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Validity Analysis of Ethno-Inquiry Integrated Digital Teaching Materials to Facilitate Creative Thinking and Students' Science Process Skills

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ABSTRACT

Creative thinking skills and science processes are the main demands in 21st century learning, especially in physics subjects that demand conceptual understanding and exploratory abilities. However, the reality in the field shows that physics learning is still conventional and minimal utilization of contextual and digital media. To answer this problem, ethno-inquiry integrated digital teaching materials were developed as an innovative solution that combines technology, local culture, and scientific approaches. The purpose of this research is to develop and analyze the validity of digital teaching materials to facilitate students' creative thinking skills and science process on heat material. This research uses the Research and Development (R&D) method with the Hannafin & Peck model through the stages of needs analysis, design, development, and implementation. Validation was conducted by three experts using instruments covering five main aspects: material substance, visual communication, learning design, software utilization, and ethno-inquiry integration. The validation results showed that all aspects obtained an average score of 0.92 which was classified as "valid". These teaching materials were designed using Canva and presented through the heyzine flipbook platform, which provides an interesting and contextual digital learning experience. Thus, this teaching material is proven to be valid and has the potential to be an alternative physics learning that is adaptive to the Merdeka Curriculum and 21st century skills-based learning needs.

Keywords: Digital teaching materials, ethnosians, inquiry, creative thinking, science process skills.

I. INTRODUCTION

21st century skills are the main demands for students in the era of the Industrial Revolution 4.0. Individuals today are not only required to master theoretical knowledge, but must also be able to apply it in practice. Various efforts and important roles are needed in the process of acquiring these skills. 21st century skills include various aspects such as, critical thinking, problem solving, collaboration, communication, and creativity. These skills are interrelated and necessary to face the complex challenges of the modern era, where changes occur rapidly and the demand for adaptation and innovation is increasing [1]. Societal learning over time creates new learning demands in the 21st century. Society evolved from a primitive society to an agrarian society, then transitioned to an industrial society, and is currently shifting towards an informative society. The informative society is marked by the development of digitalization. From 1960 until now, the use of computers, the internet and mobile phones has grown rapidly [2]. 21st century learning is characterized by a change in the learning paradigm. One form of learning paradigm adjustment is moving the center of learning from teachers to students [3]. The purpose of this paradigm shift is for students to become active in student-centered learning as reflected in student activity during learning. The realization of student-centered learning is seen in the activities of students who actively build and organize their own knowledge concepts [4].

Educators and learners must master digital technology to meet the demands of 21st century education. Technology in the field of education is utilized as a learning support, the implementation is as a learning medium and as a learning resource [5]. This implementation is in line with Permendikbudristek No. 16 of 2022 concerning process standards, namely the use of information technology devices and communication to provide

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a quality learning experience. The utilization of technology in education is expected to help students and educators in carrying out learning activities, so that technology really becomes an intermediary to achieve learning goals [6]. The development of technology changes the way of obtaining and providing information in the world of education. The development of the field of education will have an impact on changes that affect various aspects of life, because education is an influential factor in the quality of a country [7]. In the 21st century, teachers are required to be able to take advantage of technology by using new methods. Together with technology, it can create a more active, innovative and exciting teaching and learning atmosphere. Improve collaborative relationships between students, teachers, and learning media [8].

The 21st century curriculum requires students to be more independent in acquiring knowledge, both inside and outside of school. Students are given the freedom to develop their talents, skills and do various positive activities that support self-development. In today's digital era, technological developments also affect the quality of education. The Merdeka Curriculum is designed to develop literacy, skills, proficiency, attitudes, and mastery of technology, by giving students the freedom to maximize the knowledge achieved [9]. The independent learning curriculum demands learning that focuses on developing students' talents and interests. Here, students can choose what lessons they want to learn according to their talents and interests. The Merdeka Curriculum is a curriculum with diverse intracurricular learning, where subject matter will be optimized so that students have sufficient time to explore concepts and strengthen competencies. Teachers have the flexibility to choose various teaching tools so that learning can be tailored to student learning needs and interests [10].

The problem found in this study after conducting a needs analysis is the low utilization of ICT by teachers in physics learning, especially in digital teaching materials integrated with ethnoscience and inquiry models. Based on a questionnaire distributed to three physics teachers, 61.33% stated difficulties in using digital teaching materials, and 60% experienced obstacles in applying ethnoscience. In addition, students' creative thinking skills at SMA Negeri 6 Padang are still relatively low, with an average score of only 40.0 based on an essay test that measures aspects of fluency and elaboration. These results indicate that students have not been able to think creatively optimally according to the demands of 21st century learning. Students' science process skills are also still low, as seen from their weak ability to formulate hypotheses, design experiments, and draw conclusions, with an average score of around 40. The solution in this research is to develop ethno-inquiry integrated digital teaching materials designed to overcome various problems faced by teachers and students.

The inquiry model emphasizes the active involvement of students in searching and discovering the core of the material, not just receiving information from the teacher. In this process, students are encouraged to explore and find answers to the questions posed, thus fostering self-confidence. The teacher acts as a facilitator and motivator, not as the only source of information. Student activities are directed to develop independent thinking and problem-solving skills. Thus, the inquiry model not only improves understanding, but also forms students' learning independence and responsibility [11].

Ethnoscience is science that is obtained by studying the culture of a group of people. In Physics Education, ethnoscience is important because it can bridge the difference between the culture of students and the scientific culture in schools. Some reasons for the importance of ethnoscience in physics education are [12]. First, ethnoscience allows the integration of local wisdom into physics learning, which in turn can make the learning experience for students more meaningful and relevant. Second, ethnoscience has the potential to increase students' interest in science by bridging scientific concepts with their own culture and experiences. Third, ethnoscience can also stimulate students' creativity, encouraging them to think beyond conventional boundaries and create innovative solutions to problems. Fourth, ethnoscience can enhance critical thinking by challenging students to analyze and evaluate scientific knowledge embedded in culture. Ethnoscience is an important approach in Physics Education because it can help students connect scientific concepts to their own culture and experiences, increase their interest in science and encourage creativity and critical thinking [12].

The rapid development of technology in the 21st century also affects the innovation of teaching materials. The innovation in the development of teaching materials is digital teaching materials. Digital teaching materials are teaching materials whose material content is loaded in digital form in the form of audio, audio visual, or interactive multimedia. Digital teaching materials are systematically arranged in digital form which contains materials tailored to student learning needs [13]. Digital teaching materials contain material used by students in measuring the ability of students published in a digital format that can be accessed via smartphones, laptops, and PCs [14]. Some teaching materials included in digital teaching materials include books such as e-books, electronic magazines, or e-magazines, interactive multimedia CDs / DVDs, interactive flash models or slides, e-learning, and others [15].

Creative thinking skills are cognitive skills to come up with and develop new ideas, new ideas as a development of ideas that have been born before and skills to solve problems divergently (from various points of view) [16][17]. Creative thinking is one of the 4C skills that students must have in 21st century education [18]. Creative thinking skills are needed in the 21st century because life is getting more complicated and more complex [19]. The ever-changing life brings various challenges. If students do not know how to create and innovate, then they will not be ready to face the complexity of problems in the era of global competition [20]. In addition, creative thinking skills are very important in supporting the learning process, especially in physics learning [21]. Creative thinking skills help students find solutions to various challenges in physics learning and understand and explain physical phenomena clearly and effectively. Therefore, this skill is important to face the challenges of 21st century learning that requires students to have creative thinking skills in solving problems and innovating [22].

Science process skills are basic skills that facilitate learning in science, enable students to be active, develop a sense of responsibility, improve learning and research methods. Ongawa & Indoshi (2013) argue that science process skills help students to develop a sense of responsibility in learning and increase the importance of research methods in the learning process. Science process skills aim to make students more active in understanding and mastering the series they do such as observing, questioning, processing/analyzing data, evaluating, communicating results [23].

This study aims to develop and test the validity of Etno-Inquiry integrated digital teaching material products as an alternative teaching material that is more innovative and effective in facilitating students' creative thinking and science process skills. Through the integration of Ethno-Inquiry in digital teaching materials, teachers are expected to be able to more easily integrate digital media in learning, so that students have access to teaching materials that are more interesting, interactive, and able to facilitate creative thinking and science process skills. In addition, this research is also expected to be the first step in encouraging teachers to be more active in developing and using digital teaching materials, so that physics learning becomes more contextual, interesting, and in accordance with the demands of 21st century learning.

II. METHOD

The type of research applied in this study is Research and Development (R&D). R&D research is a systematic approach used to generate new knowledge, solve problems, or develop products, processes, or services [24]. The development model used in this research is the Hannafin & Peck model. The Hannafin & Peck model is one of many product-oriented learning design models [25]. The Hannafin & Peck model consists of three phases, namely needs analysis, design, development and implementation.

The research process begins with analyzing the needs needed to develop a good learning program with data collection conducted at SMA Negeri 6 Padang. Furthermore, the product design stage of preparing digital teaching materials, including components such as titles, instructions for use, learning instructions, Ethno-Inquiry explanations, learning outcomes, learning materials, practice questions, evaluations, bibliographies, and glossaries. After the product was designed, the product was validated by experts, of course, physics lecturers at Padang State University using validation instruments. The validation process assesses several aspects, including material substance, visual communication, learning design, software utilization, ethnoscience integration and inquiry learning model.

Product validation was assessed based on five main indicators: material substance, visual communication, learning design, software utilization, ethnoscience integration and inquiry learning model. Each aspect was evaluated using a Likert scale ranging from 1 to 4, with higher scores indicating higher levels of validity. Product validity was determined using Aiken's validity index, and a product was considered valid if it met a minimum criterion of ≥ 0.61, as established by Azwar (2015).

The data collection instrument used in this study was a validation sheet filled out by three physics lecturers (validators) at Padang State University (UNP). The data obtained from the validation process were analyzed using Aiken's V validity index to determine the feasibility and validity of the developed digital teaching materials. The scores given by the validators were converted into a scale of 1 to 4 and processed using Aiken's V formula to obtain the validity coefficient. Aiken's V formula is as follows:

$$V = \frac{\sum s}{n(c-1)} \quad (1)$$

(Source: Ref[25])

The final calculation results determine whether the digital teaching materials meet the predetermined validity criteria. If the validity value reaches or exceeds the minimum threshold of 0.61, then the product is considered valid and feasible to use as an innovative teaching material in Ethno-Inquiry integrated physics learning.

III. RESULTS AND DISCUSSION

A. Results

This section presents the results of the validity analysis of digital teaching materials developed with the inquiry learning model and ethnoscience approach to facilitate students' creative thinking and science process skills. The analysis was conducted to assess the feasibility of teaching materials from various aspects such as material substance, visual communication, learning design, software utilization, and ethno-inquiry integration. The assessment was conducted by experts (validators), namely three Physics lecturers at Padang State University. This analysis aims to determine the extent to which teaching materials meet valid criteria in the context of science learning. The assessment results were used to assess the feasibility of the product as a contextual and innovative learning media. The first component assessed in the validity instrument is the substance of the material can be seen in Figure 1.

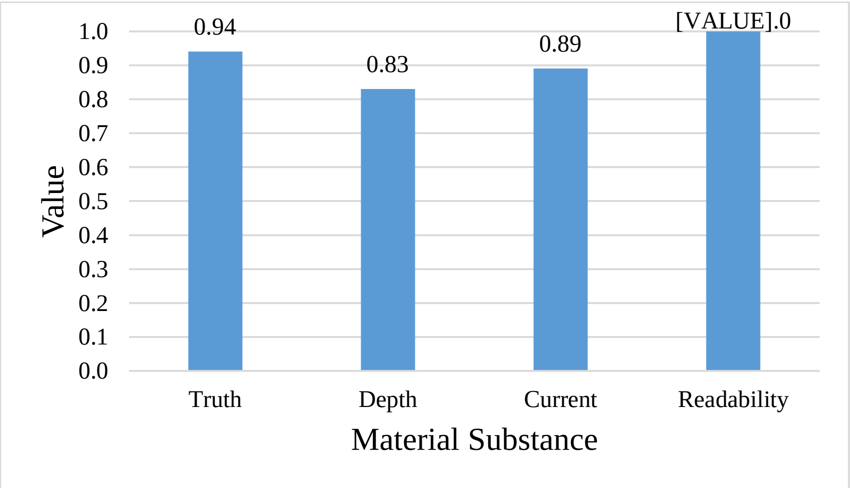


Fig. 1. Components of Material Substance

Based on Figure 1, the validity results on the material substance component show that the digital teaching materials developed have met the content eligibility standards very well. The highest score is obtained in the readability aspect of 1.00, which indicates that the material is easily understood by users. The aspect of material truth also obtained a high score of 0.94, indicating that the content of teaching materials was in accordance with correct scientific concepts. The depth aspect scored 0.83, indicating that the material has covered a fairly in-depth discussion according to the level of student development. The current aspect scored 0.89, indicating that the material presented is relevant to current issues and learning needs. Overall, the average score of 0.92 in this component proves that the substance of the material in digital teaching materials is valid and feasible to use in the physics learning process.

The second component of the validity instrument is visual communication, which plays an important role in ensuring that digital teaching materials effectively convey information in a clear, attractive and accessible way. The validity score analysis for the visual communication component is as presented in Figure 2.

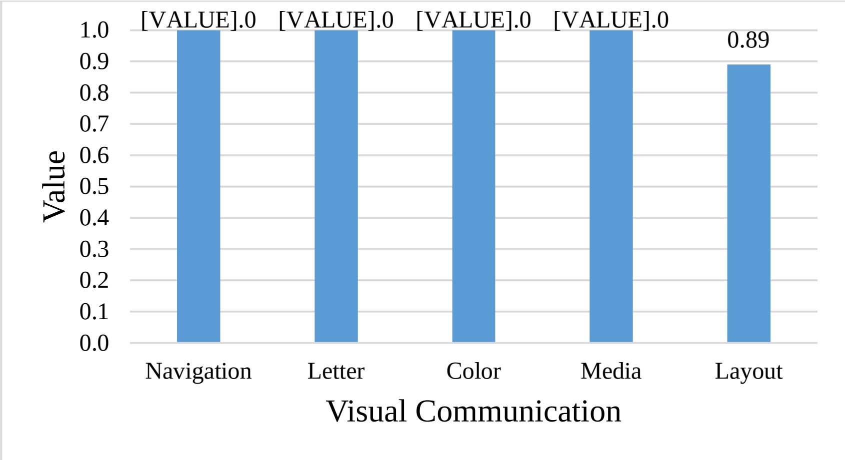


Fig. 2. Components of Visual Communication

Based on Figure 2, the results of the validity of digital teaching materials, especially the visual communication component, show a range of scores between 0.80 and 1.00. In more detail, the navigation aspect obtained a score of 1.00 in the valid category, which indicates that users can easily navigate the content. The letter aspect scored 1.00 ensuring that the text is legible and appropriately formatted for readability and in the valid category. The color aspect obtained a score of 1.00 confirming that the color scheme enhances visual appeal without causing distraction and is in the valid category. The media aspect scored 1.00 which indicates that the multimedia elements effectively support the learning process and is in the valid category. Finally, the layout aspect scored 0.89 in the valid category. Overall, the average validity score for the visual communication component is 0.98 which is categorized as valid and feasible to use in the physics learning process.

The third component of the validity instrument assessed is learning design. The assessment of this component aims to determine the extent to which the structure and systematics of teaching materials are in accordance with the learning objectives. Each aspect of learning design is assessed to ensure the integration of content, activities, and evaluation presented in digital teaching materials. The results of the validators' assessment of these aspects can be seen in detail in Figure 3.

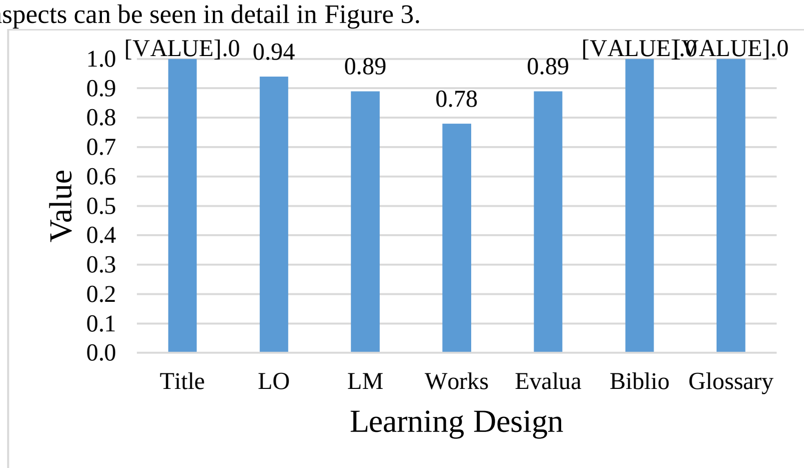


Fig. 3. Components of Learning Design

Based on Figure 3, the results of the validity of digital teaching materials, especially in the learning design component, show a score range between 0.70 and 1.00. This component ensures that the learning structure is in accordance with the learning objectives. In more detail, the title aspect scored 1.00 in the valid category. The learning outcome (LO) aspect scored 0.94 in the valid category. The learning material (LM) aspect scored 0.89 in the valid category. The worksheet aspect (Works) scored 0.78 ensuring that the work steps are well structured and aligned with the ethnoscience integration and inquiry learning model and in the valid category. The evaluation aspect (Evalua) scored 0.89 which proves its validity in measuring student progress. The bibliography aspect (Biblio) scored 1.00 which confirms that the sources that support the content of teaching materials and in the valid category. Finally, the glossary aspect scored 1.00 in the valid category. The overall average validity score for the learning design component is 0.93 classifying it as valid.

The fourth component of the validity instrument is software utilization. The assessment in this component aims to see the extent to which the software used is able to support the presentation of digital teaching materials effectively and interactively. The aspects assessed include the suitability of supporting software (canva, heyzine flipbook, google form) and the level of product originality. The results of the validators' assessment of this component can be seen in full in Figure 4.

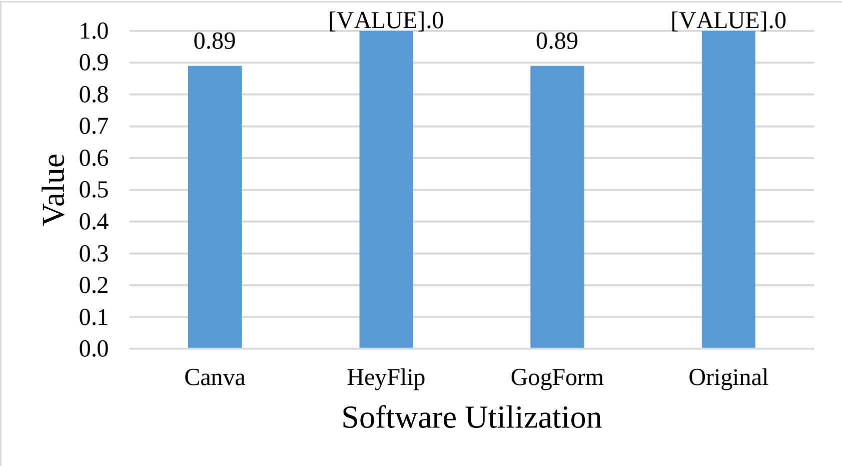


Fig. 4. Components of Software Utilization

Based on Figure 4, the validity results on the software utilization component show that digital teaching materials have been supported by software that is effective and feasible to use in learning. The score range between 0.90 to 1.00 reflects the excellent quality of software utilization. Canva as a visual design media obtained a score of 0.89, which indicates that its appearance is quite attractive and as needed. Heyzine Flipbook (HeyFlip) as an interactive presentation platform obtained a perfect score of 1.00, showing its ability to present teaching materials in an attractive and accessible manner. Google Form (GogForm) used for practice questions also scored 0.89, confirming that learning evaluation has been digitally integrated. The originality aspect received the highest score of 1.00, which indicates that the product was developed creatively and innovatively. This indicates that the teaching materials not only convey information, but also provide new learning experiences for students. With an average overall score of 0.96, the use of software in this digital teaching material is categorized as valid and feasible for use in the physics learning process.

The fifth component of the validity instrument is the integration of ethnoscience and inquiry learning models that play an important role in promoting active learning for students. These steps provide a structured framework that guides students through the ethno-inquiry process, allowing them to explore scientific concepts in a meaningful and systematic way. Analysis of the validity scores for the Ethno-Inquiry integration component as presented in Figure 5.

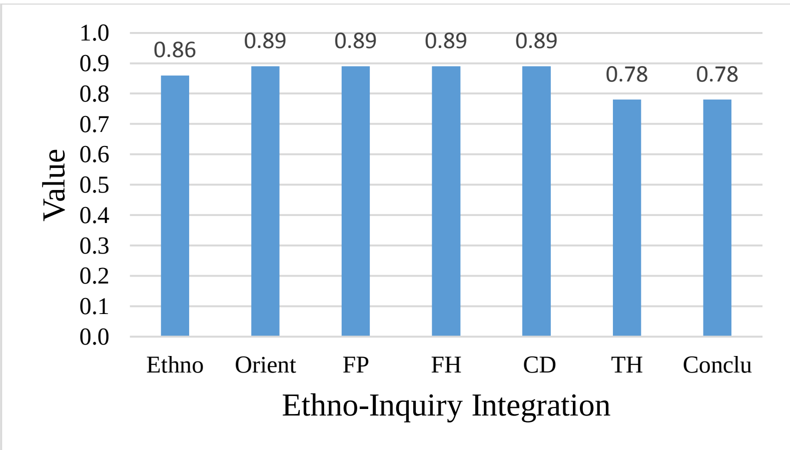


Fig. 5. Components of Ethno-Inquiry Integration

Based on Figure 5, the results of the validity of digital teaching materials, especially in the ethno-inquiry integration component, show a range of scores between 0.70 and 0.90. The ethnoscience aspect (Ethno) obtained a score of 0.86 which shows that teaching materials are integrated with local culture so that learning has a pleasant and not boring atmosphere for students and is in the valid category. The inquiry aspect of orientation

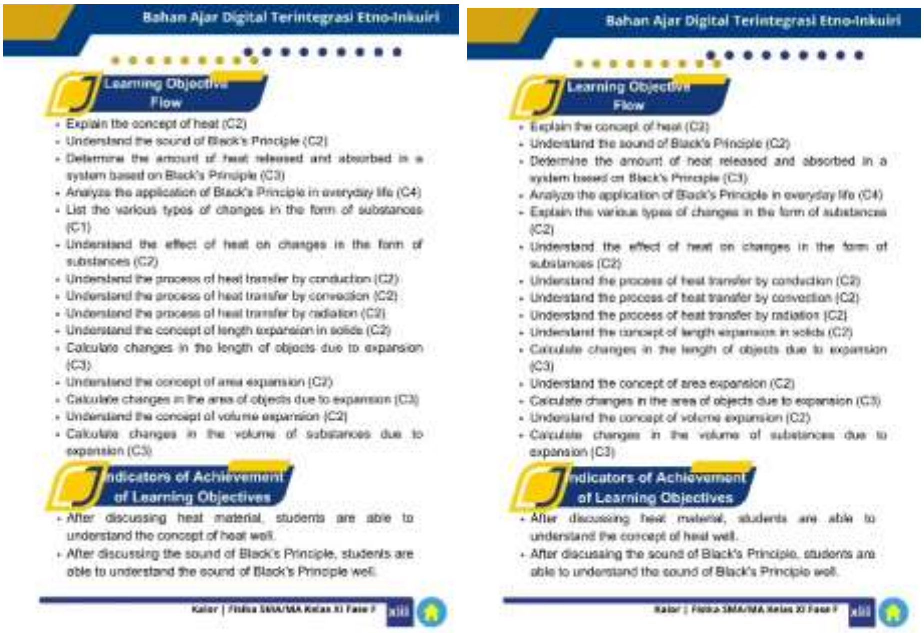
(Orient) obtained a score of 0.89 which triggered students to ask initial questions and was in the valid category. The inquiry aspect of formulating problems (FP) scored 0.89 which triggered students to be able to identify problems based on observed phenomena and in the valid category. The inquiry aspect of formulating hypotheses (FH) obtained a score of 0.89 which spurred students to convey temporary conjectures and was in the valid category. The inquiry aspect of collecting data (CD) obtained a score of 0.89 which encouraged students to seek information through observation and experimentation and was in the valid category. The inquiry aspect of testing hypotheses (TH) obtained a score of 0.78 which spurred students to prove the truth of temporary conjectures and in the valid category. The inquiry aspect of the conclusion (Conclu) obtained a score of 0.78 which encouraged students to explain the results they had obtained and was in the valid category. Overall, the average validity score for the ethno-inquiry integration component is 0.85 which is categorized as valid and feasible to use in the physics learning process.

Based on the assessment of all components, the average value of the validity of digital teaching materials integrated with Ethno-Inquiry as a whole is 0.93, including in the valid category. This indicates that the digital teaching materials developed have met the eligibility standards required for use in physics learning, especially in fostering students' creative thinking and science process skills. The validation process not only confirmed the accuracy of the material substance, visual communication, learning design, software utilization, ethno-inquiry integration, but also included constructive feedback from expert validators. These experts provided valuable insights and suggestions to address potential weaknesses in the initial version of the product, ensuring that the digital teaching materials were refined for optimal classroom implementation. Based on the feedback received, several improvements and revisions were made to enhance the quality of the digital teaching materials.

(a) Before revision (b) After revision

Fig. 6. Revised cover of teaching materials

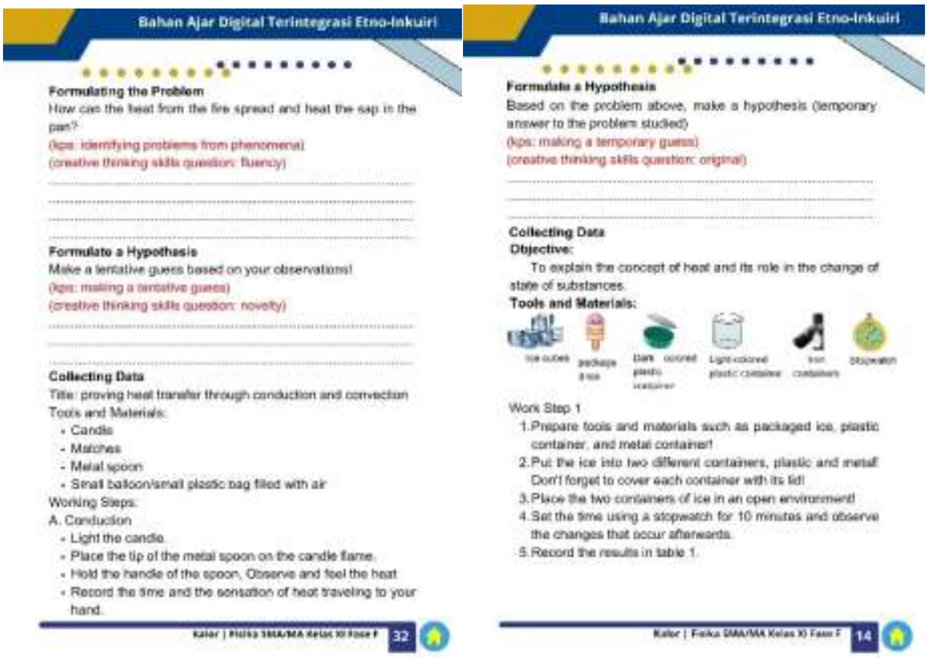
Based on Figure 6, one of the important revisions made by researchers in the development of digital teaching materials is to replace the ethnoscience examples used in the learning content. Initially, the teaching materials presented an example of the practice of burning straw as a representation of local wisdom. However, after going through the validation process and considering feedback from expert validators, the example was deemed inappropriate to be used as part of the learning, especially because of its negative impact on the environment. In response to this feedback, the researcher replaced the example of burning straw with another more appropriate ethnoscience practice, namely batangeh or traditional steam bathing.



(a) Before revision (b) After revision

Fig. 7. Revised flow of learning objectives

Based on Figure 7, the next suggestion given by the validator is related to the presentation of the flow of learning objectives in digital teaching materials. In the initial version, the teaching materials did not include the flow of learning objectives explicitly. This is considered an important shortcoming because learning objectives are a fundamental component in the structure of teaching materials that serve as a guide to the direction of learning, both for teachers and students. The validator recommended that the teaching materials contain a clear and systematic flow of learning objectives. Following up on this suggestion, the researcher made revisions by adding the flow of learning objectives to the teaching materials. After the first revision, the validators provided additional input regarding the quality of the flow. They suggested that learning objectives should not only be listed formally, but also really reflect the logical relationship between basic competencies, materials, learning activities, and evaluation.



(a) Before revision (b) After revision

Fig. 8. Revised Worksheet

Based on Figure 8, the next suggestion given by the validator relates to improving the worksheets contained in the digital teaching materials. In the initial version, the worksheets have contained activities that refer to concept exploration, but have not explicitly shown their relationship with the syntax of the inquiry learning model and indicators of science process skills. The validator suggested that each part of the worksheet be given a description that emphasizes its linkage with the stages of inquiry and the indicators of science process skills developed. Validators also suggested that the teaching materials include simple experiments or lab activities that students can do with easily found tools and materials. This is important to integrate conceptual learning with concrete experience, which is the core of the inquiry approach.

B. Discussion

This research was conducted at SMA Negeri 6 Padang. The research produced products in the form of ethno-inquiry integrated digital teaching materials to facilitate creative thinking and valid student science process skills. The development model carried out is the Hannafin & Peck model consisting of three phases, namely needs analysis, design, development and implementation. This research focuses on the validity of digital heat teaching materials. The validity of the product was assessed by three Physics lecturer experts at Padang State University using five assessment components. The assessment components refer to the guidelines for the development of ICT-based teaching materials by the Ministry of National Education in 2010, these aspects include material substance, visual communication, learning design, utilization of software [26] . The substance of the material must be in accordance with the curriculum, visually appealing, supported by the right design and software, and integrate ethno-inquiry that encourages student activeness in investigation [27] . The indicators of creative thinking skills measured are according to Harisuddin [28] . The indicators of science process skills measured are according to the Merdeka curriculum in 2024.

The development of ethno-inquiry-based digital teaching materials in this study is very relevant in the context of 21st century learning which requires students to think creatively and have science process skills. The inquiry model used emphasizes exploration, observation, and independent inference by students, as confirmed by Prasetiyo and Rosy (2020) that inquiry is a strategy that can develop students' critical and creative thinking skills. The integration of the ethnoscience approach also strengthens the link between local culture and scientific concepts so as to build contextualized learning [12] . Digital teaching materials designed with interactive platforms such as heyzine flipbook are in line with the utilization of technology in education as mandated in Permendikbudristek No. 16 of 2022 [5] . The application of learning design with this digital approach is also proven to be effective in activating students in accordance with the ideas of Hannafin & Peck, where the design must be flexible, responsive to student needs, and support active learning. Furthermore, the use of Aiken's validity indicator which reaches a value of 0.93 indicates the suitability of the instrument with the validity measurement rules recommended by Azwar (2015), strengthening that this teaching material is suitable for use in the physics learning process.

Based on the results of the analysis and research that has been done, it can be seen that the digital teaching materials developed have valid criteria with a validity level obtained of 0.93 According to Azwar (2015), a product is said to be valid if it has a category of <0.61. This is in line with research conducted by Adha, Asrizal, and Rahmi (2023) which shows that STEM-based e-modules can significantly improve students' critical and creative thinking skills [16] . The same thing was also found in the ethno-inquiry digital teaching materials in this study, which proved to be valid both from the aspect of substance and interactivity and its connection with the local cultural context. The approach that combines ethnoscience, inquiry, and digital technology is proven to be effective in supporting meaningful physics learning. The consistency of these results suggests that the integration of various innovative approaches can strengthen students' 21st century skills. Thus, such teaching materials are worth developing as contextual and relevant learning solutions.

Thus, overall the ethno-inquiry-integrated digital teaching materials to facilitate students' creative thinking and science process skills are categorized as valid and good to use in terms of material feasibility, visual communication, learning design, software utilization, and ethno-inquiry integration. However, this study has limitations, the limitations of this study lie in the scope of development which is still focused on one material topic, namely heat in physics learning. Although the teaching materials have integrated four examples of ethnoscience, the coverage of local culture is still limited to the context of Minangkabau culture, so it does not reflect the diversity of cultures from other regions in Indonesia.

IV. CONCLUSION

Based on the validity research data that has been conducted, it can be concluded that this research produces ethno-inquiry integrated digital teaching materials that are declared valid based on five main components, namely material substance, visual communication, learning design, software utilization, and integration of ethnoscience and inquiry models. The average validity value of 0.92 indicates that this teaching material is suitable for use in physics learning, especially to facilitate students' creative thinking skills and science processes. The use of ethno-inquiry approach encourages the connection between scientific concepts and local culture, and provides a more contextual and meaningful learning experience. The use of digital technology such as Canva and Heyzine Flipbook also increases the attractiveness and ease of access to teaching materials for students. The Hannafin & Peck model used in the development ensures that the product goes through systematic and needs-based stages. Adjustments to expert feedback resulted in teaching materials that were more mature in structure and content. Although this research is limited to one topic of material and a specific local culture, the results show great potential in 21st century learning innovation. Thus, this teaching material can be a creative, relevant, and contextual learning alternative in supporting the Merdeka Curriculum.

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REFERENCES

[1] S. Zubaidah, “Memberdayakan Keterampilan Abad ke-21 melalui Pembelajaran Berbasis Proyek.,” *Semin. Nas. Nas. Pendidik. Biol.*, vol. 1(2), pp. 1–19, 2019, [Online]. Available: https://www.researchgate.net/publication/336511419_Memberdayakan_Keterampilan_Abad_Ke-21_melalui_Pembelajaran_Berbasis_Proyek

[2] R. Rahayu, S. Iskandar, and Y. Abidin, “Inovasi Pembelajaran Abad 21 dan Penerapannya di Indonesia,” *J. Basicedu*, vol. 6, no. 2, pp. 2099–2104, 2022, doi: 10.31004/basicedu.v6i2.2082.

[3] A. Asrizal and A. W. Utami, “Effectiveness of Mechanical Wave Learning Material Based on ICT Integrated CTL to Improve Students Learning Outcomes,” *J. Penelit. Pendidik. IPA*, vol. 7, no. 4, pp. 632–641, 2021, doi: 10.29303/jppipa.v7i4.837.

[4] D. Kartikasari, R. Medriati, and A. Purwanto, “Penerapan Discovery Learning Model dengan Pendekatan Saintifik untuk Meningkatkan Kemampuan Berpikir Kritis Siswa pada Konsep Kalor dan Perpindahan Kalor,” *J. Kumparan Fis.*, vol. 1, no. 2, pp. 1–7, 2018, doi: 10.33369/jkf.1.2.1-7.

[5] Lestari, “Peran Teknologi dalam Pendidikan di Era Globalisasi,” *Edureligia; J. Pendidik. Agama Islam*, vol. 2, no. 2, pp. 94–100, 2018, doi: 10.33650/edureligia.v2i2.459.

[6] A. Maritsa, U. H. Salsabila, M. Wafiq, P. R. Anindya, and M. A. Ma’shum, “Pengaruh Teknologi dalam Dunia Pendidikan,” *Al-Mutharahah J. Penelit. dan Kaji. Sos. Keagamaan*, vol. 18, no. 2, pp. 91–100, 2021, doi: 10.46781/al-mutharahah.v18i2.303.

[7] P. A. Maharani, E. Risdianto, and I. Setiawan, “Pengembangan Media Pembelajaran Interaktif Berbantuan Google Sites untuk Meningkatkan Hasil Belajar Siswa pada Materi Momentum dan Impuls,” *J. Penelit. Pembelajaran Fis.*, vol. 15, no. 1, pp. 32–42, 2024, doi: 10.26877/jp2f.v15i1.17458.

[8] S. A. Hasnaa and S. Sahronih, “Pengaruh Media Pembelajaran Interaktif Berbasis Website Google Sites terhadap Hasil Belajar Siswa Sekolah Dasar,” *PERISKOP J. Sains dan Ilmu Pendidik.*, vol. 3, no. 1, pp. 21–27, 2022, doi: 10.58660/periskop.v3i1.31.

[9] S. Ariga, “Implementasi Kurikulum Merdeka Pasca Pandemi Covid-19 Implementation of the Independent Curriculum after the Covid-19 Pandemic,” *Edu Soc. J. Pendidikan, Ilmu Sos. dan Pengabdi. Kpd. Masy.*, vol. 2, no. 2, pp. 662–670, 2024.

[10] S. Mustaghfiroh, “Konsep ‘Merdeka Belajar’ Perspektif Aliran Progresivisme John Dewey,” *J. Stud. Guru dan Pembelajaran*, vol. 8, no. 1, pp. 10–37, 2020.

[11] M. D. Siregar and D. Yunitasari, “Penerapan Strategi Pembelajaran Inkuiri dalam Peningkatan Kreativitas Belajar IPS pada Siswa Sekolah Dasar,” *Educatio*, vol. 13, no. 1, pp. 68–83, 2018, doi: 10.29408/edc.v12i1.841.

[12] A. R. Harefa, “Pembelajaran Fisika Di Sekolah Melalui Pengembangan Etnosains,” *War. Dharmawangsa*, vol. 53, pp. 1–18, 2017.

[13] Y. Septi, R. Winarni, S. Slamet, J. Poerwanti, and M. Ismail, *Merancang Bahan Ajar Digital Berwawasan Budaya Nusantara*. Yogyakarta: Jejak Pustaka, 2021.

[14] D. C. Nisa, N. Purwidiani, A. K. Widagdo, and N. Astuti, “Pengembangan Bahan Ajar Digital dengan

Aplikasi Flip Pdf Corporate Edition pada Materi Peralatan Dapur Siswa Fase E," *J. Ilm. Profesi Pendidik.*, vol. 9, no. 3, pp. 1655–1661, 2024, doi: 10.29303/jipp.v9i3.2468.

[15] I. Sriwahyuni, E. Risdianto, and H. Johan, "Pengembangan Bahan Ajar Elektronik Menggunakan Flip Pdf Professional pada Materi Alat-Alat Optik Di Sma," *J. Kumparan Fis.*, vol. 2, no. 3, pp. 145–152, 2019, doi: 10.33369/jkf.2.3.145-152.

[16] T. Z. Adha, A. Asrizal, and F. R. Rahim, "Development of E-Module Integrated STEM Approach to Improve Students' Critical and Creative Thinking Skills," *Phys. Learn. Educ.*, vol. 1, no. 2, pp. 62–70, 2023, doi: 10.24036/ple.v1i2.27.

[17] W. Liliawati, "Pembekalan Keterampilan Berpikir Kreatif Siswa SMA melalui Pembelajaran Fisika Berbasis Masalah," *J. Pengajaran Mat. dan Ilmu Pengetah. Alam*, vol. 16, no. 2, pp. 93–98, 2011, doi: 10.18269/jpmipa.v16i2.227.

[18] F. Juanda, F. Festiyed, and W. S. Dewi, "The Effect of Electronic Modules Based on Problem-Based Learning on Creative Thinking Ability," *Phys. Learn. Educ.*, vol. 1, no. 4, pp. 211–216, 2023, doi: 10.24036/ple.v1i4.75.

[19] A. Fitriyah and S. D. Ramadani, "Pengaruh Pembelajaran STEAM Berbasis PJBL (Project-Based Learning) terhadap Keterampilan Berpikir Kreatif dan Berpikir Kritis," *J. Educ.*, vol. 10, no. 1, pp. 209–226, 2021, doi: 10.26737/jpmi.v1i1.76.

[20] E. M. Mursidik, N. Samsiyah, and H. E. Rudyanto, "Creative Thinking Ability in Solving Open-Ended Mathematical Problems Viewed From the Level of Mathematics Ability of Elementary School Students.," *Pedagog. J. Educ.*, vol. 4, no. 1, pp. 23–33, 2015.

[21] P. Armandita, E. Wijayanto, L. Rofiatus, A. Susanti, and S. Rumiana, "Analisis Kemampuan Berpikir Kreatif Pembelajaran Fisika di kelas XI MIA 3 SMA Negeri 11 Kota Jambi Analysis the Creative Thinking Skill of Physics Learning in Class XI MIA 3 Sman 11 Jambi City," *J. Penelit. Ilmu Pendidik.*, vol. 10, no. 2, pp. 129–135, 2018, doi: 10.21831/jpipfip.v10i2.17906.

[22] A. Asrizal and R. Husniyah, "Meta Analisis Pembelajaran Sains Berbasis Teknologi Informasi untuk Mengembangkan Keterampilan Abad 21 Peserta Didik," *Edu Sains J. Pendidik. Sains dan Mat.*, vol. 11, no. 1, pp. 1–10, 2023.

[23] A. Elvanisi, S. Hidayat, and E. N. Fadillah, "Analisis Keterampilan Proses Sains Siswa Sekolah Menengah Atas," *J. Inov. Pendidik. IPA*, vol. 4, no. 2, pp. 245–252, 2018, doi: 10.21831/jipi.v4i2.21426.

[24] D. Sugiyono, *Metode Penelitian Kuantitatif Kualitatif dan R&D*. Jawa Barat, 2010.

[25] F. A. Slamet, *Model Penelitian Pengembangan (R n D)*. Malang: Institut Agama Islam Sunan Kalijogo Malang Redaksi:, 2022.

[26] K. Kemdiknas, "Panduan Pengembangan Bahan Ajar Berbasis TIK," *Kementeri. Pendidik. Nas. Direktorat Jenderal Manaj. Pendidik. Dasar dan Menengah Direktorat Pembin. Sekol. Menengah Atas*, pp. i–23, 2010.

[27] M. B. Prasetiyo and B. Rosy, "Model Pembelajaran Inkuiri sebagai Strategi Mengembangkan Kemampuan Berpikir Kritis Siswa," *J. Pendidik. Adm. Perkantoran*, vol. 9, no. 1, pp. 109–120, 2020, doi: 10.26740/jpap.v9n1.p109-120.

[28] M. I. Harisuddin, *Secuil Esensi Berpikir Kreatif dan Motivasi Belajar Siswa*. Bandung: PT. Panca Terra Firma, 2019.