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Needs Analysis of a Deep Learning-Based E-Module on Momentum and Impulse Integrated with Local Wisdom and Assisted by Canva AI to Facilitate Students' Critical Thinking Skills

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ABSTRACT

Critical thinking skills are competencies that need to be developed in 21st-century physics education. However, the results of a needs analysis at SMA N 1 Lubuk Alung indicate that students' critical thinking skills regarding the concepts of momentum and impulse remain low. Furthermore, the instructional materials currently in use do not support deep learning, lack interactivity, and do not integrate local wisdom into the learning context. This study aims to analyze the need to develop a deep learning-based e-module that integrates local wisdom and utilizes Canva AI to facilitate students' critical thinking skills. The study employs the Research and Development (R&D) method using the 4-D development model, limited to the Define stage. Data were collected through teacher interviews, student needs surveys, instructional material analysis sheets, and critical thinking skills tests, and were then analyzed using descriptive quantitative methods. The results of the study showed that students' average critical thinking skills were 37.68%, falling into the "weak" category, while the "inference" indicator received the lowest percentage at 30.43%. The needs analysis also showed that students have a strong interest in learning physics, are ready to use digital media, and prefer audiovisual-based instructional materials. The novelty of this study lies in the needs analysis for the development of an e-module that integrates the deep learning approach, Nyarai local wisdom, and Canva AI into a single digital teaching material. The results of this study provide a foundation for the development of an e-module that is expected to support more meaningful and contextual physics learning and to facilitate students' critical thinking skills.

Keywords : E-Modules, Deep Learning, Local Wisdom, Canva AI, Critical Thinking Skills, Momentum dan Impulse

I. INTRODUCTION

21st-century education requires students not only to master concepts and knowledge, but also to possess a range of skills necessary to address increasingly complex global challenges. The 21st-century skills framework identifies the 4Cs (critical thinking, creativity, communication, and collaboration) as the key competencies that must be developed in the learning process [1]. Among these four skills, critical thinking plays a particularly important role because it serves as the foundation for students to understand information, analyze various problems, evaluate evidence, draw logical conclusions, and make sound decisions based on sound reasoning [2] [3] [4]. According to Facione [4], Critical thinking encompasses six key skills: interpretation, analysis, evaluation, inference, explanation, and self-regulation, which are interrelated in shaping the process of scientific reasoning. These components are not merely a list of standalone skills, but rather a series of interconnected cognitive processes. Inaccurate interpretation leads to weak analysis; superficial analysis affects the quality of evaluation; and ultimately results in inferences or decisions not grounded in strong evidence. Therefore, instructional materials are needed that not only present physics content but also enable students to practice each stage of critical thinking through active, interactive, and contextual learning experiences. One type of instructional material with this potential is the e-module.

E-modules are a relevant teaching resource for practicing this process because they allow for the integration of navigation links, videos, animations, and audio into a single self-paced learning unit [5] [6] [7] . These characteristics make e-modules more appealing than printed teaching materials because they can boost

motivation to learn, provide a more interactive learning experience, and help students gradually develop their conceptual understanding. According to Makhrus [8] It also shows that e-modules integrated with local wisdom have a significant impact on improving students' critical thinking skills because they enable students to connect physics concepts with their real-life experiences. Several studies specifically on physics material have highlighted the link between critical thinking skills and the learning context: an analysis of students' critical thinking skills regarding momentum and impulse shows that these skills still need to be improved [9], Meanwhile, other studies are developing physics teaching materials based on local wisdom to support more contextual learning [10] [11] [12]. Specifically, e-modules based on local wisdom covering the topics of momentum and impulse have already been developed [11], However, it has not yet been integrated with a deep learning framework or generative AI support in its production process.

This becomes even more relevant when considered in the context of deep learning, which emphasizes a mindful, meaningful, and joyful learning environment through students' active engagement in exploring and connecting concepts to real-world experiences [13] [14] [15]. A literature review of this approach in physics instruction and education in general indicates its potential to foster deeper cognitive engagement among students [13] [15] [16]. This approach is directly linked to critical thinking: the process of exploration requires interpretation and analysis, while connecting concepts to real-world experiences requires inference and evaluation. However, deep learning loses its context if the "real-world experiences" in question are not rooted in the students' sociocultural environment—this is where local wisdom serves as a concrete anchor for higher-order thinking processes, while also ensuring the relevance of cultural values and norms in science education [10]. In the context of physics education, the application of this approach becomes increasingly relevant when teaching momentum and impulse, as these concepts are frequently encountered in various aspects of daily life and in local wisdom practices. Momentum and impulse were chosen as topics because these concepts are widely manifested in everyday local wisdom practices, thereby opening up significant opportunities for this type of contextualization.

In terms of instructional material production technology, using Canva AI can serve as a tool to speed up the creation of e-modules through features such as Magic Write and Text to Image [17] [18]. The use of Canva and artificial intelligence as innovations in interactive teaching materials has begun to be explored within the context of the current curriculum [18], However, its role in supporting the development of instructional materials specifically designed to foster critical thinking through a framework of deep learning and local wisdom has not been extensively studied. In other words, Canva AI's contribution to critical thinking is indirect: it plays a role in the production of instructional materials that have the potential to reduce teachers' technical workload, thereby allowing them to shift their focus to the pedagogical aspects of how visual and narrative representations are structured to stimulate students' interpretation, analysis, and evaluation.

A review of previous studies shows that the above elements tend to be developed separately. Research [11] developed e-modules on momentum and impulse based on local wisdom, but did not use deep learning frameworks or Canva AI in their production. Research [19] conducted a needs analysis for the development of e-modules to facilitate critical thinking, but the content focused on fluids and did not explicitly integrate local wisdom or a deep learning framework. Meanwhile, a study on the deep learning approach in physics education [13] [15] [16] as well as the use of Canva and AI as teaching tools [18] Each of these studies is either conceptual or focuses on other topics, with no direct connection to the development of momentum-impulse e-modules based on local wisdom. Thus, the research gap lies in the lack of a needs analysis for the development of e-modules on momentum and impulse that are simultaneously (1) designed within a deep learning framework (mindful, meaningful, joyful), (2) integrated with local wisdom as a meaningful context, and (3) utilize Canva AI as a production tool to facilitate students' critical thinking skills.

Based on the above description, the novelty of this study lies in the integration of three elements: the deep learning approach, the context of local wisdom, and Canva AI as a production tool in the needs analysis for the development of e-modules on momentum and impulse, which are specifically designed to foster students' critical thinking skills. This study aims to analyze these needs as a basis for developing e-modules that support more meaningful, contextual, and critical-thinking-oriented physics learning..

II. METHOD

This study employs a research and development (R&D) approach. [20] research and development methods used to produce a specific product and test its effectiveness. The development model used is the 4-D model, which consists of the Define, Design, Development, and Disseminate stages, developed by [21]. In this study, the implementation was limited to the Define phase to gain an understanding of the requirements for developing e-modules. The output of this phase was a preliminary design (framework) for a deep learning-based

e-module that integrates local wisdom into the topics of momentum and impulse, to serve as the foundation for the Design phase in subsequent research.

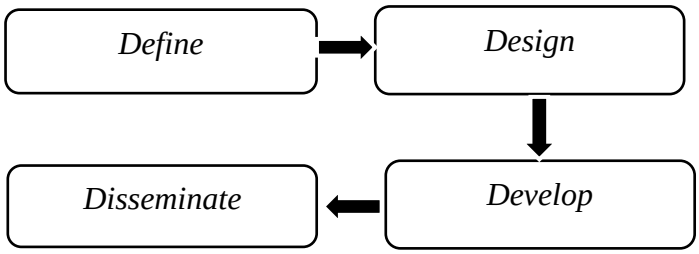


Fig 1. The 4D Development Model Stages

The initial definition phase—often referred to as the needs analysis phase—was conducted at SMA N 1 Lubuk Alung. The purpose of this phase was to identify and clarify the requirements necessary for product development in accordance with the students' needs. This stage was carried out through (1) a beginning-end analysis, (2) a student analysis, (3) a task analysis, (4) a concept analysis, and (5) a learning objective analysis [21], with the aim of obtaining an overview of the initial conditions of physics learning and analyzing the need to develop an e-module based on deep learning integrated with local wisdom on the topics of momentum and impulse.

The study was conducted at SMA N 1 Lubuk Alung during the even semester of the 2025/2026 academic year. The research site was selected because, based on preliminary observations, students were still having difficulty understanding the concepts of momentum and impulse and demonstrated low levels of critical thinking skills. The research subjects consisted of one physics teacher and 23 students in Class XI Fase F who had studied the topics of momentum and impulse. The research subjects were selected using purposive sampling, based on the consideration that the selected class possessed characteristics consistent with the research objectives and had already studied the topics of momentum and impulse.

Data collection was conducted using four instruments. First, a critical thinking skills test was administered to students to obtain an initial assessment of their critical thinking skills regarding the topics of momentum and impulse. The test consisted of open-ended questions based on the six indicators of critical thinking skills identified by Facione: interpretation, analysis, evaluation, inference, explanation, and self-regulation [4]. Each question is designed to assess students' ability to understand information, analyze relationships between concepts, evaluate problem-solving strategies, draw conclusions, explain the reasoning behind their answers, and reflect on their thought processes. The test instrument used has undergone a validation process by experts and is therefore suitable for use in research [22].

Interviews were conducted with physics teachers to gather information on the state of physics education, the difficulties students face in learning about momentum and impulse, the use of teaching materials during the learning process, and the need to develop deep learning-based e-modules integrated with local wisdom. The interviews were conducted using a semi-structured approach so that the researchers could explore the information in greater depth in accordance with the research objectives. Next, a questionnaire was distributed to students to analyze their needs regarding physics learning. The questionnaire was designed using a Likert scale with indicators covering students' interest in physics, learning styles, readiness for digital learning, and their needs regarding the topics of momentum and impulse. Finally, an analysis of instructional material needs was conducted using an instructional material analysis sheet to assess the alignment of the instructional materials used in schools with the requirements of the Merdeka Curriculum, the characteristics of momentum and impulse, and 21st-century learning needs. The assessment focused on content, presentation, language, visual elements, and the integration of instructional materials with the deep learning approach and local wisdom.

The data from the critical thinking skills test and the needs analysis questionnaire were analyzed using the following equation:

$$P = \frac{\sum x}{\sum x_i}\, x\, 100\% \qquad (1)$$

Notes :
P : percentage
x : score obtained for each indicator
x_i : number of respondents

The criteria used to interpret the data from the needs analysis are shown in Table 1.

Table 1. Percentage Criteria for Student Needs Analysis

Total Score Range (%)	Rating
81-100	Very Strong
61-80	Strong
41-60	Fair
21-40	Weak
0-20	Very Weak

The data from the needs analysis questionnaire using a Likert scale were analyzed by calculating the percentage of students' responses for each indicator, which were then categorized into the same criteria.

III. RESULTS AND DISCUSSION

Results

1) Start-to-End Analysis

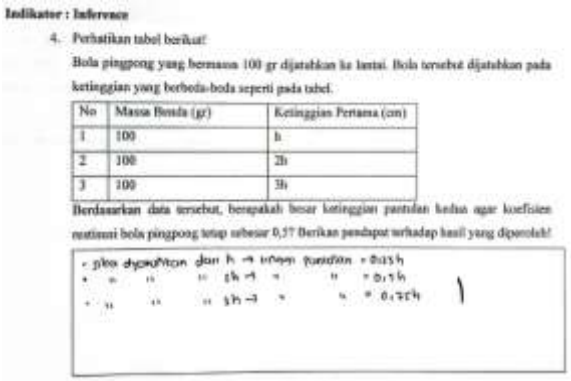
A preliminary needs analysis was conducted to identify problems in physics instruction at SMA N 1 Lubuk Alung. The data consisted of critical thinking test results, student questionnaires, teaching material checklists, and interviews with physics teachers. Based on the results of interviews with physics teachers at SMA N 1 Lubuk Alung, it was found that the topics of momentum and impulse are among those considered quite difficult by students, thus requiring more contextual and interactive teaching materials. Based on the results of the teaching materials checklist completed by the researcher, it was found that there were not enough textbooks available for all students, and that teachers did not have additional supporting teaching materials. These teaching materials also do not yet include local phenomena or examples of physics applications integrated with local wisdom. This situation is consistent with the findings [12] which states that the lack of teaching materials that adequately meet students' needs and fail to incorporate local wisdom into the learning process is a common challenge. This situation highlights the need to develop teaching materials that are more accessible, interactive, and systematic to support independent learning while also developing students' critical thinking skills.

The results of the critical thinking skills test conducted during the preliminary research phase at SMA N 1 Lubuk Alung indicate that students' performance on the topics of Momentum and Impulse falls into the "Weak" category and requires serious attention from educators. Based on the statistical data collected, the overall average student score was only 37.68%. [9] indicates that students still face difficulties in every aspect of critical thinking, particularly in providing further explanations; therefore, students' critical thinking skills still need to be improved through instruction that effectively develops these aspects of critical thinking. In line with this [23], also found that students' critical thinking skills were still below optimal levels, particularly in the areas of interpretation, evaluation, inference, and explanation. The study confirmed that critical thinking skills are an effective way to improve conceptual understanding because they are supported by through the ability to interpret, analyze, evaluate, draw inferences, and present information logically. The details of the students' average skill scores for each aspect are shown in Table 2.

Table 2. Percentage of Students' Critical Thinking Skills

Indicators	**Percentage(%)**	**Category**
Interpretation	43,48%	Fair
Analysis	35,87%	Weak
Evaluation	34,78%	Weak
Inference	30,43%	Weak
Explanation	36,96%	Weak
Self-Regulation	44,57%	Fair

Based on Table 2, the inference indicator scored the lowest percentage compared to the other indicators. The inference indicator was assessed by presenting a problem in the form of a table showing the heights from which ping-pong balls of the same mass were dropped. The following are the test results for one student on the inference indicator.


Indikator : Inference

4. Perhatikan tabel berikut!

Bola pingpong yang bermassa 100 gr dijatuhkan ke lantai. Bola tersebut dijatuhkan pada ketinggian yang berbeda-beda seperti pada tabel.

No	Massa Benda (gr)	Ketinggian Pertama (cm)
1	100	h
2	100	2h
3	100	3h

Berdasarkan data tersebut, berapakah besar ketinggian pantulan kedua agar koefisien restitusi bola pingpong tetap sebesar 0,5? Berikan pendapat terhadap hasil yang diperoleh!

Fig 2. Critical Thinking Test Results on the Inference Indicator

Based on Figure 2, the test results of one student on the inference indicator show that the student was not yet able to use the coefficient of restitution formula to determine the height of the bounce, but instead simply wrote down the result without providing a clear calculation. This indicates that the student's critical thinking skills are still low, particularly in the area of inference (drawing conclusions). This is consistent with [24] indicates that critical thinking skills are very weak, with only 4%. [19] also found similar results, with only 14% of students demonstrating strong critical thinking skills. These findings suggest that students' critical thinking skills still need to be developed in the classroom. These findings provide a very strong empirical basis for researchers to design learning activities that require more rigorous analysis within the framework of innovative e-modules designed to gradually and systematically improve students' reasoning skills using correct concepts in accordance with the scientific principles of physics.

2) Student Analysis

Based on the results of a student needs analysis aimed at identifying students' interests in physics, their learning styles, their readiness for digital learning, and their needs regarding momentum and impulse. This analysis was conducted to gain an understanding of students' characteristics and needs as a foundation for developing an e-module on momentum and impulse based on deep learning and integrated with local wisdom. The results of the analysis of the student needs questionnaire are presented in Figure 3.

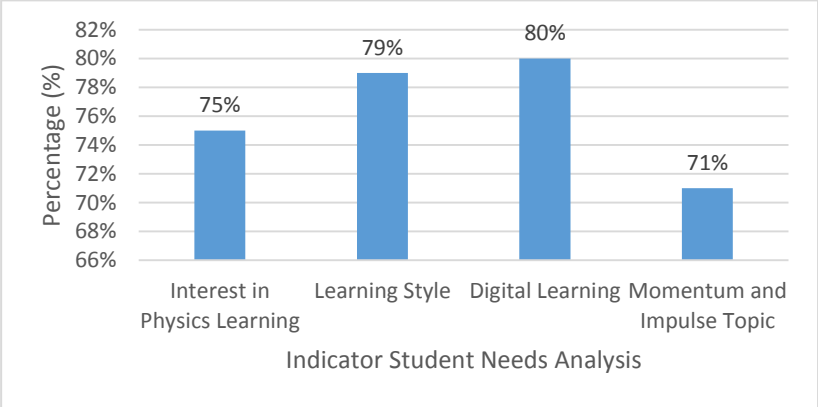


Fig 3. Results of Student Needs Analysis

Figure 3 shows that the results of the analysis indicate that students' performance in physics is relatively high, at 75%. This is supported by the students' readiness for digital learning, as evidenced by the fact that most of them already own cell phones as a learning tool. The results of interviews with physics teachers also reinforce this finding, as students are allowed to bring their cell phones to class when needed for learning. In terms of learning styles, most students find it easier to understand the material through audiovisual presentations. This is supported by [25] which states that students will find it easier to understand material presented through an audiovisual learning style. The characteristics of this learning style indicate that students require instructional materials that integrate visual and audio media with interactive activities, thereby making the learning process more meaningful and encouraging active student engagement. The use of multimedia-based instructional materials also makes it possible to present abstract physics concepts in a more concrete way through animations, simulations, videos, and interactive media, allowing students to connect the concepts they

are learning with real-world phenomena. In addition to increasing student engagement, multimedia provides students with the opportunity to explore concepts independently, receive immediate feedback, and develop a deeper understanding [13]. [13] This is in line with the deep learning approach, which emphasizes mindful, meaningful, and joyful learning, where the use of technology and interactive media can enhance cognitive engagement, facilitate critical thinking, and help students connect physics concepts to real-world situations.

3) Concept Analysis

A conceptual analysis was conducted to identify the key concepts covered in the topic of Momentum and Impulse. This topic consists of several key concepts, namely momentum, impulse, the relationship between momentum and impulse, the law of conservation of momentum, as well as various types of collisions and their applications in everyday life.. These concepts are closely linked to various real-world phenomena that can be integrated with local wisdom, thereby making learning more contextual and meaningful [11]. In this study, the concepts of momentum and impulse are integrated with the local wisdom of Nyarai, Padang Pariaman Regency—such as Silek Tuo Nyarai, Mahseer fly fishing at Lubuk Larangan, and Nyarai trekking—as a context for understanding the application of physics concepts in real life. The selection of these examples of local wisdom is based on the characteristics of momentum and impulse, as these activities incorporate the concepts of motion, force, momentum, impulse, and collision, which can be directly observed in everyday life.

In addition, interviews with physics teachers revealed that incorporating local cultural phenomena or activities into instruction can help students understand physics concepts more easily and increase their interest and motivation to learn. The context of local wisdom is considered relevant for integration into the e-modules being developed. [13] This integration supports the implementation of deep learning-based instruction, which encourages students to gain a deep understanding of concepts through critical thinking, exploration, reflection, and problem-solving based on authentic learning experiences. The selection of these concepts was also supported by the results of an analysis of students' needs, which showed that they require instructional materials that not only present physics concepts theoretically but also relate them to real-world phenomena that are relevant to their daily lives. Therefore, the development of deep learning-based e-modules on momentum and impulse that incorporate local wisdom is expected to foster mindful, meaningful, and joyful learning, while also facilitating the development of students' critical thinking skills [13]**.**

4) Task Analysis

A task analysis was conducted to identify the skills that need to be developed through the e-modules to be designed. The primary focus of this study is the development of critical thinking skills based on the indicators proposed by Facione, namely interpretation, analysis, evaluation, inference, explanation, and self-regulation. These six indicators are integrated into deep learning-based learning activities that emphasize a mindful, meaningful, and joyful learning process. Through the presentation of contextual phenomena integrated with the local wisdom of Nyarai, students are guided to interpret information, analyze problems, evaluate various solutions, draw conclusions based on evidence, explain their reasoning logically, and reflect on their learning process and outcomes. Thus, learning activities The e-module is designed to facilitate the development of students' critical thinking skills in a gradual, systematic, and contextual manner through authentic learning experiences. The framework linking critical thinking indicators and learning activities in the e-module is presented in Table 3

Table 3. Framework for the Relationship Between Critical Thinking Indicators (Facione) and Learning Activities in the E-Module

Critical Thinking Indicators	Indicator Description	Activities in the E-Module
Interpretation	The ability to understand and convey the meaning of data, events, or situations	Students are presented with contextual phenomena based on the local wisdom of Nyarai (such as videos or illustrations of physics phenomena in the Nyarai environment), and are then asked to identify and formulate the physics concepts or problems associated with those phenomena
Analysis	The ability to identify relationships among statements, concepts, or data to uncover arguments or issues	Students describe the variables involved in a phenomenon (for example, using a table of data from observations or experiments) and identify the relationships among those

		variables
Evaluation	The ability to assess the credibility of a statement or the strength of an argument or alternative solution	Students are given several alternative solutions or interpretations of the data, and are then asked to evaluate and select the most appropriate alternative, providing scientific reasoning
Inference	The ability to identify the elements needed to draw reasonable conclusions from data or evidence	Students draw conclusions based on data from observations or experiments (for example, determining the relationship between variables), supported by explicit quantitative calculations or analyses
Explanation	The ability to present the results of reasoning in a logical and clear manner, supported by relevant evidence or concepts	Students present or write down their thoughts (conclusions, answers, or solutions) in a systematic manner, accompanied by explanations of the underlying physics concepts
Self-regulation	The ability to monitor and reassess one's own thought processes and learning outcomes	Students are given a reflection session at the end of each learning unit to reassess their understanding, identify errors, and refine their thinking process

5) Analysis of Learning Objectives

Based on the results of the preliminary analysis, learner analysis, conceptual analysis, and task analysis, the learning objectives for the "Momentum and Impulse" unit are designed to help students gain a deep understanding of the concepts and develop critical thinking skills, including interpretation, analysis, evaluation, inference, explanation, and self-regulation. In addition, the instruction also aims to help students be able to relate the concepts of momentum and impulse to real-world phenomena found in local wisdom, thereby making these physics concepts more contextual and meaningful. Specifically, these learning objectives are formulated as follows:

1. Students are able to analyze the relationship between mass, velocity, and momentum in various motion scenarios in everyday life.
2. Students are able to analyze the relationship between force, the time interval during which the force acts, and impulse in various collision scenarios.
3. Students are able to evaluate the application of the law of conservation of momentum in various types of collisions based on observations or experimental data.
4. Students are able to design simple solutions to reduce the effects of impact forces by applying the concept of impulse in everyday life.

These learning objectives serve as the foundation for the development of deep learning-based e-modules integrated with the local wisdom of Nyarai, Padang Pariaman Regency. Through these e-modules, students are expected to have a learning experience that is mindful, meaningful, and joyful, enabling them to develop a deep conceptual understanding while enhancing their critical thinking skills.

6) Design Characteristics of the Proposed E-Module

The e-module designs were created using Canva AI as a tool to assist in the development of digital instructional materials. The use of Canva AI enables the creation of engaging and interactive e-modules through the integration of various multimedia elements, such as text, images, illustrations, videos, animations, icons, and hyperlinks. The strength of Canva AI lies in its ability to speed up the creation of educational media through features such as Magic Write and Text to Image, which can help teachers produce teaching materials that are more creative, adaptive, and tailored to learning needs [18].

The e-module is designed using a deep learning approach that emphasizes mindful, meaningful, and joyful learning. This approach is implemented through the presentation of contextual phenomena integrated with the local wisdom of Nyarai, Padang Pariaman Regency, such as Silek Tuo Nyarai and Mahseer Fly Fishing in Lubuk Larangan and the Nyarai Trekking Trail as a context for learning about momentum and impulse. This integration is expected to help students connect physics concepts with real-world experiences, making learning more relevant and meaningful.

The structure of the e-module is designed to facilitate the development of the six indicators of critical thinking skills identified by Facione: interpretation, analysis, evaluation, inference, explanation, and self-regulation. Each learning activity is designed to enable students to interpret phenomena, analyze identifying

problems, evaluating alternative solutions, drawing conclusions based on evidence, explaining their reasoning logically, and reflecting on the learning process. With these characteristics, e-modules have the potential to facilitate the development of students' critical thinking skills.

Discussion

The results of the needs analysis in this study show that students' critical thinking skills regarding the topics of Momentum and Impulse are still in the "weak" category, with an average overall score of 37.68% and the lowest achievement on the inference indicator (30.43%). These findings indicate that students are not yet accustomed to systematically drawing data-based conclusions, as evidenced by the test results which indicates that students only wrote down the final answer without showing the calculation process using the coefficient of restitution formula. This finding is consistent with previous findings stating that students still struggle with every aspect of critical thinking, particularly in providing further explanations, as well as other findings indicating that students' abilities in interpretation, evaluation, inference, and explanation are still not optimal. The low achievement on the inference indicator, in particular, is also consistent with studies reporting very weak critical thinking skills (only 4%) as well as other studies finding that only 14% of students falls into the "good" category. The similarities in the patterns observed across these studies reinforce the hypothesis that weak inferential skills are not merely a localized issue at a single school, but rather a general trend resulting from physics instruction that remains focused on procedural problem-solving (formula-calculation-answer), without explicitly training students to connect observational data with scientific conclusions.

Findings from the student analysis and concept analysis have important implications for the direction of instructional material development. Students' preference for audiovisual learning styles and their high level of readiness for digital learning indicate that conventional instructional materials—which lack visual elements and local context—are no longer sufficient to facilitate the understanding of abstract concepts such as momentum and impulse. This supports the view that the use of multimedia allows learners to explore concepts independently and receive immediate feedback, thereby fostering a deeper understanding. Consequently, deep learning-based e-modules that integrate Nyarai's local wisdom such as Silek Tuo Nyarai, Mahseer Fly Fishing, and Nyarai Trekking not only serves not only as a medium for conveying concepts, but also as a means of systematically developing Facione's six indicators of critical thinking through activities such as interpreting phenomena, analyzing data, evaluating alternative solutions, drawing evidence-based conclusions, providing logical explanations, and engaging in self-reflection. Thus, learning is directed not only toward the theoretical mastery of physics concepts, but also toward the development of the habit of scientific reasoning, which has long been a weak point for students, particularly in the area of inference.

Nevertheless, this study has several limitations that need to be noted. First, the needs analysis was conducted at only one school (SMA N 1 Lubuk Alung), so any generalization of the findings to other school contexts should be made with caution. Second, the data on critical thinking skills used as the basis for developing the e-modules is still limited to the results of the initial test (preliminary study), Therefore, it does not yet reflect the effectiveness of the e-modules developed in improving these skills, given that this study is still in the needs analysis (front-end analysis) phase and has not yet reached the stage of extensive product testing. Third, the integration of Nyarai's local wisdom, which is specific to the cultural context of Padang Pariaman Regency This could potentially limit the transferability of the e-module to other regions with different cultural characteristics, so contextual adaptation is necessary if this e-module is to be applied outside the context of this study.

IV. CONCLUSION

Based on the results of the needs analysis, it was found that students' critical thinking skills regarding the topics of momentum and impulse remain in the low category, with an average achievement rate of 37.68%, particularly in the inference indicator. A preliminary analysis also showed that the teaching materials used in schools are still limited and do not yet integrate local wisdom into the learning context. On the other hand, the results of the An analysis of students' needs shows that they have a strong interest in learning physics, tend to have an audiovisual learning style, and are highly prepared for digital learning. Based on these findings, it appears that students still need learning experiences that can foster their ability to analyze, evaluate, and reflect on various issues related to climate change in greater depth. The results of this study indicate the need to develop innovative teaching materials that integrate digital technology, deep learning approaches, and local wisdom to facilitate the development of critical thinking skills students. Therefore, deep learning-based e-modules integrated with local wisdom are proposed as an alternative teaching resource with the potential to support more contextual and meaningful learning about climate change. Further research will focus on the full development of the e-modules, including validity testing, practicality testing, and effectiveness testing through wider implementation to determine its contribution to improving students' critical thinking skills and science literacy.

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