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Need Analysis to Create Heat E-Module with Problem Based Learning Model Asisted Heyzine Application to Promote Student's Critical Thinking Skills

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ABSTRACT (10 PT)

The ideal condition of 21st-century physics learning is the implementation of interactive, student-centered learning that integrates technology and innovative learning models to develop students' critical thinking skills. However, the results of the needs analysis conducted at SMA Negeri 14 Padang indicate several problems. First, students' critical thinking skills are still in the very low category, with an average score of 40. Second, the teaching materials used in schools have not fully supported 21st-century learning, particularly in the visual and multimedia aspects (40) and adaptive aspect (46.67). Third, the integration of the Problem Based Learning model in teaching materials is still not optimal, especially in the aspects of developing and presenting work (30) and analyzing and evaluating the problem-solving process (40). Fourth, students' mastery of physics concepts is still relatively low, with an average score of 43.8. In addition, the analysis of student characteristics indicates that students have positive responses toward technology-based learning. These findings indicate the need to develop a Problem Based Learning-based e-module assisted by the Heyzine application. The developed e-module is expected to provide more interactive, adaptive, and meaningful learning experiences while facilitating the improvement of students' critical thinking skills and conceptual understanding in heat learning.

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INTRODUCTION

Twenty first century education is undergoing significant transformations along with rapid technological advances. Learning is shifting from traditional methods to interactive approaches that provide broad, flexible, and open access to teaching materials. This shift requires the education system to emphasize not only knowledge transfer but also the development of critical thinking, creativity, communication, and collaboration skills to prepare students to face the challenges of an increasingly dynamic and global world (Yerlikaya & Sahin, 2023). The education demands integration between knowledge mastery, soft skills

development, and effective learning strategies to shape individuals who are adaptive, collaborative, and resilient in facing global challenges.

The learning must be able to develop students' skills. This aligns with the 21st-century educational paradigm, which emphasizes the development of core skills such as critical thinking, creativity, collaboration, and communication, as essential tools for students to face increasingly complex and rapidly changing global challenges (Arkanudin et al., 2025). Problem solving skills are also a crucial aspect in the learning process so that students are able to adapt to the rapid development of technology (Chusna et al., 2024). To optimize student capabilities, learning strategies are needed that not only utilize technology effectively but also adapt to their needs, interests, and characteristics through a student centered learning approach. This approach encourages students to play an active role in building knowledge and developing skills comprehensively throughout the learning process.

Important skills that students must possess to face the challenges of 21st-century learning. The 6C skills consist of critical thinking, creativity, collaboration, communication, computational thinking, and compassion (Inganah et al., 2023; Sulaiman & Mansyur, 2023; Astuti, 2024). These skills help students analyze information, solve problems, collaborate, communicate effectively, and have concern and the ability to think systematically in facing technological developments and changes in the times (Bulkis et al., 2025). Therefore, the integration of 6C skills in learning is essential to prepare students to adapt and succeed in the future. The implementation of these skills can increase students' engagement, motivation, and active participation during the learning process. Through 6C integration, students are encouraged to think critically and creatively in solving contextual problems encountered in everyday life. In addition, collaborative and communicative activities provide opportunities for students to exchange ideas, respect others' opinions, and develop teamwork skills. Computational thinking helps students solve problems systematically and logically, while compassion fosters empathy, social awareness, and responsibility toward others. Thus, the integration of 6C skills not only enhances students' cognitive abilities but also develops the social and character competencies needed in the 21st century.

One of the essential skills that 21st century students must possess is critical thinking. Critical thinking is crucial in physics learning because it helps students develop problem-solving skills and draw conclusions effectively (Syafitri et al., 2021). Critical thinking skills are also able to encourage students to analyze problems in depth so that they are able to uncover and solve problems faced in everyday life (Mardliyah, 2023). Critical thinking skills are one of the components that students must develop. Developing critical thinking skills can train students to analyze a problem, break it down systematically, and thus find various ideas for solving it (Aripin et al., 2021). Critical thinking skills are expected to produce students who are able to provide solutions to various problems in the field of education.

Critical thinking skills play a crucial role in 21st century learning. However, various studies show that the level of critical thinking skills among high school students, particularly in physics, remains relatively low. Research by Hasanah (2023) at SMA Nurul Iman Tanjung Morawa, the research results show that 21% of students have moderate critical thinking skills, 64% of students have low critical thinking skills, and 15% of students have very low critical thinking skills. Research by Afifah & Asrizal (2025) shows that the results of research on critical thinking skills are still relatively low. Research by Sari (2025) The results of the study indicate that the average critical thinking ability of students is in the low category. Low levels of critical thinking skills have implications for students' readiness to face the demands of 21st-century learning, which focuses on higher order thinking skills and problem-solving as core competencies. If this problem is not addressed appropriately, students have the potential to experience difficulties in adapting to the dynamics of 21st century learning. These difficulties can hinder the development of necessary skills, thereby reducing their opportunities for

future success (Asrizal et.al., 2022). Therefore, effective learning efforts are needed to improve students' critical thinking skills so that they are able to meet the demands of 21st century learning. These efforts need to be designed through a learning process that not only focuses on mastering concepts, but also trains students to analyze problems, evaluate information, and make logical decisions so that they are able to play an active role and have good problem-solving skills in the modern era.

Efforts to foster students' critical thinking skills in physics learning require the application of appropriate learning models. One learning model proven effective in honing students' critical thinking skills is the Problem Based Learning model (Islamiah et al., 2018). The Problem Based Learning model requires students to identify problems, collect data, analyze information, and develop appropriate solutions, all of which are important elements in critical thinking (Widiastuti et al., 2023). However, teaching materials are needed that can optimally support the implementation of the Problem Based Learning model. These materials must include authentic problems, investigative steps, and analytical activities that encourage students to think critically and find solutions independently. Teaching materials that integrate the Problem Based Learning model into physics learning can improve students' critical thinking skills.

One effort that can be made to address students' low critical thinking skills is to develop e-modules using the Heyzine application to facilitate students' critical thinking skills. The advantages of e-modules lie not only in their flexible and accessible presentation format, but also in their ability to provide a more interactive learning experience than printed modules. The use of multimedia elements such as video, animation, and simulations helps students gain a deeper understanding of the concepts being studied (Aeni & Widodo, 2022). E-modules that can be accessed via smartphones and laptops using applications make it easier for students to learn practically, flexibly, and effectively.

The learning process can be simplified with various applications. One such application is Heyzine. It is important for Heyzine to be easily accessible to students because most students already use smartphones. With its attractive features, it is hoped that it can provide more information, making it easier for students to use it as a learning resource (Bagaskara, 2025). The Heyzine application also makes it easy for users to insert multimedia elements such as videos, images, graphics, sounds, and links into the E-modules they create, so that the appearance becomes more attractive and interactive (Muljo et al., 2024). The importance of the Heyzine app in learning lies in its ability to present material in an engaging and interactive manner. With multimedia features such as video, images, sound, graphics, and links, Heyzine transforms e-modules into more engaging and accessible learning resources. High accessibility via smartphones also makes it easier for students to access materials anytime, anywhere. This makes Heyzine a modern solution that supports active student engagement, fosters interactive learning experiences, and enhances meaningful participation in the learning process.

The initial stage in developing an e-module based on the Problem Based Learning model is conducting a needs analysis. This analysis is crucial because it serves to identify the needs of teachers and students regarding the teaching materials to be developed, so that the resulting product is truly relevant and appropriate to the learning context. By understanding these needs, the creation of an e-module based on the Problem Based Learning model to facilitate critical thinking skills assisted by the heyzine application can be designed appropriately. Therefore, this study aims to explore and analyze these needs as the main foundation in the process of developing effective and contextual teaching materials.

METHODS

The type of research used is research and development (R&D). Research and development methods is a type of research used to produce a specific product and test its effectiveness (Yahya, 2014). The research and development conducted resulted in an e-module based on the Problem Based Learning model to facilitate critical thinking skills in the heat topic. The development model applied in this research is the 4-D development model. The 4-D development model consists of four stages: Define, Design, Develop, and Disseminate (Thiagarajan et al., 1974). The 4-D model is a systematic development model based on educational product design theory, ensuring that the resulting product meets eligibility standards. Furthermore, the 4-D model has a clear development procedure, making it easier for researchers to produce structured products that align with learning objectives.

In this development research, the object of research is an E-module based on the Problem Based Learning model on the heat material intended for students at SMA N 14 Padang. This E-module is designed to facilitate critical thinking skills. The E-module based on the Problem Based Learning model on the heat material was validated by 3 experts. The experts who conducted the E-module validity test were 3 physics lecturers from the Faculty of Mathematics and Natural Sciences, Universitas Negeri Padang. If the product validation results are valid, then it is continued with a practicality test. The practicality test was conducted on students and teachers at SMA Negeri 14 Padang.

Furthermore, this research focuses on empowerment efforts in the development of teaching materials, namely through a needs analysis of teaching materials designed in the form of an e-module based on the Problem Based Learning model. The development of this e-module aims to facilitate students' critical thinking skills, by utilizing the Heyzine application as a supporting medium for the heat material. In addition, this research focuses on empowerment efforts in the development of teaching materials, namely through an analysis of the needs of teaching materials designed in the form of e-modules based on the Problem Based Learning model. The development of this e-module aims to facilitate students' critical thinking skills by utilizing the Heyzine application as a supporting medium for the heat material. Through interactive and problem-solving-oriented learning activities, this e-module is expected to increase student engagement, conceptual understanding, and the ability to solve problems in real-life contexts. Therefore, the development of innovative digital teaching materials is important to support effective and meaningful physics learning in the 21st century.

This research was conducted at SMA Negeri 14 Padang with a population involving physics teachers and 30 students of grade XI Phase F. Data collection was carried out through several instruments, namely a critical thinking ability test, a physics teacher interview guide, and an instrument to identify student characteristics. Interviews with teachers aimed to obtain information needed in the development of electronic modules based on the Problem Based Learning model. Meanwhile, the creative thinking ability test was presented in the form of essay questions containing indicators of critical thinking abilities with the aim of measuring the extent to which students have mastered one of the important competencies that need to be developed in 21st century learning. In addition, the instrument for determining student characteristics was filled out directly by students to identify various problems that arise during the learning process in class. All instruments were systematically arranged and adjusted to the needs of the analysis, so that they can support the development of teaching materials that are more contextual, interactive, and relevant to real conditions in the field.

This research uses qualitative data analysis through interviews and quantitative analysis using descriptive statistics to evaluate the results of the critical thinking ability test and student characteristics questionnaire. To clarify the presentation of quantitative data, the analysis results are presented in tables and summaries per group. This descriptive approach aims to

provide a more comprehensive interpretation of the scores obtained. Furthermore, the analysis categories for determining student characteristics are determined based on the scores calculated from each respondent. The valuesfor each indicator are obtained using the following formula. The formula used is in equation 1.

$$P = \frac{\sum x}{\sum xi} \times 100\% = \cdots \quad (1)$$

Description:
P = Percentage
x = Score obtained for each indicator
xi = many respondents

Symbol P represents the percentage of achievement, x represents the score obtained for each indicator, and xi represents the number of respondents. The percentage values obtained are then used as a basis for grouping student achievement levels into predetermined categories, thus providing a clear picture of the overall condition and characteristics of students.

The following describes the results of the analysis conducted on each student according to the criteria and provisions presented in Table 1. The analysis was carried out to identify students' needs, learning difficulties, and responses toward the use of innovative teaching materials in the learning process. The obtained data were then used as the basis for developing an e-module that is appropriate to students' characteristics and learning needs.

Table 1. Student Characteristics Analysis Category

Interval	Category
81-100	Very high
61-80	Tall
41-60	Enough
21-40	Low
0-20	Very Low

(Source: Riduwan, 2012)

Scoring is conducted based on the established assessment guidelines. After all students completed the written test, each answer was carefully evaluated according to the predetermined indicators. A score ranging from 0 to 5 was assigned for each indicator to measure students' performance. The obtained scores were then calculated using the following formula to determine the level of students' critical thinking skills. The results of the scoring were used to analyze students' abilities in understanding concepts and solving problems systematically. The formula used is in equation 2.

$$N = \frac{R}{SM}\ x\ 100 \quad (2)$$

Description:
N = Percentage value sought
R = Score obtained by the student
SM = Ideal maximum score for the test in question
100 = Fixed number

The score interpretation criteria were used to determine the level of achievement based on the assessment results obtained. These criteria help classify students' performance into several categories according to their scores. Through this interpretation, the level of students'

critical thinking skills can be identified more clearly and systematically. The classification of score interpretation criteria is presented in Table 2.

Table 2. Critical Thinking Skills Criteria

Score (%)	Category
81-100	Very high
76-85	Tall
60-75	Enough
55-59	Low
≤54	Very low

(Source : Purwanto, 2013: 93)

RESULTS AND DISCUSSION

Results

The first research result was an analysis of students' critical thinking skills. Data were collected through a critical thinking skills worksheet given to 30 Phase F grade XI students. The critical thinking skills assessment was based on four indicators: basic clarification (BC), bases for a decision (BD), inference (IF), and advanced clarification (AC). The analysis of students' critical thinking skills for each indicator is presented in Figure 1.

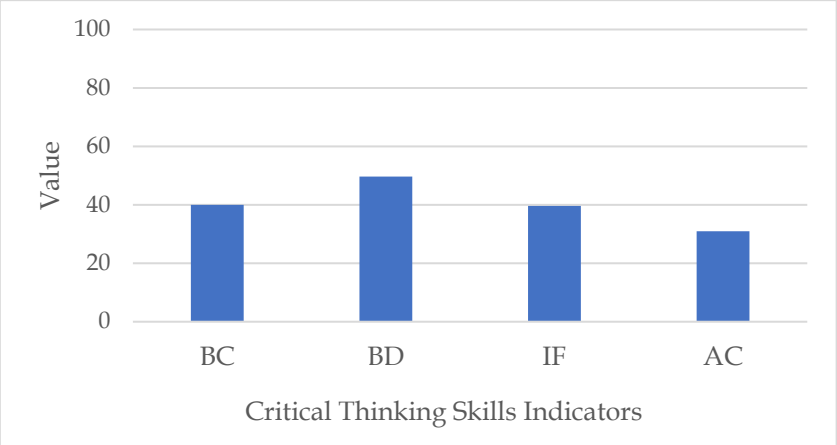

Figure 1. Results of Analysis of Students' Critical Thinking Skills

Based on the data in Figure 1, it is clear that students' thinking skills in physics learning are still very low and require serious attention. Students' critical thinking skills showed an average score of 40, which is included in the very low category. This finding indicates that most students have difficulty analyzing information, evaluating arguments, and drawing logical conclusions from a physics problem. This low ability also reflects students' limitations in asking in-depth questions, critiquing existing information, and making decisions based on evidence and logical reasons. In addition, students tend to rely on memorization rather than conceptual understanding and analytical reasoning when solving physics problems. As a result, students often experience difficulties when faced with contextual problems that require interpretation, analysis, and evaluation of information. This condition indicates the importance of developing teaching materials that not only convey material but also stimulate students' critical thinking skills. Therefore, the development of E-Modules based on the Problem Based Learning model is a good strategy in creating meaningful, contextual learning

and encouraging active student involvement. Through authentic problem-solving activities, students are expected to become more active in constructing knowledge, analyzing phenomena, and formulating solutions based on scientific reasoning. These results provide a strong foundation for the development of innovative teaching materials to improve the quality of physics learning in schools and support the enhancement of students' critical thinking skills.

The second research result is an analysis of the context of the teaching materials used at SMA Negeri 14 Padang. This analysis covers seven aspects, namely self instructional (SI), self contained (SC), stand alone (SA), user friendly (UF), visual and multimedia (VM), adaptive (AD), and contextual (CT). The analysis was carried out by comparing the ideal characteristics of teaching materials with the conditions of the teaching materials used in schools. The purpose of this analysis is to identify the gap between ideal conditions and actual conditions of teaching materials. The results of the analysis show that the adaptive, visual and multimedia aspects received the lowest scores, so it is necessary to develop teaching materials that are more in line with technological developments and student needs. The results of the context analysis of teaching materials are presented in Figure 2.

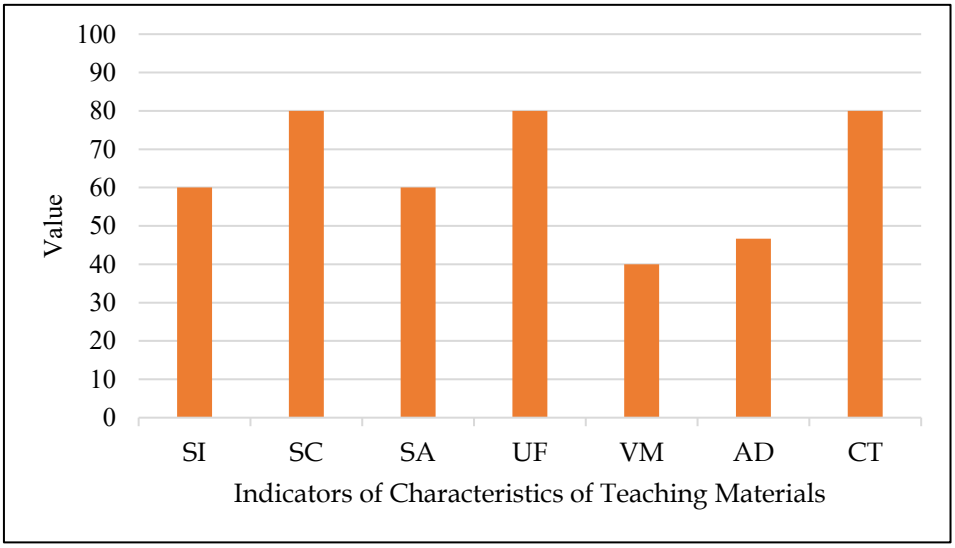

Figure 2. Results of the Context Analysis of Teaching Material

Based on Figure 2, the results of the context analysis of the teaching materials show that the self-contained, user-friendly, and contextual aspects obtained the highest score, namely 80, which indicates that the teaching materials contain quite complete material, are easy to use, and are able to relate learning concepts to everyday life. However, the visual and multimedia aspects obtained the lowest score, namely 40, while the adaptive aspect obtained a score of 46.67. These results indicate that the teaching materials used are still dominated by static text and images and have not optimally utilized interactive multimedia, such as videos, animations, and learning simulations. In addition, the teaching materials also do not fully support flexible technology-based learning and can be accessed through various digital devices. Meanwhile, the self-instructional and stand-alone aspects each obtained a score of 60, which indicates that the teaching materials are not fully able to facilitate independent learning without teacher assistance or additional learning resources. Therefore, it is necessary to develop a problem-based learning model-based e-module that is able to integrate interactive multimedia and digital technology to support more effective, independent learning, and in accordance with the needs of students in the digital era.

The third research result is an analysis of the integration of the Problem Based Learning model into teaching materials used in schools. This analysis was conducted based on the five syntaxes of the Problem Based Learning model, namely orienting students to problems (OS),

organizing students to learn (OSL), guiding individual or group investigations (GI), developing and presenting work (DP), and analyzing and evaluating the problem-solving process (AE). The purpose of this analysis was to identify the extent to which the characteristics of Problem Based Learning have been integrated into the teaching materials used in schools. The results of the analysis show that the aspects of developing and presenting work and analyzing and evaluating the problem-solving process obtained the lowest scores, namely 30 and 40, respectively. This finding indicates that the teaching materials used have not optimally facilitated students to produce work from the results of investigations and evaluate the problem-solving process that has been carried out. The results of the analysis of the integration of the Problem Based Learning model in teaching materials are presented in Figure 3.

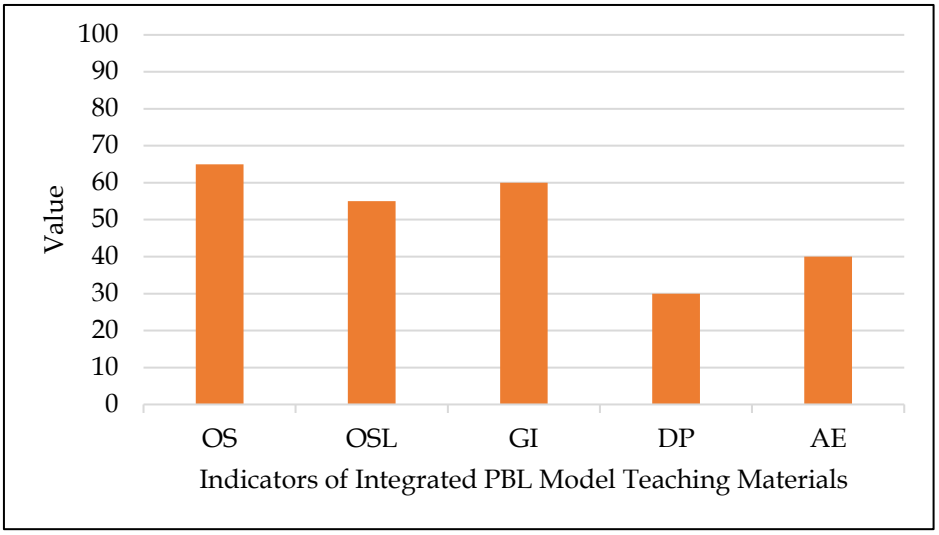

Figure 3. Results of the Analysis of the Integration of the PBL model in Teaching Material

Based on Figure 3, the results of the analysis of the integration of the Problem Based Learning model in the teaching materials show that the aspect of orienting students to problems obtained the highest score of 65, followed by the aspect of guiding individual/group investigations at 60 and organizing students for learning at 55. These results indicate that the teaching materials have been able to present contextual problems and facilitate simple investigation activities that support conceptual understanding. However, the aspect of developing and presenting work obtained the lowest score, at 30, while the aspect of analyzing and evaluating the problem-solving process only obtained a score of 40. These findings indicate that the teaching materials used are still focused on conveying basic learning concepts and activities, but have not optimally facilitated students to produce work, present the results of investigations, and conduct reflection and evaluation of the problem-solving process that has been carried out. This condition shows that the integration of Problem Based Learning syntax in teaching materials is still not comprehensive, especially at the product development and evaluation stages of the problem-solving process. Therefore, it is necessary to develop teaching materials that are more integrated with Problem Based Learning syntax to be able to encourage active involvement of students in generating solutions, communicating learning outcomes, and developing problem-solving skills in more depth.

The fourth research result relates to the level of student mastery of the material as measured by the results of the Final Semester Exam. Data were obtained from 27 Phase F students of class XI F.1. The analysis results indicate that student mastery of the material is still not optimal. Most students have not reached the expected level of mastery, which indicates that there are still difficulties in understanding physics concepts in depth and

applying them in problem solving. This condition indicates the need for efforts to improve the quality of learning through the use of teaching materials that are more innovative, interactive, and able to facilitate students in building conceptual understanding independently. The results of the analysis regarding the level of student mastery of the material are presented in Table 3.

Table 3. Results of Material Mastery Analysis

No.	Statistical Parameters	Mastery of Material	Description
1.	Number of Students	30	The number of students who were the research sample was 30 people.
2.	Average	43.8	The average value of students' mastery of the material is classified as low because it is still below 50% of the maximum score.
3.	Mode	40	The most common score obtained by students is 40
4.	Median	43	As many as 50% of students obtained scores below or equal to 43 and the other 50% above or equal to 43
5.	Lowest Score	27	The lowest score obtained by students was 27, indicating that there are still students with very low mastery of the material
6.	Highest Score	68	The highest score obtained by students was 68, but it still did not reach the maximum score
7.	Range	41	The difference between the highest and lowest scores is 41, indicating that there is variation in the ability to master the material between students.

Based on Table 3, the results of the analysis of students' mastery of the material indicate that the level of mastery of the material is still relatively low. The average score obtained by students was only 43.8 out of a maximum score of 100, with a median of 43 and a mode of 40. In addition, the highest score achieved by students was only 68, while the lowest score reached 27 with a range of 41. These results indicate that most students have not been able to master the material optimally and still experience difficulties in understanding the physics concepts being studied. This low mastery of the material indicates that the ongoing learning has not been fully able to help students build a deep conceptual understanding. This condition indicates the need to develop more innovative, interactive, and student-centered teaching materials so that they can facilitate a more meaningful learning process and help improve students' mastery of the material optimally.

The final research finding relates to the analysis of students' mastery of physics concepts.

This analysis was conducted using the results of the end-of-semester examination to determine students' level of understanding of physics concepts and identify learning difficulties experienced during the learning process. Data were collected through questionnaires distributed to 30 students in Phase F of grade XI. Identifying student characteristics is important as a basis for designing appropriate learning strategies and teaching materials that support students' needs and learning conditions. The questionnaire analysis consisted of five aspects: student background(SBG), student learning interest (SLI), student learning motivation (SLM), student learning style (SLS), and digital learning (DLR). The analysis results indicate that students have varied characteristics in each aspect, which provides important information for developing interactive and student-centered learning innovations in physics learning. The results of the student characteristics analysis can be seen in Figure 4.

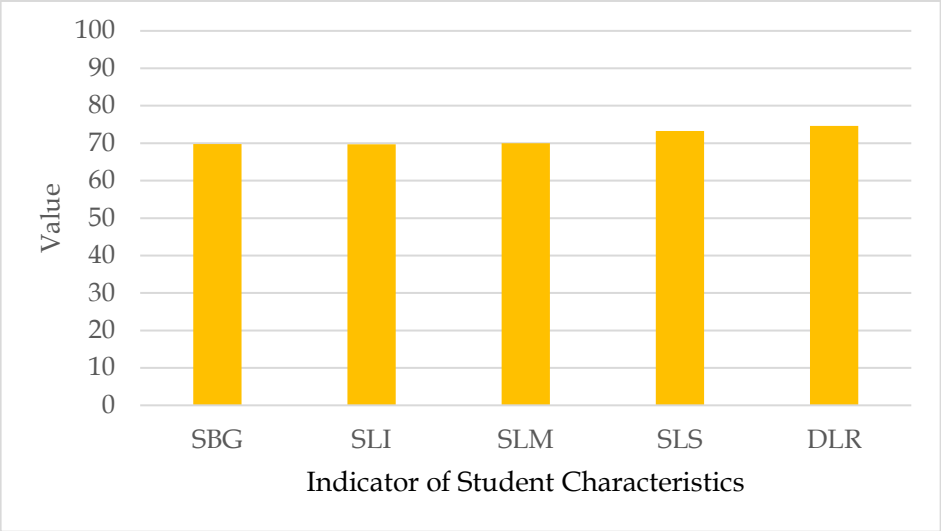

Figure 4. Results of Student Characteristics Analysis

The data presented in Figure 4 show that the student background aspect obtained a score of 69.8, indicating that students already have initial conditions that support digital-based learning. The student learning interest aspect scored 69.7, reflecting that students have begun to show interest and participation in physics learning, although it has not yet reached an optimal level. The learning motivation aspect obtained a score of 70, indicating that students have sufficient encouragement to learn, but their participation in learning activities still needs improvement. Furthermore, the student learning style aspect scored 73.23, showing that students tend to prefer learning methods that support their understanding of the material. Meanwhile, the digital learning aspect obtained the highest score of 74.6, indicating that students have shown a positive response toward the use of technology in learning, even though its implementation in schools is still not fully optimal. Overall, these findings indicate that students have characteristics that support the development of innovative, interactive, and technology-based learning in physics learning.

DISCUSSION

Based on the research results, this study identified three main findings: low critical thinking skills of students, the implementation of Physics learning that is still conventional, and student characteristics that show potential in supporting the implementation of digital based learning. This finding is in line with research by Yu & Zin (2023) which states that conventional learning tends to limit students' cognitive involvement, thereby inhibiting the development of critical thinking skills. This finding is in line with the results of a meta-analysis by Su (2025) which states that a student-centered learning approach is more effective in

improving higher-order thinking skills than traditional methods. The first finding shows that students' critical thinking skills are in the very low category, with an average score of 40. The value of the critical thinking ability indicator proposed by Ennis (2016) identified three key areas of focus: Basic Clarification, Basis for a Decision, Inference, and Advanced Clarification. This finding indicates that students still experience difficulties in identifying problems, providing logical reasons for decision making, drawing conclusions, and conducting further clarification of a concept. This indicates that students' critical thinking skills have not developed optimally, influenced by teacher centered learning, resulting in students' lack of involvement in the analysis and problem solving process. These findings are consistent with recent international studies which report that students' critical thinking skills in physics tend to be low when learning is still dominated by teacher-centered approaches (Suprapto et al., 2024). The use of Problem Based Learning can address this issue by encouraging students to actively engage in problem-solving and analytical thinking processes (Abdullah et al., 2025). This finding aligns with the findings of Xhomara (2022) shows that teacher-centered and memorization oriented learning hinders the development of critical thinking skills because students are passive. This is further strengthened by recent research by Rianti (2021) stated that low critical thinking skills are also influenced by the lack of teaching materials specifically designed to train these skills. Critical thinking helps students analyze and evaluate information accurately (Supriandi, 2023). Therefore, innovation is needed in the development of teaching materials that are not only oriented towards delivering material and memorization, but can also facilitate the development of students' critical thinking skills.

The results of the second study on teaching materials used in schools do not fully support 21st-century learning. Aspects including independent, user-friendly, and contextual received high scores, namely 80 each, while the visual and multimedia and adaptive aspects still received low scores, namely 40 and 46.67, respectively. These findings indicate that the teaching materials used are still dominated by conventional material presentation through text and images, so the use of interactive multimedia and digital technology to support a deep and interesting understanding of physics concepts is not optimal. These findings explain that the use of interactive multimedia can improve conceptual understanding and student engagement in science learning, especially in abstract material (Hermansyah et al., 2022; Wahidin et al., 2025). This finding is in line with research Abdulrahaman (2020), which states that interactive multimedia can enhance students' conceptual understanding, engagement, and learning experience through the integration of various visual and digital elements. Furthermore, the use of educational technology can increase student participation and engagement in the learning process, making learning more effective and meaningful (Bond et al., 2020). Thus, the development of E-Modules based on problem-based learning models is important to carry out as an effort to provide teaching materials that are more adaptive, interactive, and in accordance with the needs of students and the demands of 21st-century learning.

The results of the third study on teaching materials integrated with problem-based learning models in schools do not fully support 21st-century learning. The aspects covering orienting students to problems, organizing students for learning, and guiding individual/group investigations obtained quite good scores, while the aspects of developing and presenting work and analyzing and evaluating the problem-solving process still obtained low scores, namely 30 and 40, respectively. These results indicate that the teaching materials have not optimally facilitated students to produce work, communicate the results of investigations, and reflect on and evaluate the problem-solving process that has been carried out. This finding explains that student involvement in producing products, presenting work results, and conducting reflections is an important component in problem-based learning because it can help students develop critical thinking, problem-solving, communication, and collaboration skills (Abdullah et al., 2025; Widiastuti et al., 2023). In addition, the evaluation

stage in Problem Based Learning plays an important role in helping students assess the effectiveness of the strategies used and improve the learning process to face similar problems in the future (Su et al., 2025; Xhomara, 2022). Therefore, it is necessary to develop teaching materials that integrate Problem Based Learning syntax more comprehensively to be able to facilitate students in developing 21st century skills optimally.

The results of the fourth study regarding students' mastery of physics material indicate that the level of mastery of physics material is still relatively low. This is indicated by the average score of students of 43.8 with the highest score of 68 and the lowest score of 27. These results indicate that most students have not been able to understand and apply physics concepts optimally in solving problems, thus indicating that the ongoing learning process has not been fully able to build a deep conceptual understanding. This finding is in line with research Asrizal (2022), states that students' mastery of concepts is influenced by the quality of the teaching materials and the learning process used. Furthermore, the use of interactive e-modules can help students better understand concepts through more engaging, interactive, and easy to understand presentations (Abdulrahaman et al., 2020; Aeni & Widodo, 2022). Therefore, it is necessary to develop an e-module based on Problem Based Learning assisted by the Heyzine application which is able to facilitate students in building a deeper understanding of concepts and improving their mastery of physics material.

The final finding relates to student characteristics., which indicate that they generally have quite good potential to support the learning process. This is reflected in scores obtained in several aspects, namely student background (69.8), learning interest (69.7), learning motivation (70), learning style (73.23), and digital learning (74.6). Although these achievements are not yet fully optimal, this data indicates a positive tendency of students towards learning activities, especially those involving the use of digital technology. The high score in the digital learning aspect indicates student interest in technology based learning, although its implementation in the school environment is still not optimal.

This situation opens up significant opportunities for developing digital based teaching materials, such as e-modules integrated with the Heyzine application. E-modules are based on the Problem Based Learning model supported by Heyzine. Heyzine can provide more interactive learning through the integration of text, images, video, and animation (Sari & Anggreni, 2023). In addition, the Problem Based Learning model encourages students to actively participate in the learning process through contextual project activities, so that they can effectively develop their critical thinking skills (Abdullah & Munawwaroh, 2024). Thus, the results of this study indicate a gap between the ideal conditions of 21st century learning and the learning practices that occur in the field. To address this problem, the development of innovative teaching materials in the form of e-modules based on the Problem Based Learning model supported by the use of digital technologies such as heyzine is needed. This development is expected to increase student engagement, accommodate diverse learning styles, and optimize students' critical thinking skills in physics learning.

CONCLUSION

Based on the results of the needs analysis conducted at SMA Negeri 14 Padang, several important findings were obtained. First, students' critical thinking skills are still in the very low category with an average score of 40. Second, the teaching materials used in schools do not fully support 21st-century learning, especially in the visual and multimedia and adaptive aspects, which still receive low scores. Third, the integration of the Problem Based Learning model in teaching materials is not optimal, especially in the aspects of developing and presenting work results and analyzing and evaluating the problem-solving process. Fourth, students' mastery of physics material is still relatively low with an average score of 43.8. In

addition, the results of the analysis of student characteristics indicate that students have a fairly good interest, motivation, and readiness for digital technology-based learning. These findings indicate a gap between current learning conditions and the demands of 21st-century learning. Therefore, the development of e-modules based on Problem Based Learning assisted by the Heyzine application is needed as an alternative teaching material that is more interactive, adaptive, and student-centered to facilitate the improvement of critical thinking skills and mastery of physics concepts.

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