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Validity Analysis of the Development of Integrated Global Warming Digital Teaching Material using Ethno-PBL to Improve Students Critical Thinking Ability

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ABSTRACT

Critical thinking is a key competency required in 21st-century learning; however, field observations indicate that students' critical thinking skills remain relatively low. This condition is closely related to the use of teaching materials that have not optimally implemented the Problem Based Learning (PBL) model and have not integrated local cultural contexts. To address this gap, this study developed digital teaching materials on global warming integrated with Ethno-Problem Based Learning (Ethno-PBL). The purpose of this study was to determine the validity of the developed Ethno-PBL-based digital teaching materials as a foundation for supporting the development of students' critical thinking skills. This research employed a research and development approach, limited to the product validation stage conducted by expert validators. The validation process evaluated five aspects: material substance, learning design, visual communication, software utilization, and Ethno-PBL integration. The results showed that the developed digital teaching materials achieved a high level of validity, with an average validity score of 0.94. Specifically, the validity scores for material substance, learning design, visual communication, software utilization, and Ethno-PBL integration were 0.90, 0.95, 0.96, 0.97, and 0.94, respectively. These findings indicate that the Ethno-PBL-based digital teaching materials are valid, feasible, and beneficial for use in physics learning on global warming topics, and have the potential to facilitate more contextual, meaningful, and critical learning experiences for students.

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INTRODUCTION

The 21st century demands quality human resources. This is characterized by demands for students to possess the 4Cs: critical thinking, creative thinking, collaboration, and communication (Nazifah & Asrizal, 2022; Novitra, 2021) . One of the essential competencies in 21st-century education is critical thinking skills (Yuliani & Mufit, 2025) . Critical thinking skills are essential for training students in problem-solving, providing reasoned explanations, and evaluating the information they receive (Savitri & Kholiq, 2023) . Therefore, educators need to design learning that is adaptive, innovative, and oriented

toward strengthening 21st-century skills, especially critical thinking skills.

The 21st-century learning demands student-centered learning. This means that students are not merely objects but also active subjects in the learning process, directly involved in discovering, understanding, and applying knowledge. Learning must be student-focused, providing space for students to develop their potential according to their individual interests, abilities, and learning pace (Mashudi, 2021) . The physics learning process must be student-centered, enjoyable, motivating, and meaningful to students (Yuliana, 2024) . Thus, 21st-century learning is not only oriented towards mastery of material but also towards character building and developing life skills.

The use of information technology is essential for 21st-century learning. Technology is a crucial tool in supporting effective, interactive, and flexible learning processes in line with current developments (Fuadah et al., 2023) . Through technology, students can access a wide range of learning resources quickly and broadly, and communicate without the constraints of space and time (Yuliantaningrum et al., 2020) . The use of technology as a learning resource and medium in schools is a powerful way to enhance the learning process (Rosmawati, 2023) . Technology can also encourage student-centered learning by stimulating interaction, improving basic skills, arousing curiosity, transforming the learning environment, and ensuring broad and efficient access to educational resources (Asrizal & Amnah, n.d.) . The presence of technology also enables learning processes to take place online and offline by utilizing engaging digital media. Therefore, teachers need to have good digital literacy to optimally integrate technology into the learning process.

The Independent Curriculum is an effort to create more flexible and student-centered learning. By giving educators the freedom to design and adapt learning to local contexts and individual student needs, this curriculum supports more relevant and meaningful learning (Fratiwi et al., 2024) . This approach also emphasizes character building through the Pancasila Student Profile, which encourages students to develop 21st-century skills, such as critical thinking, creativity, and collaboration (Wahyuningsih, 2021). Furthermore, the Independent Curriculum prioritizes project-based learning, enabling students to address real-world challenges and hone practical skills needed in everyday life (Wahyudin et al., 2024) . Thus, the Independent Curriculum is expected to create a generation that is more independent, adaptive, and ready to face rapid global developments.

Local wisdom plays a crucial role in the Independent Curriculum. Through the integration of local wisdom, students not only learn academic material but also understand the values, norms, and traditions that exist within their communities. This aligns with the principles of the Independent Curriculum, which provide educational units with the freedom to develop learning materials tailored to the context and potential of their respective regions (Ministry of Education, Culture, Research, and Technology, 2022). Furthermore, local wisdom-based learning can foster a sense of patriotism, foster cultural identity, and build character in students, enabling them to adapt to global developments without losing their identity (Utami, 2021). Therefore, the integration of local wisdom into the Independent Curriculum serves as a strategic tool for developing a generation that is intelligent, has character, and is culturally aware.

The reality on the ground does not reflect the expected conditions based on the actual conditions. Therefore, a preliminary study was conducted to assess the reality on the ground. This study identified four real-world conditions: an analysis of students' critical thinking skills, an analysis of student learning outcomes, an analysis of global warming material, and an analysis of teaching materials available at SMAN 1 V Koto Kampung Dalam.

The first problem relates to students' critical thinking skills. Students' initial critical thinking skills are assessed through student worksheets. The assessment of students' critical

thinking skills uses Ennis's (2011) indicators, namely drawing conclusions (inference), developing strategies and tactics (strategy and tactics), providing simple explanations (elementary clarification), and building basic support skills. The results of the critical thinking skills conducted at SMAN 1 V Koto Kampung Dalam obtained an average score of 30.6. Based on these initial student abilities, it can be seen that students' critical thinking skills are in the low category. 5 The second problem relates to global warming material. Based on research conducted by Ma'riah et al., (2017), students have difficulty understanding the concept of global warming and its impact on the environment. This is evident from the large number of students who have not been able to explain the phenomena of climate change and the greenhouse effect in the context of everyday life. In addition, according to Prakoso and Kurniawan (2022), students are less skilled in analyzing data and information related to global warming, so they have difficulty understanding the relationship between human activities and climate change.

The second problem relates to global warming. Research conducted by Ma'riah et al. (2017) found that students struggle to understand the concept of global warming and its impact on the environment. This is evident in the large number of students who are unable to explain the phenomena of climate change and the greenhouse effect in the context of everyday life. Furthermore, according to Prakoso and Kurniawan (2022), students lack the skills to analyze data and information related to global warming, making it difficult for them to understand the relationship between human activity and climate change.

The third problem relates to the teaching materials available in schools. Based on the results of the identification at the school, it was found that the teaching materials used did not fully meet the criteria for ideal teaching materials. Some teaching materials still did not include specific and measurable learning objectives, the material presented did not fully refer to the learning outcomes of the latest curriculum, and learning activities were still limited and did not encourage student activeness. Furthermore, the use of interactive digital media in teaching materials was still very minimal, while in today's digital era, technology-based teaching materials are a crucial need to support 21st-century learning.

As a solution to this problem, it is necessary to develop effective teaching materials to help students understand global warming material. An approach that can be applied is the Development of Digital Teaching Materials for Global Warming Integrated with Ethnoscience and Problem-Based Learning (PBL). The integration of ethnoscience in learning has been shown to improve students' critical thinking skills (Mukti et al., 2022) . Another opinion states that by using the PBL learning model, students' critical thinking skills can be improved (Rahmawati et al., 2020) . With the Development of Digital Teaching Materials for Global Warming Integrated with Ethno-PBL, physics learning is expected to become more interactive and contextual, thereby improving students' critical thinking ability. In addition, the use of these Digital Teaching Materials can also help teachers in implementing innovative, technology-based learning methods that are in accordance with local wisdom, thereby creating more effective and meaningful learning for students.

Good teaching materials must have good validity values. Good learning tools must meet the validity criteria of expert validators and practitioner validators (Kaya et al., 2025). In the process of developing teaching materials, the validity testing stage is a very important step to ensure that the resulting product is suitable for use in learning. The validity of teaching materials indicates the extent to which their content, appearance, and presentation are appropriate. Without going through validity testing, teaching materials have the potential to contain conceptual errors, inconsistencies with the curriculum, or less attractive presentations, making them ineffective in helping students achieve the expected competencies.

The purpose of this study was to test the validity of digital teaching materials on

global warming developed using an ethno-Problem Based Learning (ethno-PBL) approach to improve students' critical thinking skills. This validity test included an assessment of the content, construction, and appearance of the digital teaching materials. The content aspect was assessed based on the material's suitability to learning outcomes and the Independent Curriculum, the validity of scientific concepts, and the integration of relevant local wisdom values. The construction aspect was seen from the integration of learning components, the clarity of the ethno-PBL-based activity flow, and its suitability to the objectives of developing critical thinking skills. Meanwhile, the appearance aspect was assessed in terms of visual design, interactivity, language, and presentation appeal to suit the characteristics of high school students. It is hoped that this digital teaching material is declared appropriate and of high quality, and can be used as an interesting, contextual, and effective learning medium in improving students' critical thinking skills.

METHODS

This research is a research and development (R&D) using the Hannafin and Peck development model. The Hannafin and Peck design model is a simple yet elegant model. All three phases are connected by evaluation and revision activities (Fayrus & Slamet, 2022) . This model consists of three main stages: Needs Assessment, Design Phase, Development, and Implementation. In the first stage, an initial needs analysis was conducted. This needs assessment was carried out through an analysis of the needs required to develop a good learning program. At this stage, an analysis of problems with students' critical thinking skills, an analysis of student learning outcomes, an analysis of global warming material, and an analysis of teaching materials available at the school, specifically at SMAN 1 V Koto Kampung Dalam, was carried out.

At this stage, the structure of digital teaching materials based on Ethno-PBL was developed. The materials were structured to include local phenomena such as community environmental management practices, visual illustrations, contextual videos, and problem-solving activities aligned with critical thinking indicators. Each component of the teaching materials was systematically organized, starting from the introduction, presentation of learning materials, student activities, and evaluation. The digital teaching materials developed were not only oriented towards mastering physics concepts, but also on developing scientific attitudes, higher-order thinking skills, and an appreciation of cultural and environmental values.

The designed digital teaching materials were then validated by experts in their respective fields. The validators were physics lecturers from the Faculty of Mathematics and Natural Sciences, Universitas Negeri Padang. The aspects tested for validity were material substance, learning design, visual communication, software utilization, and suitability for ethno-PBL. These aspects align with the provisions for developing ICT-based teaching materials according to the Hannafin and Peck research scheme, as shown in the following figure.

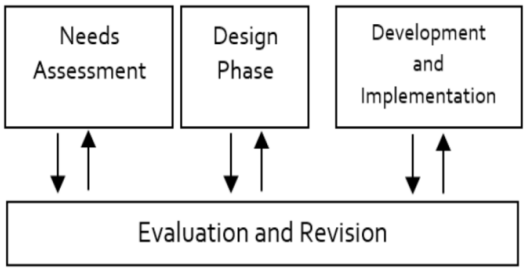

Figure 1. Hannafin and Peck Stages

The validation assessment of this teaching material uses a Likert scale. A Likert scale is a type of measurement scale used to assess a person's attitude, opinion, or perception toward a particular object, statement, or phenomenon. This product assessment uses a scale of 1 to 5, as shown in Table 1. Each score on the scale has a specific meaning that indicates the level of suitability or validity of the components of the teaching material being assessed. By using this scale, researchers can obtain more measurable and objective data to determine the feasibility of the developed teaching material.

Table 1 Likert Scale

Likert scale	Category
1	Strongly disagree
2	Disagree
3	Undecided
4	Agree
5	Strongly agree

Source: (Sugiyono, 2017) .

The data obtained were analyzed using the validity index proposed by Aiken. The scale used was 1 to 5, with three validators. Aiken's formula used is equation 1.

$$V = \frac{\sum s}{n(c-1)}$$
$$s = r - l_0 \qquad (1)$$

Description:
V = Rater agreement index
l 0 = Lowest validity rating (in this case = 1)
c = Highest validity rating (in this case = 5)
r = Number given by a rater
n = Number of raters

After obtaining the rater agreement index, the category of the index value is decided. The results of the category decision based on Aiken's V Index as in Table 2.

Table 2. Decision Based on Aiken's V Index

Interval	Category
V ≥ 0.90	Valid
V< 0.90	Valid

Source: (Aiken, 1985)

Item validity based on Aiken's V-index can be classified into two categories: valid and invalid. The validity of a product is determined by the Aiken validation table. Validation results are seen based on the number of validators and the scale used. If the V-index is greater than 0.90, it is considered valid. If the V-index is less than 0.90, it is considered invalid.

RESULTS AND DISCUSSION

Results

Result of Analysis of each Motivation Indicator

After the product was developed, a formative evaluation was conducted through a validity test. At this stage, the aspects evaluated included material substance, learning design, visual communication, software utilization, and Ethno-PBL integration. The validation results showed that the developed digital teaching materials were valid. The first aspect evaluated was material substance. This aspect included eight indicators in the instrument, including the validity of the suitability of physics principles, physics facts,

material completeness, physics concepts, physics phenomena, contextual learning videos, and the use of communicative and informative language. This was followed by the learning design aspect in Table 3.

Table 3. Validation Results on the Material Substance Aspect

Assessed Indicators	V Value	Average	Category
Compliance with the principles of physics	0.83	0.90	Valid
physical facts	1.00		
Complete and accurate	0.83		
Complete and accurate physics concepts	0.83		
Physical phenomena are often encountered nowadays.	1.00		
Features contextual learning videos related to the field of technology	0.92		
Using communicative language	0.83		
Using informative language	0.92		

Based on the validation analysis using the Aiken formula, the substance indicators in the developed product obtained an average V value of 0.90 and were classified as valid. The V value for each aspect was in the range of 0.83–1.00, indicating a high level of material suitability. The highest value was obtained for material indicators based on facts and physical phenomena that are closely related to everyday life. These findings indicate that the learning content is relevant to the real context and is in line with the physics concepts being studied. Overall, the validation results confirm that the Ethno-PBL integrated digital teaching materials have met the scientific aspects, ethnoscience context, and clarity of material presentation, making them suitable for use in physics learning.

Next, product validity was evaluated based on the learning design. This indicator was evaluated based on seven aspects, including the suitability of learning objectives, the flow of learning activities, the suitability of exercises with achievement indicators, and the clarity of the presentation structure. These results can be seen in more detail in Table 4.

Table 4. Validation Results on Learning Design Aspects

Assessed Indicators	V Value	Average	Category
Consistency with title/identity	1.00	0.95	Valid
Relevance to physics learning objectives	1.00		
Alignment with the learning objectives	1.00		
Appropriateness of materials for each learning activity	0.83		
Alignment of exercises/evaluations with achievement indicators	0.92		
Containing the list of authors	0.92		
Include complete information in the bibliography	1.00		

Based on the validation results, the learning design indicators in the developed product obtained a V value of 0.95 and were categorized as highly valid. The V value for each indicator ranged from 0.83 to 1.00, with some indicators reaching the maximum value of 1.00. These findings indicate that the teaching materials have been designed systematically, are in line with learning outcomes, and are supported by accurate reference

sources. Indicators with a V score of 0.83 indicate that there is still room for improvement, particularly in terms of improving the consistency of material presentation in each learning activity. Overall, the validation results confirm that the Ethno-PBL integrated digital teaching materials are suitable for use because they meet the criteria for content suitability, objectives, and a good physics learning structure.

Next is the product validity for the visual communication display indicator. This indicator is divided into seven assessment aspects, including image clarity, font proportion, color combination, and visual design appeal. This assessment aims to ensure that digital learning materials are not only aesthetically appealing but also facilitate student understanding. The results for this aspect can be seen in Table 5 below.

Table 5. Validation Results on Visual Communication Aspects

Assessed Indicators	V Value	Average	Category
Easier navigation between slides	0.83	0.96	Valid
Provides proportional font and slide spacing	1.00		
Clear images	0.92		
Images are relevant to the physics material	1.00		
Videos are relevant to the physics material	1.00		
Attractive	1.00		
Contains comprehensive information Features an appealing design	1.00		

Based on the validation results, the visual communication indicator of the developed product obtained a V value of 0.95 and was categorized as highly valid. The highest scores were obtained in the aspects of letter and slide space proportions, the suitability of images and videos with physics material, color combinations, and design appeal. These findings indicate that the visual and aesthetic aspects of the teaching materials have been optimally designed and support material comprehension. The indicator of ease of access between slides obtained a V score of 0.83, indicating that navigation is adequate but could still be improved. Overall, the validation results confirm that the digital teaching materials are valid, communicative, aesthetic, and support student comfort in the learning process.

Furthermore, the validity of the product was evaluated based on the use of software. This aspect assesses the suitability of software use in the development of digital teaching materials such as Microsoft Word, Canva, and Heyzine Flipbook. This evaluation is divided into eight aspects that cover the software's ability to support text, image, video, and navigation between slides or pages. The results of this aspect are described in detail in Table 6 below.

Table 6. Validation Results on Software Utilization Aspects

Assessed Indicators	V Value	Average	Category
Adding images, videos, animations	0.92	0.97	Valid
Easy to access	1.00		
Attractive	0.92		
Easy to publish online	1.00		
Custom-designed	1.00		
Designed based on your own ideas	1.00		
Using Microsoft Word and Canva	0.92		
Using Heyzine Flipbooks	1.00		

The validation results for the software utilization indicator showed a V value of 0.94 and was categorized as highly valid. The indicators for the use of images, videos, animations, interest levels, and the use of Microsoft Word and Canva obtained a V value of 0.92, which indicates effective support for multimedia content presentation. The aspects of software accessibility and online publishing capabilities obtained a V value of 1.00, indicating that the software is easy to operate and supports the distribution of digital teaching materials. The development of teaching materials with independent designs and ideas through Microsoft Word, Canva, and Heyzine Flipbook also obtained a score of V = 1.00. Overall, these results confirm that the use of software supports the development of interactive, attractive, and easy-to-use digital teaching materials.

Finally, validity was evaluated in the Ethno-PBL integration indicator. This evaluation consisted of six aspects covering the suitability of content with local policies, the relevance of local phenomena to learning, and the application of PBL steps to develop students' critical thinking skills. The evaluation results for this aspect can be seen in detail in Table 7 below.

Table 7. Validation Results on the Ethno-PBL Integration Aspect

Assessed Indicators	V Value	Average	Category
Contains local cultural elements relevant to the concept of physics	0.92		
Links the Problem-Based Learning model to cultural phenomena in society	0.92		
Encouraging students to analyze and solve ethno-science-based problems scientifically.	0.92	0.94	Valid
Encouraging student involvement in exploring physics in everyday life.	1.00		
Clear stages in line with the Problem-Based Learning model.	0.92		
Using language and illustrations that reflect cultural values.	1.00		

The validation results on the Ethno-PBL integration aspect show that the developed digital teaching materials are in the highly valid category, with an average score of 0.94 and a range of V scores for each indicator between 0.92 and 1.00. These findings indicate that local cultural elements have been integrated in a relevant manner with physics concepts and are in line with problem-based learning syntax. The teaching materials are also considered capable of encouraging student engagement in the exploration of contextual physics phenomena through the use of language and illustrations that reflect cultural values without neglecting scientific principles. In addition, the indicators of ethnoscience-based analysis and problem solving as well as the clarity of the PBL stage application obtained a V value of 0.92, which indicates the consistency of the learning model application. Overall, these validation results confirm that the integration of cultural context and Problem Based Learning has been applied systematically, effectively, and in accordance with the characteristics of contextual physics learning.

Discussion

The research results show that the development of digital global warming teaching materials integrated with Ethno-PBL has gone through three main stages: needs assessment, design phase, and development and implementation. Each stage plays a crucial role in producing valid teaching materials that are relevant to learning needs and support the

development of high school students' critical thinking skills. This development process is carried out systematically, paying attention to the suitability between the material content, learning model, and local cultural context integrated into each learning activity.

The needs analysis stage shows a gap between the demands of 21st-century learning and the actual conditions of physics learning in schools. Based on the results of the assessment of students' critical thinking skills at SMAN 1 V Koto Kampung Dalam, an average score of 34.2 was obtained, which is included in the low category. This is also in line with previous studies that stated that students' critical thinking skills are still low (Kafii et al., 2023; Sari et al., 2016) . These results indicate that students still have difficulty in identifying problems, linking concepts to real phenomena, and drawing conclusions based on data. Students also lack exercises that guide students to solve problems that require analysis, evaluation, and argumentation (Kafii et al., 2023) . Another opinion states that low critical thinking skills are caused by teaching materials that tend to be monologic so that students do not stimulate students to ask more questions or express opinions in a pleasant discussion atmosphere (Artiwi et al., 2020) .

The needs analysis also revealed that physics teaching materials used in schools are still conventional, not yet integrated with the local context, and do not accommodate problem -based learning. Some teaching materials still do not present clear and specifically measurable learning objectives. The material presented is not fully aligned with the learning outcomes in the latest curriculum, and the available learning activities are still limited, thus less encouraging active student participation. This is in line with the theme that teaching materials tend to be monologic, therefore need to be replaced with dialogic teaching materials that can stimulate students to ask more questions or express opinions in a fun discussion atmosphere (Putra et al., 2023; Rosmawati, 2023) . In addition, the use of interactive digital media in teaching materials is also still low. Therefore, in the current digital era, the use of technology-based teaching materials is very important to support 21st-century learning (Virijai & Asrizal, 2023).

After the product was developed, a formative evaluation was conducted through expert validity testing to ensure product quality from various aspects. Based on the validation results, an average value of V = 0.94 was obtained, which is included in the valid category. The material substance aspect obtained a value of V = 0.90, indicating that the physics material presented was correct. Based on all aspects, the material substance received the lowest value. This is because the validators were unable to ensure that the questions presented could actually improve students' knowledge and critical thinking skills (Widia et al., 2025) . An effectiveness test is needed to determine this (Kurniawan & Syafriani, 2021) .

The learning design aspect has a V value of 0.95, indicating that the learning structure is systematic and in accordance with the PBL stages. This is in line with Widia's (2025) opinion that high-quality learning materials must be developed with a coherent structure, logical content flow, and systematic presentation, all of which are based on the principles of effective learning design. Therefore, the resulting product can be said to be valid in terms of learning design aspects.

The visual communication aspect with a value of V = 0.96 indicates that the teaching materials have an attractive and communicative appearance. In line with the opinion of Virijai (2023) who stated that the visual communication display in digital teaching materials can make it easier for students to carry out learning with a clear navigation display, legible letter display, media that helps learning, and proportional color combinations and there are already media such as videos and images that can motivate students in learning. The existence of visual elements, text, animation, video, and quizzes in the media, which are in line with the content of the material and help clarify the delivery of learning to students (Febriani, 2025) . So that the teaching materials that have been developed can attract

students' interest in learning.

Meanwhile, software utilization received the highest score, V = 0.97, indicating the effectiveness of selecting and using digital media such as Microsoft Word, Canva, and Heyzine in developing accessible teaching materials. This aligns with Virijai's (2023) opinion , which shows that using software in digital teaching materials can facilitate users' use. Therefore, choosing the right software when developing teaching materials is crucial (Fitriani Zakiah et al., 2021) .

Finally, the Ethno-PBL integration aspect obtained a V value of 0.94, indicating that the local cultural context and the problem-based learning model have been integrated very well. Ethno-PBL integration has been proven to enrich the context of physics learning, making it more meaningful. In line with the results of Kharisma's (2023) research , the use of ethnoscience in teaching materials can improve students' critical thinking skills and scientific attitudes because it links scientific concepts with local culture. Good critical thinking skills make students more capable of designing solutions that are not only scientifically appropriate but also relevant to the local cultural context (Susilawati et al., 2025) .

This study is limited to the validity testing stage; therefore, further research should focus on practicality and effectiveness testing to examine the direct impact of Ethno-PBL-based digital teaching materials on students' critical thinking skills. Nevertheless, the findings demonstrate that the developed teaching materials meet excellent validity criteria in accordance with the teaching material development principles proposed by the Ministry of National Education (2010) , covering material substance, learning design, visual communication, software utilization, and Ethno-PBL integration. These results confirm that integrating local wisdom into physics learning contributes significantly to the development of students' critical thinking skills. The findings also support Franstito's (2025) study, which reported that local wisdom-based learning effectively enhances students' analytical and explanatory abilities in solving contextual problems. Through the Ethno-PBL approach, the teaching materials function not only as innovative learning media but also as a meaningful medium for internalizing cultural values. Therefore, the developed digital teaching materials are considered appropriate for implementation in secondary schools as an alternative resource for global warming instruction.

CONCLUTION

Based on the research objectives, it can be concluded that the Validity of Ethno-PBL Integrated Global Warming Digital Teaching Materials to Improve Students' Critical Thinking Skills is valid. The feasibility component of the material substance is included in the valid category. The visual communication aspect is also categorized as valid. Similarly, the feasibility aspect of the instructional design received a valid assessment. The software utilization aspect was also declared valid. Then the ethno-PBL integration aspect was also declared valid. Overall, the validity of the ethno-PBL integrated digital teaching materials obtained an average score of 0.94 which is categorized as valid. These results indicate that the digital teaching materials are considered feasible, so they can be continued to the practicality testing stage with students.

REFERENCES

Aiken, L. R. (1985). *Educational and Psychological Measurement*.

Artiwi, R. P., Asrizal, Desniita, & Darvina, Y. (2020). Pengaruh E-Book Pengayaan Fisika Disertai Tugas Berita dan Fakta Terhadap Keterampilan Berpikir Kritis dan Kreatif Peserta Didik Kelas X SMAN 2 Padang. *Pillarof Physics Education, 13(2), 289–296*.

Asrizal, & Amnah, R. (nd). *Ethno-STEM Integrated Digital Teaching Material with Augmented Reality to Promote Students' Learning Skills and Innovation To cite this article : Ethno-STEM Integrated Digital Teaching Material with Augmented Reality to Promote Students' Learning Skills*.

Fayrus, & Slamet, A. (2022). *Development Research Model (R n D)*.

Febriani, R. (2025). Development of Digital Flipbook Media Based on Local Wisdom to Improve Students' Critical Thinking Skills. *Lambda Journal, Lembaga "Bale Literasi" , 5 (2), 439–450*.

Fitriani Zakiah, I., Karim, S., Efendi, R., & Feranie, S. (2021). Design and Construction of an Interactive E-book on Light Waves. *WaPFi (Physics Education Forum) , 6 (1), 1–8*.

Franstito, NA, Surabaya, UN, Surabaya, UN, & Info, A. (2025). *Ethnoscience-Based E-Module Development . 13 (1), 1–15*.

Fratiwi, NJ, Septiani, S., Suminar, I., & Meisya, R. (2024). *Learning Transformation in the Era of the Independent Learning Curriculum* (November Issue).

Fuadah, AT, Mudjenan, IM, & Hasan, ML (2023). Perspective ; Utilization of Information and Communication Technology in 21st Century Learning in Junior High Schools. *Transformative Education Journal (Jupetra) . 02 (02), 154–164*.

Kafii, MS, Dwikoranto, & Setiani, R. (2023). Validity Development of Critical Thinking Skill Test Instruments on Running and Stationary Wave Materials. *IPF: Physics Education Innovation , 12 (Vol.12 No.3 (2023): Volume 12 Number 3 of 2023), 111*.

Kaya, V., Yusuf, FM, Nusantari, E., Husain, IH, & Jannah, M. (2025). *USING LEARNING MODELS . 8 , 4240–4248*.

Kharisma, V., Ilahi, PC, & Maharani, S. (2023). *The Effect of Ethnoscience-Based Learning on Students' Critical Thinking Skills*. Proceedings of the 2023 National Seminar on Biotechnology, UIN Raden Fatah Palembang , 1159–1167.

Kurniawan, R., & Syafriani, S. (2021). Practicality and Effectiveness of Using High School Physics E-Modules Based on Guided Inquiry Integrated with Ethnoscience to Improve Students' Critical Thinking. *Jurnal Eksakta Pendidikan (Jep) , 5 (2),* 135–141.

Mashudi. (2021). *Modern Learning : Equipping Students with 21st Century Skills . 4 (1),* 93–114.

Ministry of Education, Culture, Research, and Technology. (2022). *Pocket book on the implementation of the Independent Curriculum*. Jakarta: Ministry of Education, Culture, Research, and Technology.

Ministry of National Education. (2010). *Guide to Developing ICT-Based Teaching Materials* .

Mukti, H., Suastra, IW, Bagus, I., & Aryana, P. (2022). *Integration of Ethnoscience in Science Learning . 7 (2),* 356–362.

Nazifah, N., & Asrizal. (2022). *Development of STEM Integrated Physics E-Modules to Improve 21st Century Skills of Students . 8 (4),* 1783–1789.

Novitra, F. (2021). *Development of Online-based Inquiry Learning Model to Improve 21st-Century Skills of Physics Students in Senior High School . 17 (22)*.

Putra, IS, Aswirna, P., Asrar, A., Physics, T., Islam, U., Imam, N., & Padang, B. (2023). *Development Of E-Module On Ethno STEM Physics For The Creatdddion Of Jambi Batik And Its Impact On Students Creative Thinking Abilities* . 801–813.

Rahmawati, I., Hidayat, A., & Rahayu, S. (2020). Analysis of Junior High School Students' Critical Thinking Skills on the Material of Style and Its Application. In Pros. *National Seminar on Science Education, Postgraduate Program, UM (Vol. 1, p. 13)*.

Rosmawati, W. (2023). *The Effectiveness of Using E-Books to Train Students' Critical Thinking Skills . 7 (3)*, 979–1002.

Sari, ALR, Parno, & Taufiq, A. (2016). Critical Thinking Skills and High School Physics Concept Understanding on Newton's Laws. In Pros. *National Seminar of Science Education, Postgraduate Program, UM (Vol. 1, pp. 88–99)*.

Savitri, I., & Kholiq, A. (2023). Validity of Digital Physics Comics to Train Students' Critical Thinking on Friction Force Material. *Physics Education Innovation , 12 (3)*, 41–47.

Sugiyono. (2017). *Research and Development Methods (R&D) (S. Yustiyani (ed.))*.

Susilawati, Andayani, Y., & Hasan, Y. (2025). *Development of E-Module Based on Ethnoscience for Cidomo Transportation . 6 (2)*.

Utami, S. (2021). Integration of local wisdom in learning based on the Independent Curriculum. *Indonesian Journal of Education, 4 (2)*, 88-97.

Virijai, F., & Asrizal, A. (2023). Development of Ethnophysics-Based Augmented Reality Assisted Digital Teaching Material for 21st Century Learning. *Journal of Science Education Research , 9 (11)*, 9200–9209.

Wahyudin, D., Subkhan, E., Malik, A., & Hakim, A. (2024). *Independent Curriculum*.

Wahyuningsih, S. (2021). Character-based learning in the Independent Curriculum. *Journal of Character Education, 5 (2)*, 75-84.

Widia, W. E., Asrizal, A., Hidayati, H., & Yumna, H. (2025). *Validation Analysis of Interactive Teaching Materials on Environmental Pollution Integrated with Ethno-Meaningful Learning to Facilitate Students' Knowledge and Creative Thinking Skills. Physics Learning and Education, 3(2)*, 241–253.

Yuliana, N. (2024). *Pengaruh Penggunaan Video Pembelajaran Fluida Berbasis Kontekstual Terhadap Kemampuan Kolaborasi. 9*, 1284–1291.

Yuliani, N., & Mufit, F. (2025). *Design and Validity of Electronic Assessments to Assess Students Critical Thinking Abilities on Circular Motion Materials. 3(1)*, 80–93.

Yuliantaningrum, L., Sunarti, T., Fisika, J., & Surabaya, UN (2020). *Development of HOTS Question Instruments to Measure Critical Thinking, Creative Thinking, and Problem Solving Skills in Straight Motion Material in High School Students . 09 (02)*, 76–82.