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Needs Analysis for Developing a Sound Wave E-Module Integrated with Ethnoscience and Meaningful Learning to Enhance Students' Knowledge and Creative Thinking Skills

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ABSTRACT

The 21st-century curriculum requires mastery of adaptive, critical, and creative skills, in line with the Merdeka Curriculum and the Pancasila Student Profile. However, preliminary studies at SMA Negeri 1 Lembah Gumanti show obstacles in teaching sound waves, such as limited digital teaching materials, low integration of ethnoscience and meaningful learning, and low knowledge and creative thinking skills among students. This study uses the R&D method with the Hannafin & Peck model at the needs analysis stage. The results show a score of 63.8 fair for the use of teaching materials, 54.17 poor for the integration of ethnoscience, 53.1 poor for meaningful learning, 64.9 fair for knowledge, 50.8 low for creative skills, and 57.8 fair for mastery of the material. These findings confirm the need to develop interactive digital e-modules based on ethnoscience and meaningful learning to improve knowledge and creative thinking skills. The uniqueness of this study lies in its attempt to combine local wisdom with modern pedagogy to produce innovative e-modules that are interactive, contextual, and in line with the demands of the 21st century. This study is limited to one school with descriptive analysis; further research is recommended to cover a broader context, use experimental validation, and test the effectiveness of e-modules in improving student learning outcomes.

Keywords: E-Modules, Ethnoscience, Meaningful Learning, Sound Waves, Creative Thinking Skills.

I. INTRODUCTION

The development of science and technology (IPTEK) in the era of globalization has affected almost all aspects of human life, including education. The use of technology in the teaching and learning process has made learning more advanced, interactive, and adaptive to the times. The presence of computers, the internet, and smartphones has required students and teachers to adapt to these changes. Thus, 21st-century learning requires students to have a variety of new skills in order to compete in the face of global challenges [1]. In addition, the development of science and technology has also influenced learning methods and media, making them more innovative and contextual [2]

The main characteristic of 21st-century learning is a paradigm shift from a teacher-centered model to a student-centered one. This shift emphasizes the active role of students in constructing knowledge through direct learning experiences, rather than simply receiving information from teachers [3].The learning process that places students as active subjects allows for the development of creativity, independence, and in-depth problem-solving skills [4] .This change is in line with the goal of modern education to produce quality human resources who are adaptive to change [5]. In addition, the student-centered model also requires teachers to be more creative in designing learning strategies [6].

In the context of 21st-century learning, the 4C skills—critical thinking, creative thinking, communication, and collaboration—are essential competencies for students [7]. Mastery of these skills allows students to adapt to rapid changes and increase future success opportunities [8]. Through critical thinking, students can analyze problems rationally [9]. Meanwhile, communication and collaboration skills equip students to work effectively in increasingly complex environments [10].

Creative thinking skills are one of the primary abilities that need to be developed in 21st-century students [11].This ability not only helps students generate innovative ideas but also enables the creation of original

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solutions to various real-life problems [12]. Students with creative thinking skills can process information deeply, formulate alternative solutions, and find new ways to solve problems [13].

The Indonesian government's Merdeka Curriculum policy is a response to the demands of 21st-century learning [14].This curriculum provides schools the freedom to design learning according to students' needs and local cultural characteristics [15].The Culturally Responsive Teaching (CRT) approach emphasizes integrating community cultural diversity into learning, making education more relevant and contextual for students.

Preliminary studies at SMA Negeri 1 Lembah Gumanti show various problems in physics learning. First, the available learning materials do not fully support the learning process, with an average analysis score of 63.8, which is considered sufficient [16]. Second, students' creative thinking skills remain low, with an average score of 50.8 [17]. Third, students' learning outcomes are not yet optimal, with an average daily test score of 64.9 [18]. Fourth, students experience difficulties in understanding the sound wave material, scoring 62.5, which is considered sufficient. These findings indicate a gap between the ideal condition and field reality, requiring more effective learning innovations.

One solution to address these problems is the development of interactive digital learning modules (e-modules) [19]. E-modules offer various advantages, such as flexible access, attractive displays, and multimedia features that can increase students' motivation to learn [20]. Moreover, e-modules can be designed according to students' needs, supporting more personalized, contextual, and enjoyable learning [21]. Thus, e-modules serve as a strategic alternative to enhance learning effectiveness and develop students' creative thinking skills [22].

The integration of ethnoscience in physics learning is an effective approach to make the learning process more contextual and meaningful [23]. Ethnoscience connects scientific concepts with local culture, such as the application of sound wave principles in traditional musical instruments [24]. Through this integration, students can more easily understand the material because it relates to real-life experiences [25]. Additionally, ethnoscience fosters pride in local culture, motivating students to be more active in learning [26].

The meaningful learning approach plays an important role in helping students connect new knowledge with prior experiences or information [27]. This process makes learning deeper, so students do not merely memorize material but truly understand the concepts being learned [28]. By applying meaningful learning, students can think critically and creatively, and apply physics concepts in daily life [29].

The effectiveness of E-Modules can be improved through the integration of ethnoscience approach and meaningful learning. The ethnoscience approach provides opportunities for students to link science concepts with local wisdom, while meaningful learning allows students to build new knowledge that is connected to previous experiences. The integration of these two approaches not only makes learning more contextualized, but also encourages students' active involvement in understanding the concept of sound waves more deeply. The initial stage in the E-Module development process begins with a needs analysis which is an effort to explore information related to the problems faced by teachers and students in physics learning. The results of this analysis became the basis for designing and developing E-Modules integrated with ethnoscience and meaningful learning approaches. The developed sound waves E-Module is expected to facilitate students' knowledge and creative thinking skills optimally and in accordance with the characteristics of 21st century learning. The main objective of developing E-Modules integrated with ethnoscience and meaningful learning is to facilitate students' knowledge and creative thinking skills so that they meet the expected learning quality criteria

II. METHOD

This study uses the research and development (R&D) method. In the book Research and Development Methods, Sugiyono explains that this method is used to develop specific products and evaluate the extent to which these products are effective [30]. The object of this study is digital teaching materials about sound waves integrated with ethnoscience and meaningful learning to facilitate students' knowledge and creative thinking skills. The research subjects consisted of a physics teacher at SMA N 1 Lembah Gumanti who collaborated with students in class XII Fase F to assess the students' initial abilities.

In this study, the researcher chose to use the Hannafin & Peck development model. The Hannafin & Peck model is a learning design model consisting of three main stages, namely: (1) initial needs analysis, (2) design, and (3) development and implementation[31]. In this study, emphasis was placed on the initial needs analysis stage as the basis for designing and developing digital teaching materials that are in line with student characteristics and learning needs. The following diagram illustrates the stages of development based on the HanHannafin & Peck model.

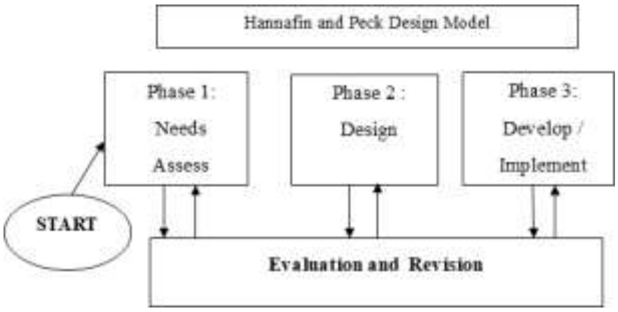

Fig.1. Hannafin&PeckDevelopmentModel

This study uses a quantitative descriptive approach for data analysis. Descriptive statistics are used to process and interpret the data collected in its original form, providing a clear picture of the existing conditions. Data were obtained using specific research instruments. The instruments used in this study included a needs analysis sheet and a creative thinking ability test sheet. These tools were designed to collect data that would support further research and development of the e-module. Data from the creative thinking ability test were categorized based on each creative thinking indicator, according to the framework proposed by Harisuddin (2019) [20]. A final index for each creative thinking indicator was then calculated. The following is the formula used to calculate the index for each indicator:.

$$\% \text{ percentage score} = \frac{score\ obtained}{maximum\ score} \times 100 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(1)$$

Explanation: P = Percentage score, O = Score obtained, M = Maximum score

Table 1. Score interpretation categories

Interval(%)	Kategori
85-100	Very Good
70-84	Good
55-69	Fair
40-54	Poor
0-39	Very Poor

(Souce: Ref [32])

III. RESULTS AND DISCUSSION

Result

An analysis of the need for digital teaching materials on sound waves integrated with ethnoscience and meaningful learning was conducted using questionnaires and preliminary tests distributed to teachers and students. The subjects of the analysis consisted of a physics teacher from SMA N 1 Lembah Gumanti and students from class XII Fase F. The purpose of this needs analysis was to identify real problems in learning, the suitability of teaching materials, and the initial conditions of students' knowledge and creative thinking skills as a basis for developing e-modules. The needs analysis instruments covered five aspects of assessment, namely: (1) students' knowledge and creative thinking skills,(2) mastery of sound wave material, (3) the use of teaching materials in learning, (4) the integration of ethnoscience in teaching materials, and (5) the integration of meaningful learning.

The results of the first needs analysis related to students' knowledge and creative thinking skills are presented based on data processing using the statistical formulas listed in Table 2. This analysis presents quantitative information on the extent to which students master concepts and demonstrate their ability to think innovatively on the material covered. These findings become an important foundation in designing learning strategies that are more focused and in line with students' needs.

Table 2. Statistical Parameters

NO	Parameter Statistics	Knowledge Student Skills	Creative Thinking
1	Number of Respondents	36	36
2	Mean Score {%)	65,0	51,0
3	Mode	78	53
4	Median	68	51
5	Highest Score (%)	85	69
6	Lowest Score (%)	35	42

Based on the descriptive statistical parameters table displayed, it is known that there are a total of 36 students analyzed on two main aspects, namely Knowledge and Creative Thinking Skills. In the Knowledge aspect, students obtained an average score of 65.0%, with a mode value of 78 and a median of 68, indicating that most students have a fairly good level of understanding. The highest score obtained was 85%, while the lowest score was 35%, resulting in a score range of 50 points. This indicates a fairly good variation in student achievement in the knowledge aspect. Meanwhile, in the creative thinking skills aspect, students obtained an average of 51.0%, with a mode of 53 and a median of 51. The highest score was recorded at 69%, and the lowest score was 42%, with a range of 27 points. This shows that the distribution of students' creative thinking skills scores tended to be more evenly distributed compared to the knowledge aspect. In general, these results indicate that although students' knowledge understanding is quite good, their creative thinking skills still need to be improved. This finding is an important reference in designing more contextual and innovative learning strategies, one of which is through the development of ethnoscience-based E-Modules with a meaningful learning approach.

The second analysis focuses on the problems faced by students in understanding sound waves. Data was obtained through distributing questionnaires to 36 students of class XII IPA F SMA Negeri 1 Lembah Gumanti. Based on the results of the analysis, it is known that students' problems on sound waves are classified in the moderate category, with an average score of 57.8. The questionnaire analyzed included three submaterial components, namely the basic concepts of sound waves (CW), strings and organa pipes (SP), and the Doppler effect and sound intensity (DI). Each component provides a more detailed explanation of the aspects of the material that are still a challenge for students. Visualization of the results of the analysis of student problems can be seen in Figure 1.

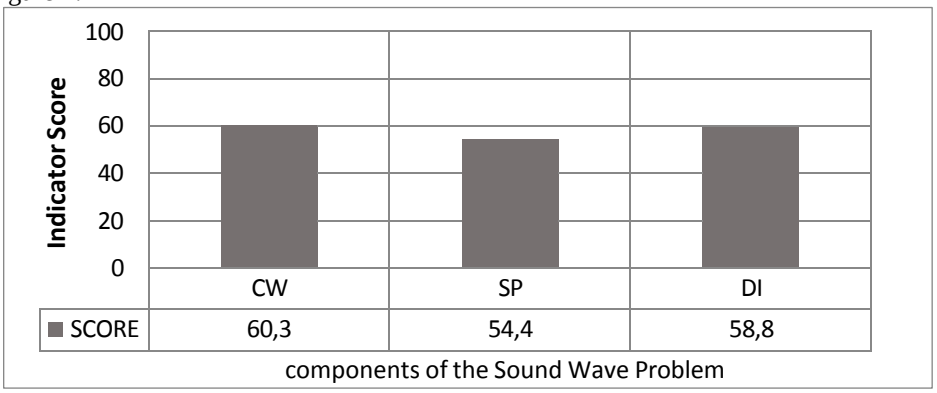

Fig. 2. Results of Problem Analysis on Sound Waves

Based on Figure 2, It can be described that students' problems in understanding sound wave material are in the adequate category. Basic Concepts of Sound Waves (CW) scored 60.3, indicating that most students have a basic understanding of sound wave concepts, although they still need reinforcement in certain aspects. The string and pipe organ component (SP) scored 54.4, which is also in the poor category. This shows that students are able to apply the concept of sound waves in the context of questions or applications, but still have difficulty in solving analysis-based questions. The Sound Intensity and Doppler Effect (DI) component had the highest score of 68.8, indicating that students were quite capable of understanding the impact and application of sound waves in everyday life. Overall, these three components reflect that students have a fairly good understanding of sound wave material, but still require more contextual and meaningful learning strategies to improve the quality of their understanding.

The third focuses on the analysis of e-modules in physics learning at school. Data were obtained through an e-module context analysis instrument. The analysis consisted of eight components: attractive display (AD), language and narrative (LN), interactive presentation (IP), learning style (LS), suitability to student characteristics, material and objectives (SMO), supporting suggestions (SS), comprehensive learning (CL), and support for virtual learning (SL). In general, these eight components were used to assess the quality and suitability of e-modules as open learning materials. The results of the e-module analysis can be seen in Figure 3.

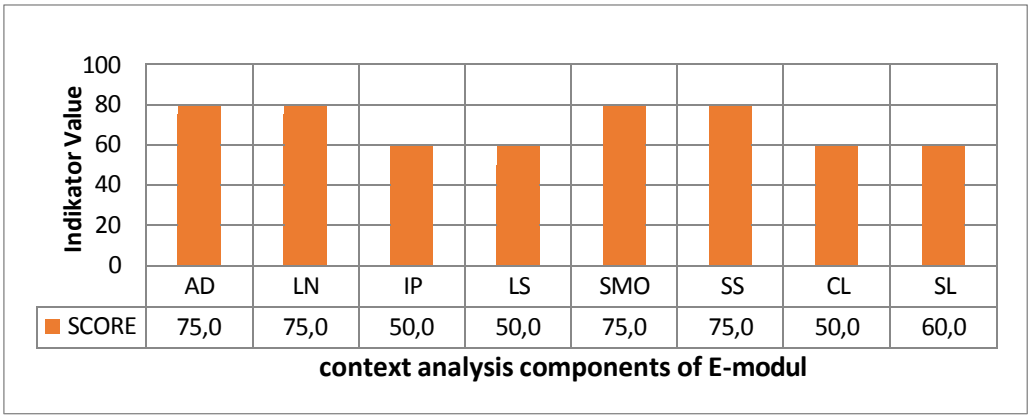

Fig. 3. Results of Problem Analysis of E-module Teaching Materials

Based on Figure 3, It can be stated that the analysis of the eight components of the e-learning module yielded an average score of 63.8, which is classified as adequate. The highest scores were obtained for the indicators of attractive display, language and narration, suitability of student characteristics, material and objectives, and supporting suggestions, each with a score of 75.0. This shows that the e-module has good visuals, appropriate language use, and harmony between the material and learning objectives. However, low scores were found in the indicators of interactive presentation, learning style, holistic learning, and support for virtual learning, which were still in the range of 50.0 to 60.0. Therefore, future development of e-modules needs to focus on improving interactivity, diversity of learning styles, more integrated material, and optimization of support for virtual-based learning so that e-modules can provide a more effective and meaningful learning experience for students..

The fourth analysis result relates to the integration of ethnoscience in teaching materials. Data were obtained through a teacher questionnaire sheet distributed to one physics teacher. Based on the analysis conducted, it was obtained that the integration of ethnoscience in teaching materials was categorized as lacking with an average value of 54.17. The analyzed questionnaire consists of three components, namely knowledge about ethnoscience (KE), integration of ethnoscience in teaching materials (IM), and integration of ethnoscience in the learning process (IP). The results of the analysis of ethnoscience integration in teaching materials can be seen in Figure 3.

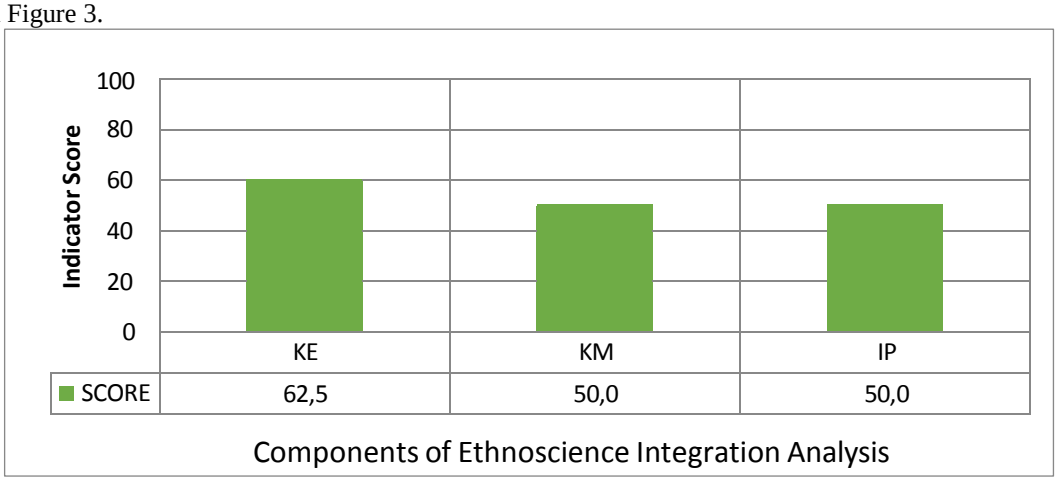

Fig. 4. Results of Analysis of Ethnoscience Integration of Teaching Materials

Based on Figure 3, it can be seen that the integration of ethnoscience in teaching materials has not been well implemented. The component of knowledge about ethnoscience obtained a high score of 62.5 with a sufficient category. In general, teachers still recognize and know about ethnoscience. However, teachers' knowledge of ethnoscience is still not in-depth. The component of ethnoscience integration in teaching materials obtained the lowest score of 50.0 with a category of less. Teaching materials used by teachers have not been integrated with ethnoscience optimally. The component of ethnoscience integration in the learning process obtained a score of 50.0 with a category of less. Teachers still do not really integrate ethnoscience in the learning process such as explaining physics concepts by connecting Minangkabau culture in explaining material to students. However, the integration carried out by teachers is still limited so that the integration of ethnoscience in the learning process has not been maximized.

The final context analysis is the integration of meaningful learning in e-modules. Data was obtained through context analysis questionnaires. Based on the analysis, the integration of meaningful learning in teaching materials was categorized as poor, with an average score of 53.1. The questionnaire analysis consisted of four components, namely prior knowledge (PK), intention to learn meaningfully (IM), concept elaboration (CE), and advance organizer (AO). The results of the analysis of learning problems in the context analysis of the integration of meaningful learning in teaching materials can be seen in Figure 5.

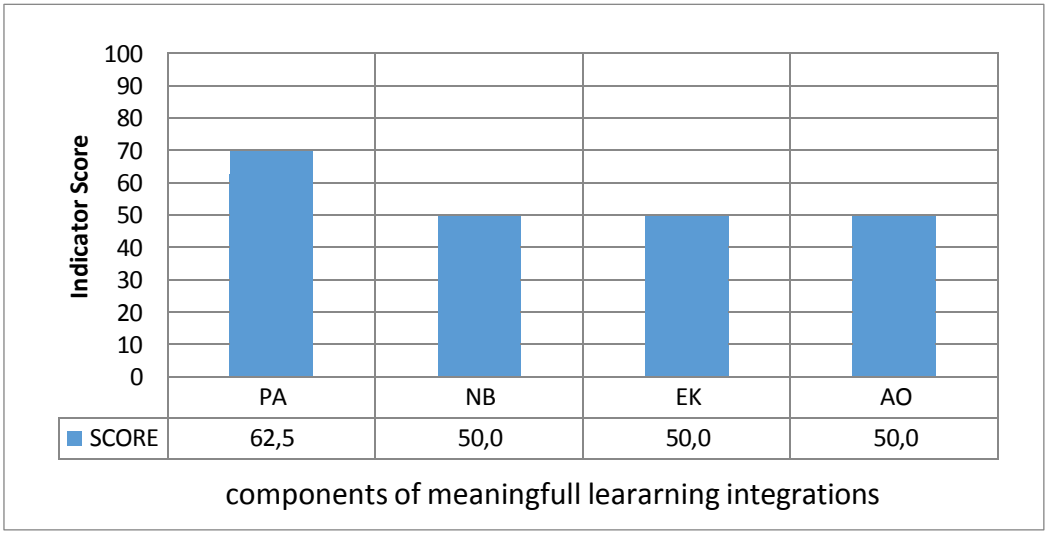

Fig. 5. Analysis result of meaningfull learning integration in teaching materials

Based on Figure 5, it can be explained that the integration of meaningful learning in teaching materials has not been implemented properly. The meaningful learning material component obtained the highest score of 62.5, which is categorized as sufficient. This shows that the teaching materials have begun to encourage students' motivation to learn meaningfully, although it still needs to be strengthened. Meanwhile, the components of prior knowledge and intention to learn meaningfully each scored 50.0, which is categorized as poor. This score indicates that the teaching materials have not optimally linked new material to students' prior knowledge, have not presented concepts logically and sequentially, and have not provided initial aids such as concept maps or introductions that can help build students' understanding. Thus, the integration of the meaningful learning approach in teaching materials is still limited and has not been implemented optimally, so further development is needed so that teaching materials can facilitate more meaningful learning for students.

DISCUSSION

Based on the results of the needs analysis, it was found that the use of teaching materials was still not optimal. This shows that it is not in line with the demands of the 21st century [33]. In terms of the use of teaching materials, teachers tend to use printed teaching materials and rarely use digital teaching materials. On the other hand, teaching materials integrated with technology are an important learning resource to support the learning process in the 21st century [34]. The results of this analysis also show that the integration of ethnoscience and meaningful learning in learning is still lacking and there are no teaching materials integrated with ethnoscience and meaningful learning in schools. The results of the needs analysis related to student characteristics show that they are adequate, but this is not in line with the low scores for creative thinking skills among students. The low scores for creative thinking skills among students occur because there are no supporting teaching materials to facilitate student learning.

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