 3
(Safitri & Fadillah, 2021).

Table 1. Criteria for Validity

Percentage (%)	Interpretation of Validity
$85 \leq \bar{x} \leq 100$	Very valid, or can be used without revision
$70 \leq \bar{x} < 85$	Moderately valid, or can be used but needs minor revisions
$50 \leq \bar{x} < 70$	Less valid, recommended not to be used because it needs major revision
$0 \leq \bar{x} < 50$	Invalid, or should not be used

(adapted from Agung, 2024)

Results and Discussion

At the defining stage, it was found that in class VIII science learning, no teaching materials were available that could train critical thinking skills and had not been connected to

Jurnal Paedagogy:
Jurnal Penelitian dan Pengembangan Pendidikan
https://e-journal.undikma.ac.id/index.php/pedagogy/index
Email:paedagogy@undikma.ac.id

Vol. 12 No. 3 : July 2025
E-ISSN: 2722-4627
pp. 648-655

local culture or ethnoscience. The teaching materials used are still in printed form; one of the teachers said he had used only e-modules during the pandemic. At the design stage, starting with the selection of applications to design e-modules. The application used is Canva. Canva is an application that provides an alternative design convenience. Canva is an online-based application that provides attractive designs with themes, features, and categories. An appealing design in learning media aims to make the learning process not monotonous and boring so that it creates enthusiasm and interest (Ende et al., 2022). The design of e-modules is adapted to the times and technology, that printed teaching materials can be presented in a different format, namely digitally packaged. This is supported by data contained in the publication of statistics on the welfare of the people of Bondowoso Regency in 2023 namely 70.96 percent of the population of Bondowoso Regency aged over 5 years stated that they had used a cellular telephone in the last three months (BPS, 2024). The next step was to select 8th-grade science learning materials, namely vibrations and waves, which were then connected to Bondowoso ethnoscience.

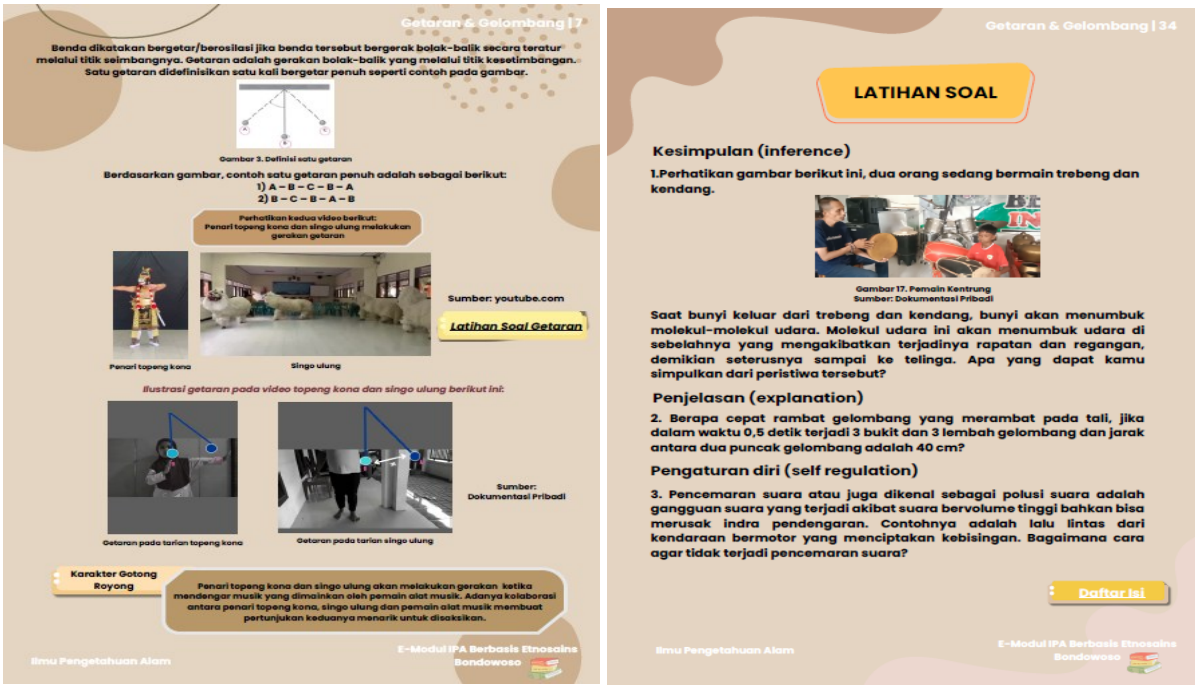

Figure 1. Example display of Bondowoso ethnoscience-based science e-module

The third stage in the development of the 4D model is development. At this stage, the e-module is validated by experts. The validators were two lecturers and one science master teacher. The validators provided input in the form of comments and suggestions, such as adding a button to return to the previous page on the exercise question, making the table of contents numbering flat, adding a description to the image, and adding the author to the end of the e-module.

Table 2. Media Expert Validation Results

Validation Aspect	Percentage	Interpretation of validity
Construct	87.5%	Very Valid

Based on the construct validation aspect calculation, the percentage obtained is 87.5%. Thus, the interpretation of the validity of the media validation is very valid. The media used in the Bondowoso ethnoscience-based science e-module is considered feasible to be implemented in learning. Construct validation in educational design research aims to ensure that the product

Jurnal Paedagogy:
Jurnal Penelitian dan Pengembangan Pendidikan
https://e-journal.undikma.ac.id/index.php/pedagogy/index
Email:paedagogy@undikma.ac.id

Vol. 12 No. 3 : July 2025
E-ISSN: 2722-4627
pp. 648-655

or learning design represents the theoretical construct on which it is based. Constructs about critical thinking skills, collaboration, or self-regulated learning are visible in the design elements developed. This validation is done through expert analysis, expert discussion, and literature review to assess the suitability between theory and implementation in the design. This process is essential so that the design is practically effective and conceptually valid. Thus, the research product has a strong theoretical basis and can be academically accounted for.

Table 3. Material Expert Validation Results

Validation Aspect	Percentage	Interpretation of validity
Content feasibility	91.7%	Very Valid
Presentation feasibility	91.7%	Very Valid
Average	91.7%	Very Valid

The percentages obtained from calculating the validation aspects of content and presentation feasibility are 91.7% and 91.7%. The average score of the two validation aspects is 91.7%, with a very valid interpretation indicating that the material validation is suitable for learning activities. Images, videos, and illustrations presented in the Bondowoso ethnoscience-based science e-module are related to local culture or Bondowoso ethnoscience. Integrating ethnoscience into science learning has enormous potential to improve student competence in the modern era (Ismail et al., 2024). Content validity refers to the extent to which the developed learning product or design components reflect the relevant content or competencies according to the educational objectives. This validity ensures that elements such as materials, activities, and assessments in the design have thoroughly and representatively covered the required content based on the curriculum or theory used. Content validation is conducted through expert judgment to review whether the design aligns with the scientific substance or targeted competencies. Content validity is essential to ensure the design is innovative, academically, and practically relevant. With strong content validity, the design results can be used more widely and scientifically justified.

Table 4. Results of Language Expert Validation

Validation Aspect	Percentage	Interpretation of validity
Language feasibility	89.3%	Very Valid

Based on the calculation of the language feasibility validation aspect, the percentage obtained is 89.3%, and the interpretation of validity is very valid. This shows that the language used in the Bondowoso ethnoscience-based science e-module is considered suitable for educational implementation.

Table 5. Total Feasibility Test Score by Expert Validators

Validation Aspect	Percentage	Interpretation of validity
Media Validation	87.5%	Very Valid
Material Validation	91.7%	Very Valid
Language Validation	89.3%	Very Valid
Average	89.5%	Very Valid

The media, material, and language validation results show that Bondowoso ethnoscience-based science e-modules are feasible to use in learning activities with an average score of 89.5%, and the interpretation of validity is very valid. The assessment of teaching material is valid if the validator gives an assessment classified as good or very good, and the validator chooses the option worth using without revision or using with revision (Akram et al., 2023). Using Canva-based e-modules as learning media is feasible because the layout and design of e-modules using Canva are more attractive in terms of presenting shapes, images, colors, and

Jurnal Paedagogy:
Jurnal Penelitian dan Pengembangan Pendidikan
https://e-journal.undikma.ac.id/index.php/pedagogy/index
Email:paedagogy@undikma.ac.id

Vol. 12 No. 3 : July 2025
E-ISSN: 2722-4627
pp. 648-655

letters (Maulinda et al., 2024). Based on the comments and suggestions the validators gave, some improvements have been made to improve the quality of the e-module. The following are the improvements made by researchers.

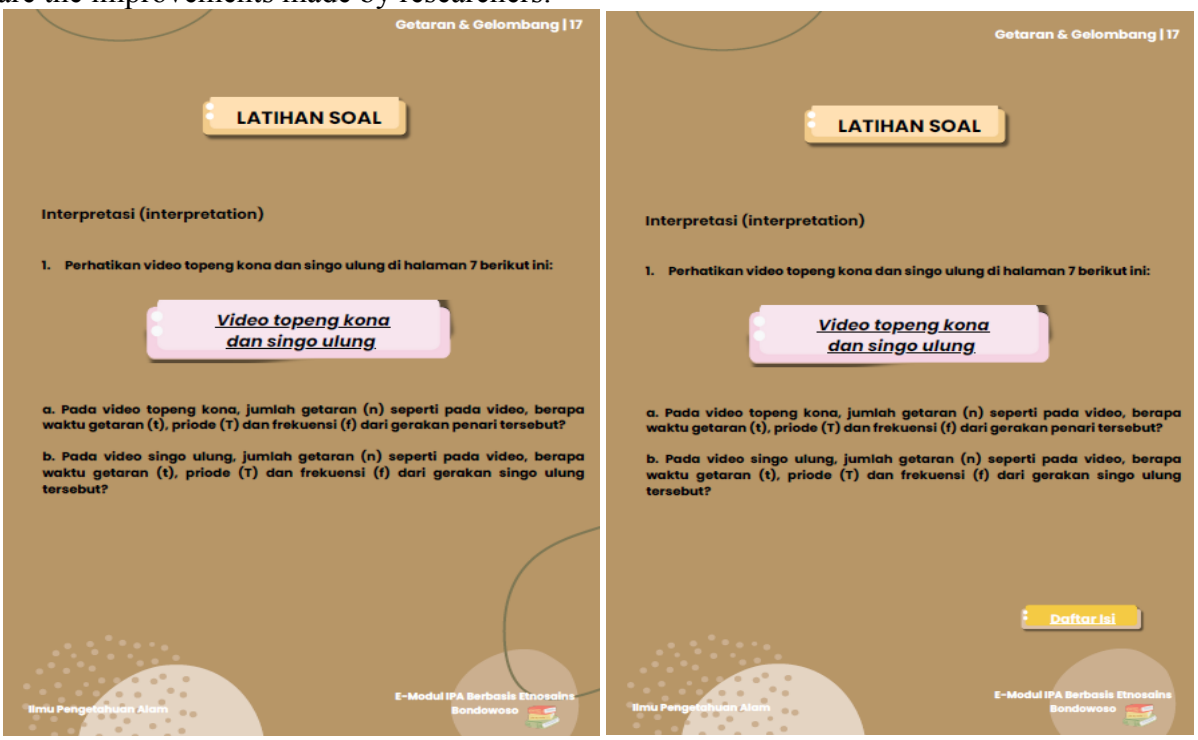

Figure 2. Bondowoso ethnoscience-based science e-modules before and after revision

Bondowoso ethnoscience-based science e-modules that validators have validated will then be implemented in learning; then, at the last stage, namely disseminate, Bondowoso ethnoscience-based science e-modules will be disseminated. As a continuation of this research, the developed products will be implemented in teaching and learning activities in the classroom. Students and teachers use the product during teaching and learning activities. Students perform various learning activities according to the product's guidelines to improve critical thinking skills. The conceptual implication of the research shows that Bondowoso ethnoscience-based science e-modules can improve student's critical thinking skills. From a practical point of view, the findings of this research present a new approach to teaching science relevant to advances in educational technology.

Conclusion

From the development that has been done, it can be concluded as follows: The feasibility of Bondowoso ethnoscience-based science e-modules on vibration and wave material from media validity obtained 87.5% results, material validity obtained 91.7% results, and from language validity obtained 89.3% results with an average score of 89.5% and interpretation of validity is very valid. This shows that the Bondowoso ethnoscience-based science e-module on vibration and wave material is suitable for use in learning activities.

Recommendation

Recommendations that can be given for further research are to develop science e-modules as learning media for all science materials that can be connected to Bondowoso ethnoscience.

Vol. 12 No. 3 : July 2025
E-ISSN: 2722-4627
pp. 648-655

For teachers to increase creativity in using and providing learning media by practicing the making of learning media.

Acknowledgments
The researcher would like to thank the Ministry of Higher Education, Science, and Technology for research funding support through the Postgraduate Grant - Master Thesis Research Year 2025 with Contract Number 072/C3/DT.05.00/PL/2025.

References
Adri, J., Refdinal, Ambiyar & Abdullah, A. S. (2022). Critical thinking skills in performance-based assessment: Instrument development and validation. *Journal of Technical Education and Training*, *14*(1), 90-99.

Akihary, W., Maruanaya, R. F., Lestuny, C., & Maruanaya, S. P. (2023). The YouTube-assisted discovery learning model: Improving students' cognitive learning outcomes and critical thinking. *Journal of Education and Learning (EduLearn)*, 17(4), 548-554.

Akram, S. A., Nurhidayah, N., & Jirana, J. (2023). Pengembangan E-modul dengan Pendekatan SETS (Science, Environment, Technology, and Society) pada Materi Sistem Peredaran Darah Kelas XI SMA/MA. Saintifik. *Jurnal Matematika, Sains, dan Pembelajarannya*, 9(1), 88-94.

Agung, I. W. (2024). Pengembangan UKBM-EL berbasis problem based learning (PBL) materi unsur, senyawa, dan campuran untuk melatih keterampilan berpikir kritis siswa SMP. *Jurnal MIPA dan Pembelajarannya (JMIPAP)*, 4(2), 5-5.

Badan Pusat Statistik. (2024). *Statistik Daerah Kabupaten Bondowoso*. Badan Pusat Statistik Kabupaten Bondowoso.

Ende, A. M. N, Jasril, I. R., & Jaya, P. (2022). Perancangan dan Pembuatan E-Modul Interaktif Berbasis Canva pada Mata Pelajaran Dasar Listrik dan Elektronika. *JTEV (Jurnal Teknik Elektro Dan Vokasional),* 8(2), 193.

Fatmawati, R., Supeno, S., & Bachtiar, R. W. (2024). Pengaruh model PBL berbantuan authentic video pada materi getaran dan gelombang terhadap kemampuan berpikir kritis dan hasil belajar siswa. *PENDIPA Journal of Science Education*, *8*(2), 337-341.

Febriati, Y., Sholahuddin, A., & Ajizah, A. (2021). Pengembangan modul IPA SMP berbasis literasi sains dengan kearifan lokal pada materi proses dan produk teknologi ramah lingkungan. *Jurnal Pendidikan Sains dan Terapan*, 1(1), 64-76.

Handayani, M., Puryatmi, H., & Hanafi, H. (2022). Peningkatan keterampilan berpikir kritis melalui model problem based learning dalam pembelajaran IPA di sekolah dasar. *Edukatif: Jurnal Ilmu Pendidikan*, 4(1), 548-555.

Hidayati, S., Ahied, M., Hadi, W. P., & Munawaroh, F. (2023). Pengembangan modul IPA berbasis model experiential learning. *Natural Science Education Research (NSER)*, 6(2), 1-10.

Ismail, I. A., Weriza, J., Mawardi, M., Lufri, L., Usmeldi, U., Festiyed, F., & Handri, S. (2024). Tinjauan sistematis analisis integrasi etnosains dalam pembelajaran IPA dan dampaknya terhadap kompetensi era modern dan nilai-nilai pancasila. *Jurnal Pendidikan dan Teknologi Indonesia*, 4(5), 207-219.

Kementerian Pendidikan dan Kebudayaan. (2017). *Ilmu Pengetahuan Alam*. Kemendikbud

Vol. 12 No. 3 : July 2025
E-ISSN: 2722-4627
pp. 648-655

Khumairok, W., Wulandari, A. Y. R., Qomaria, N., & Muharrami, L. K. (2021). Profil keterampilan berpikir kritis siswa SMP pada materi getaran gelombang dan bunyi menggunakan soal berbantuan prompting question. *Natural Science Education Research (NSER)*, 4(1), 35-44.

Kemdikbud. (2024). *Rapor Pendidikan Indonesia Kabupaten Bondowoso*. Kemdikbud.

Luqmanto, L., Hendriani, A., & Shiera, N. D. (2024). Pengembangan bahan ajar berbasis model discovery learning untuk meningkatkan keterampilan berpikir kritis siswa kelas IV sekolah dasar. *Jurnal Pendidikan Guru Sekolah Dasar*, 9(1), 38-47.

Mardianti, I., Kasmantoni, K., & Walid, A. (2020). Pengembangan modul pembelajaran IPA berbasis etnosains materi pencemaran lingkungan untuk melatih literasi sains siswa kelas VII di SMP. *BIO-EDU: Jurnal Pendidikan Biologi*, 5(2), 97-106.

Muhasabah, B. A., Supeno, S., & Yusmar, F. (2025). Real-world in science learning: An Science, Technology, Society (STS)-based science e-module to enhance critical thinking skills. *Jurnal Paedagogy*, *12*(2), 346-357.

Mutmainnah, S. L., Suhartono & Suryandari, K. C. (2021). Hubungan antara kemampuan berpikir kritis aspek menganalisis dan menarik kesimpulan terhadap hasil belajar IPA siswa kelas V SDN sekecamatan klirong tahun ajaran 2020/2021. *Kalam Cendekia: Jurnal Ilmiah Kependidikan*, 9(3), 860-866.

Maulinda, T. N., Megawati, E., & Rafidah, F. (2024). Efektivitas Pengembangan E-Modul Interaktif Bahasa Indonesia Materi Teks Prosedur Berbasis Canva. *SAP (Susunan Artikel Pendidikan)*, 8(3), 486-493.

Nur, S. F., Arsih, F., Fadillah, M., & Anggriyani, R. (2023). Pengaruh penerapan model pembelajaran problem based learning (PBL) berpendekatan etnosains terhadap keterampilan berpikir kritis peserta didik pada materi perubahan lingkungan. *Jurnal Pendidikan Tambusai*, 7(2), 16312-16322.

Permana, N. D., Ramadan, C. P., Syarif, M. I., Mahartika, I., Setyaningsih, R., & Wibowo, F. C. (2023). The development of science e-modules in junior high schools integrated with Al-Qur'an verses and assisted by virtual simulations on the subject of vibration, waves and sound. *Jurnal Inovasi Pendidikan IPA*, 9(2), 164-176.

Putri, A. S., Prasetyo, Z. K., Purwastuti, L. A., Prodjosantoso, A. K., & Putranta, H. (2023). Effectiveness of STEAM-based blended learning on students' critical and creative thinking skills. *Int J Eval & Res Educ ISSN*, *2252*(8822), 8822.

Rianti, N. A., Wati, M., Suyidno & Sasmita, F. D. (2021). Pengembangan bahan ajar dengan model inkuiri terbimbing untuk melatih kemampuan berpikir kritis peserta didik. *Jurnal Ilmiah Pendidikan Fisika*, 5(2), 94-106.

Rachmawati, D., Suharno, S., & Roemintoyo, R. (2023). The effects of learning design on learning activities based on higher order thinking skills in vocational high schools. *Open Education Studies*, *5*(1), 20220202.

Saputra, H. N., & Salim, S. (2020). Penerapan bahan ajar berbasis keterampilan berpikir kritis. *PEDAGOGIK: Jurnal Pendidikan*, 7(1), 22-46.

Safitri, I., & Fadillah, N. (2021). Pengembangan bahan ajar tematik berbasis sains teknologi masyarakat (STM) untuk meningkatkan kompetensi siswa di SDN 1 alue dua. *Jurnal Tunas Bangsa*, 8(1), 53-61.

Yunika, E., Iriani, T., & Saleh, R. (2020). Pengembangan media video tutorial berbasis animasi menggunakan 4D untuk mata kuliah praktik batu beton. *SNITT-Politeknik Negeri Balikpapan,* 299–306.

