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NEEDS ANALYSIS OF INTERACTIVE PHYSICS E-MODULES IN SENIOR HIGH SCHOOL TO DEVELOP STUDENTS' HIGHER-ORDER THINKING SKILLS AND SELF-REGULATED LEARNING

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Abstract

This study examines the critical role of interactive e-modules in enhancing physics learning in senior high schools by identifying the pedagogical and technical needs of both students and teachers. A descriptive survey design employing a mixed-methods approach was used, integrating quantitative data from student questionnaires with qualitative insights obtained through teacher interviews. The participants consisted of 46 Grade XI students from a senior high school in Nganjuk and eight physics teachers who actively integrate technology into their instructional practices. Data were analyzed using descriptive statistics and thematic analysis. The findings indicate a clear need for innovative instructional media. Although 52% of students reported an interest in physics, 48% reported difficulties understanding key concepts, highlighting the need for more accessible, interactive learning approaches. Notably, 85% of students preferred digital learning media, such as e-modules and instructional videos, over traditional textbooks, and 61% reported using digital devices daily for learning. Most students perceived e-modules as beneficial, particularly valuing features that provide clearer explanations and interactive elements, including animations and videos. Teachers corroborated the effectiveness of e-modules in facilitating the comprehension of abstract physics concepts but emphasized the need for systematic training and improved technical infrastructure to ensure effective implementation. In conclusion, the development of interactive e-modules is essential for enhancing student engagement, fostering higher-order thinking skills (HOTS), and promoting self-regulated learning (SRL). Therefore, this study recommends that educational institutions prioritize targeted teacher-training programs and infrastructure development to support the optimal and sustainable integration of e-modules into physics education.

Keywords: Development of Interactive E-Modules, Higher-Order Thinking Skills, Learning Media, Physics Learning, Technology-based Learning

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INTRODUCTION

Physics learning in high schools faces significant challenges in facilitating students' understanding of abstract and complex concepts (Prayogi & Verawati, 2024). The Merdeka Curriculum prioritizes the development of critical, creative, and analytical thinking skills, as well as learner independence, and therefore requires more innovative learning approaches (Hosaini et al., 2024). Amid rapid technological advancements, digital-based learning, particularly interactive e-modules, offers a promising solution for improving the quality of physics education. Interactive e-modules provide engaging and accessible learning materials that support the development of students' higher-order thinking skills and self-regulated learning (Ayani et al., 2025; YANİAWATİ et al., 2021).

Physics education in Indonesia has evolved with the implementation of the 2013 Curriculum, which emphasizes the development of 21st-century skills (Haryani, 2020). This approach has been further advanced through the Merdeka Curriculum, which provides students with greater autonomy and flexibility to learn in accordance with their interests and needs. The Merdeka Curriculum encourages active student participation in the learning process and promotes the development of higher order thinking skills (Hunaepi & Suharta, 2024). However, physics learning practices in secondary schools continue to face limitations in the availability of instructional media that effectively support the achievement of these competencies. Moreover, the advancement of Industry 4.0 has further increased the importance of technology integration in education (Oke & Fernandes, 2020). Interactive e-modules, which utilize technology to present learning materials through multimedia formats, can serve as effective tools for supporting physics instruction (Ali & Zaini, 2023; Ayani et al., 2025).

Higher order thinking skills (HOTS) in the context of physics require students to move beyond basic comprehension to apply, analyze, evaluate, and create knowledge (Anderson & Krathwohl, 2001). These complex cognitive skills are fundamental to the objectives of the Merdeka Curriculum (Hunaepi & Suharta, 2024). Previous research consistently indicates that interactive learning media, such as e-modules, play a crucial role in fostering HOTS by providing students with opportunities for problem solving, real-time feedback, and engagement with complex simulations (Resnick, 1987).

Self-regulated learning (SRL) is equally essential and is defined as a cyclical process in which students proactively regulate their behavior, cognition, and motivation to achieve academic goals (Zimmerman, 2000). SRL consists of three primary phases: forethought, performance, and self-reflection. Interactive e-modules are well-positioned to serve as effective scaffolds for SRL, as their design enables learners to control the pace of learning and receive immediate feedback, thereby enhancing study time management and effort regulation (Pintrich, 2000; Schunk & Zimmerman, 2008).

Based on these developments, this study aims to answer three main questions: (1) What are the needs of students and teachers in interactive e-module-based physics learning in senior high schools? (2) How can interactive e-modules support the development of higher-order thinking skills and self-regulated learning in students? (3) What are the challenges and obstacles faced in implementing interactive e-modules in physics learning in high school?

Previous research on the use of e-modules in physics learning has shown that they are effective in improving conceptual understanding and student motivation. Sukmadewi & Jumadi (2023) found that mobile-based e-modules for learning physics on momentum and impulse can improve conceptual understanding and learning interest among 10th-grade students, with validation results indicating that the e-modules are highly suitable for use. Research by Yuyun et al. (2022) also shows that flipbook-based e-modules can improve students' physics learning outcomes, with higher N-Gain scores indicating significant gains in understanding the material. Furthermore, Permata et al. (2021) showed that KFM (Kvisoft Flipbook Maker)-based e-modules can improve students' understanding of physics concepts. However, most of these studies focus more on the effectiveness of e-modules in improving learning outcomes, without delving deeply into students' and teachers' needs and the role of e-modules in supporting the development of higher-order thinking skills and self-regulated learning. The novelty of this research lies in its more holistic approach, exploring the needs of students and teachers regarding interactive e-modules in physics learning. It also analyzes how e-modules can contribute to the development of critical thinking, analytical skills, and independent learning abilities, which are highly relevant to the demands of the Merdeka Curriculum and Industry 4.0.

Although interactive e-modules show significant potential for improving the quality of learning, their implementation in high schools in Indonesia remains limited (Dewi et al., 2022). This is due to various factors, including limited access to adequate technology, limited teacher training in using e-modules, and challenges in integrating technology into existing curricula (Ayani et al., 2025). Several studies have shown that although e-modules can improve students' conceptual understanding and learning interest, many schools still rely on traditional learning methods such as textbooks and teachers (Sudarmo et al., 2021). This reliance on conventional methods hinders the full adoption of interactive e-modules, even though this technology can make physics learning more engaging and effective, and encourage students to think more critically and independently.

On the other hand, although numerous studies have demonstrated the effectiveness of interactive e-modules in improving student learning outcomes and motivation, numerous challenges remain in optimizing the use of their use in the classroom. One major challenge is the need for more intensive training and mentoring for teachers to utilize e-modules (Zamtina & Susilo, 2024). Without an adequate understanding of how to use and apply technology in learning, interactive e-modules will not achieve their maximum impact. Furthermore, infrastructure limitations, such as unstable internet connections and uneven distribution of digital devices, also hinder effective implementation (Salim et al., 2024). Therefore, the government and educational institutions must address these barriers to optimally harness the potential of interactive e-modules to support more innovative physics learning that aligns with current developments.

In conclusion, this research is expected to provide new insights into the role of interactive e-modules in improving the quality of physics learning at the high school level, particularly in developing students' higher-order thinking skills and self-regulated learning. By identifying the needs of students and teachers and the challenges faced in implementing e-modules, this study makes an important contribution to developing learning media that are more relevant to the context of the Independent Curriculum and the challenges of Industry 4.0. Furthermore, the novelty of this study lies in its holistic approach, namely, not only evaluating the effectiveness of e-modules in improving learning outcomes but also highlighting how e-modules can help develop students' critical thinking, analytical skills, and independent learning abilities. The results of this study are expected to serve as a reference for e-module developers and educators to create learning tools better suited to the needs and challenges of high schools, as well as increase student engagement and motivation in the physics learning process.

METHOD

Research Design

This study employed a descriptive survey with a mixed-methods approach, combining quantitative and qualitative data. This approach aims to gain a deeper understanding of the role of interactive e-modules in physics learning in high schools, as well as to identify the needs of students and teachers. Descriptive surveys describe a group or phenomenon's current condition or situation and are often the initial step in research (Deckert & Wilson, 2023). A mixed-methods approach offers the advantage of combining numerical data analysis with in-depth insights gained from interviews (Bidwell & Báez, 2025).

Participants

This study used a purposive sampling technique to select participants with specific characteristics relevant to the research objectives (Campbell et al., 2020). Participants were 11th-grade students at a high school in Nganjuk, East Java, who had gained experience in guided inquiry-based physics learning and used technology in their learning, such as mobile phones, tablets, laptops, and other digital devices. This purposive sampling technique enabled researchers to select students who were already familiar with technology and experienced in guided, inquiry-based learning approaches that use interactive e-modules as learning tools. The study involved 46 students, 26 female and 20 male.

Furthermore, the eight physics teachers selected as research participants also had experience teaching physics using guided inquiry approaches and digital technology, including interactive e-modules. These teachers were expected to provide in-depth insights into the application of e-modules in physics learning and the challenges and opportunities they face in integrating technology in the classroom. Using purposive sampling, researchers ensured that the sample would yield accurate and relevant data to answer the research questions and to provide a broader understanding of the application of guided inquiry-based learning and technology in high school physics instruction.

Test Instruments

The data collection instruments used in this study consisted of student questionnaires and teacher interviews. The questionnaires were distributed directly to students to collect quantitative data on their perceptions and needs regarding the use of interactive e-modules in physics learning. The questionnaire, adapted from Farida & Ratnawuri (2021), included items measuring students' learning interest, perceived difficulty in understanding physics concepts, preferences for learning media, desired features of e-modules, and perceptions of the effectiveness of technology-based learning in supporting higher-order thinking skills (HOTS) and self-regulated learning (SRL).

Teacher interviews were conducted both face-to-face and via Google Meet to obtain qualitative data. These interviews aimed to explore teachers' perspectives on students' learning conditions, their instructional needs, and the challenges encountered in implementing e-modules in physics classrooms. To ensure coherence between the quantitative and qualitative data, the interview indicators were deliberately aligned with the constructs measured in the student questionnaire. This alignment enabled data triangulation and strengthened the needs analysis by integrating students' self-reported experiences with teachers' classroom observations. The alignment between teacher interview indicators and student questionnaire constructs is presented in Table 1.

Table 1. Alignment of teacher interview indicators with student questionnaire constructs

Number	Teacher Interview Indicators	Related Student Questionnaire Indicators
1	Teachers' perceptions of student interest and learning difficulties in physics.	Students' interest in physics and reported difficulty in understanding the material.
2	Availability and frequency of digital device use in physics learning.	Frequency of student use of digital devices in physics learning activities.
3	Teachers' views on learning media preferences	Student preference for digital media versus textbooks
4	Teachers' expectations of effective e-module features	Features students desire in physics e-modules
5	Teachers' perceptions of e-modules in fostering higher-order thinking	Student perception of technology-based learning effectiveness in improving HOTS
6	Teachers' views on e-modules supporting learning autonomy	Student perception of e-modules in improving time management and self-motivation (SRL)
7	Teachers' perceptions of challenges in implementing e-modules	Student rating of e-module effectiveness in overcoming learning difficulties

Prior to data collection, the student questionnaire was tested for validity and reliability. Content validity was examined using Aiken's V, involving five experts in physics education. The results indicated that Aiken's V coefficients for all questionnaire items ranged from 0.82 to 0.94, exceeding the minimum validity criterion ($V > 0.80$) and confirming the validity of all items (Aiken, 1980, 1985). Furthermore, the questionnaire's reliability was assessed using Cronbach's alpha, yielding $\alpha = 0.89$, indicating high internal consistency (Malapane & Ndlovu, 2024). These results confirm that the questionnaire was both valid and reliable for measuring students' perceptions and needs regarding interactive e-modules in physics learning.

Data Analysis

The validity of the data in this study was strengthened through method triangulation, combining student questionnaire results and teacher interview data. This triangulation process was conducted in depth using a mixed-methods approach, in which quantitative data from the questionnaires were analyzed using descriptive statistics to illustrate trends and patterns in student perceptions (Habibullah et al., 2025). Qualitative data from the interviews were then integrated to better understand the context and teachers' perspectives. By comparing data from these two sources, researchers could ensure the consistency and reliability of the findings and gain a more comprehensive perspective on the phenomenon under study (Susanto et al., 2023).

Furthermore, this data triangulation not only strengthened the validity of the findings but also helped identify areas requiring further attention, thus providing a more substantial basis for the recommendations generated from this study (Meydan & Akkaş, 2024). Before data collection, participants were provided with information regarding the study's purpose and methods, and informed consent was obtained from each participant. The data obtained were kept confidential by omitting participants' identities from the research results.

RESULTS AND DISCUSSION

1. Student and Teacher Needs for Interactive E-Module-Based Physics Learning in High School

A questionnaire distributed to 46 students yielded several important insights into students' needs for using interactive e-modules in physics learning. Figure 1 shows that although the majority of students (52%) expressed interest in learning physics, nearly half (48%) reported difficulty understanding the subject matter. This finding highlights a significant discrepancy between students' interest and their conceptual understanding, underscoring the need for more interactive, accessible learning approaches, such as e-modules, to bridge this gap.

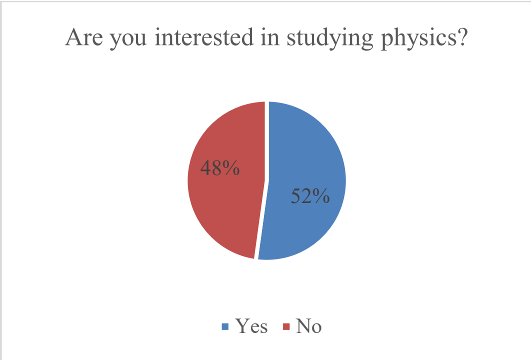

Figure 1. Students' interest in physics and reported difficulty in understanding the material

As shown in Figure 2, these data indicate a high level of technological readiness among students, with 61% using digital devices daily for learning. Furthermore, the widespread accessibility reported by the majority of students (96%) confirms that student-related infrastructure strongly supports the implementation of interactive e-modules, positioning them as a feasible and relevant instructional solution.

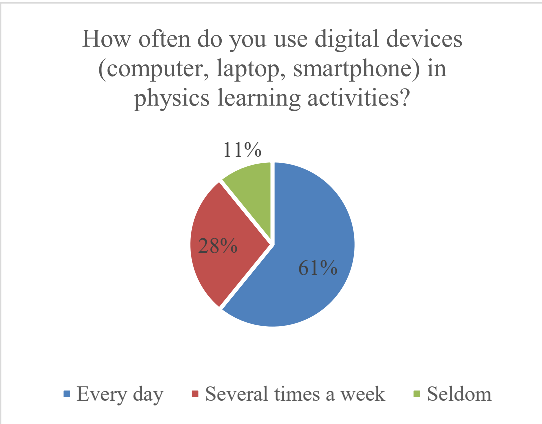

Figure 2. Frequency of student use of digital devices (computer, laptop, smartphone) in physics learning activities

Meanwhile, Figure 3 shows that 85% of students prefer using digital media over textbooks, such as e-modules, learning videos, or other applications. Most students (96%) also consider using technology, such as e-modules, very important in understanding physics material. This indicates that students expect more technology-based and interactive physics learning.

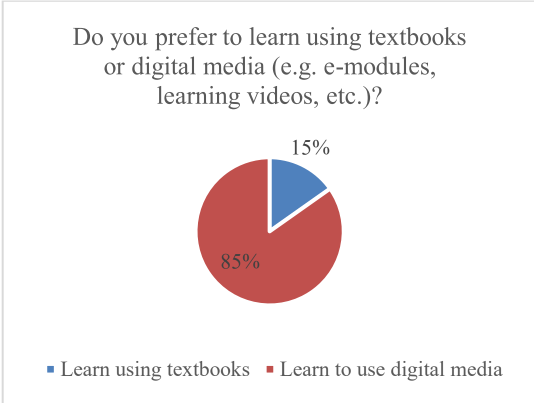

Figure 3. Students' preference for digital media versus textbooks in learning

Figure 3 illustrates a strong preference for digital learning media, with 85% of students favoring digital resources (e-modules and instructional videos) over conventional textbooks. This preference is further supported by students' perceptions that technology, including e-modules, is essential for understanding physics content, as reported by 96% of respondents. These findings provide clear evidence that students' expectations align well with the adoption of technology-based, interactive learning approaches.

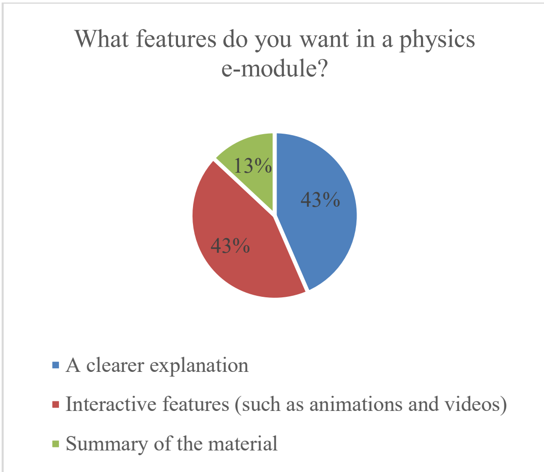

Figure 4. Features students desire in physics e-modules, highlighting the demand for clarity and interactivity

Overall, the results of this questionnaire indicate that students strongly desire the use of interactive e-modules to support their physics learning process. They desire more interactive, engaging, and accessible learning media to enhance their understanding of complex physics material.

Interviews with eight physics teachers highlighted a strong demand for integrating interactive e-modules into physics instruction. 75% of participants reported that these modules are highly effective at explaining complex material, particularly for abstract topics such as heat, thermodynamics, and waves. They emphasized that multimedia elements, including animations and videos, significantly enhance students' conceptual understanding. Despite these perceived benefits, around half of the teachers noted the need for additional training to effectively use e-modules in classroom practice. Moreover, 37.5% expressed the importance of incorporating features that enable real-time student feedback, supporting assessment and progress monitoring.

In addition, 62.5% of teachers believed that interactive e-modules could facilitate more diverse and engaging learning activities, thereby boosting student motivation and participation. Nonetheless, infrastructure-related barriers posed notable challenges, including unstable internet connectivity and limited device access in some schools. Over half of the respondents identified these technical issues as the primary obstacles to broader implementation. Consequently, while teachers demonstrated strong enthusiasm for adopting interactive e-modules, comprehensive technical training and improved school infrastructure are essential to ensure their effective and sustainable use in physics education.

2. Developing Higher-Order Thinking Skills and Self-Regulated Learning Through Interactive E-Modules

Based on the survey results shown in Figure 5, nearly all students (99%) believe that technology-based learning can enhance their critical, analytical, and creative thinking skills, which are key components of higher-order thinking skills (HOTS). According to the revised Bloom's taxonomy proposed by Anderson & Krathwohl (2001), HOTS refers to higher-level cognitive processes, including analyzing, evaluating, and creating. In this study, these processes were operationalized through survey indicators measuring students' perceptions of critical thinking, analytical thinking, and creativity in physics learning.

This near-universal belief reflects a strong recognition that interactive e-modules, through their visual, interactive, and simulation-based features, serve as effective tools for stimulating deeper and more complex thinking. From a constructivist learning perspective, learning occurs when students actively construct knowledge through interaction with learning materials rather than passively receiving information (Bodner, 1986; Bruner, 1983).

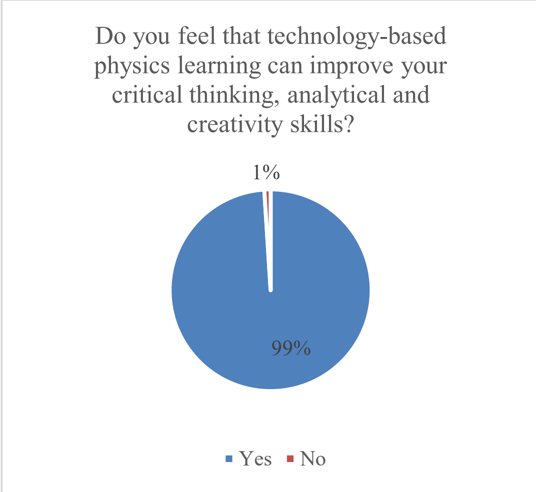

Figure 5. Students' perception on the effectiveness of technology-based learning in improving critical thinking, analytical, and creativity skills (HOTS)

Figure 5 shows that only 1% of students felt that technology-based learning did not significantly impact the development of their higher-order thinking skills. This may be related to personal factors, such as a preference for traditional learning methods or limited experience with digital learning tools. Teacher interview findings support this interpretation, as several teachers noted that a small number of students still rely heavily on teacher explanations and require guidance to fully engage with interactive digital materials.

Students' confidence in the ability of interactive e-modules to improve higher-order thinking skills also aligns with the development of self-regulated learning (SRL), as shown in Figures 6 and 7. Self-regulated learning is defined by P. R. Pintrich & De Groot (1990) as an active and constructive process in which learners set learning goals and regulate their cognition, motivation, and behavior through the phases of forethought, performance, and control. In this study, SRL was measured using survey indicators of time management, self-motivation, and effort regulation.

Figure 6 shows that most students (65%) felt that learning supported by e-modules was very helpful in improving their ability to manage study time and motivate themselves. These indicators correspond to the forethought and performance phases of SRL, which involve forethought, planning, and activation, monitoring, control, and reaction and reflection (P. S. Pintrich et al., 1991). Providing accessible, structured, and self-paced content in e-modules enables students to monitor and plan their learning autonomously. Teachers also reported during interviews that e-modules enable students to review materials independently outside classroom hours, reinforcing learning autonomy and responsibility. While 7% of students reported low utility in time management and motivation, potentially due to technological friction or entrenched traditional learning habits, the overall trend strongly supports the role of e-modules as instructional scaffolds for independent learning. This finding is consistent with self-regulated learning theory, which emphasizes learner autonomy and responsibility in managing the learning process (Gupta et al., 2024).

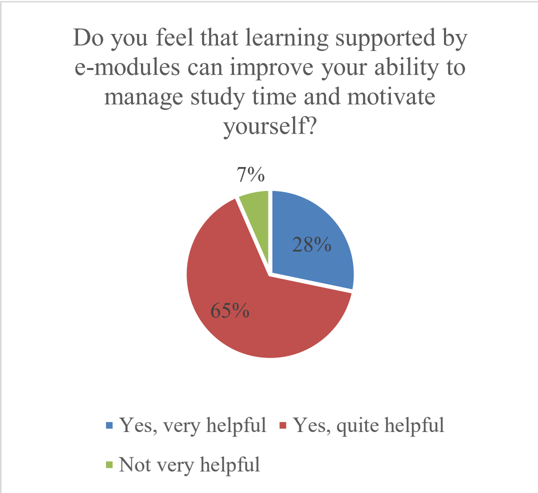

Figure 6. Students' perception on how e-modules improve their ability to manage study time and self-motivate (self-regulated learning components)

Figure 7 shows that the majority of students (a combined 68% reporting "very effective" and "moderately effective") perceive e-modules as playing a significant role in helping them overcome difficulties in learning physics and increasing their effort in completing academic tasks. These findings are closely related to effort regulation, a crucial component of the control phase of self-regulated learning (SRL) (P. R. Pintrich & De Groot, 1990). From a social cognitive perspective, interactive features and instant feedback provided by e-modules can enhance students' self-efficacy, which influences their persistence and resilience when facing challenging learning tasks (Zimmerman & Schunk, 2003).

However, the finding that a minority of students (17% ineffective in overcoming difficulties and 15% ineffective overall) felt less supported by the e-modules must be acknowledged. This variation in perceived effectiveness suggests that effort regulation through e-modules is contingent on individual factors, including digital literacy and the ability to adapt to technology-enhanced learning environments. Teacher interviews further revealed that differences in students' technological readiness and learning habits remain a challenge in the full implementation of e-modules.

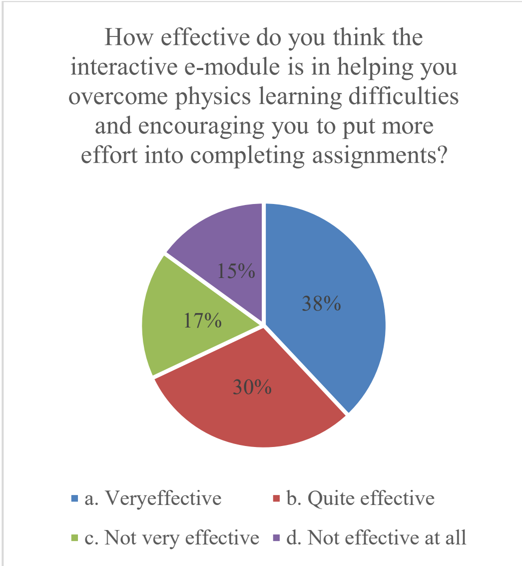

Figure 7. Students' rating of e-module effectiveness in overcoming learning difficulties and encouraging increased effort in completing assignments (effort regulation)

Overall, these findings indicate that interactive e-modules have substantial potential to support the development of higher-order thinking skills (analyzing, evaluating, and creating) and self-regulated learning (planning, motivation, and effort regulation). By integrating student survey data with teacher interview themes and established learning theories, this study demonstrates that interactive e-modules function not only as digital learning resources but also as pedagogical tools that promote active, independent, and higher-level learning in physics education.

3. Limitations of the Study

While this study provides valuable insights into the needs analysis of interactive physics e-modules, it is important to acknowledge several limitations related to sampling and research design:

a. Sampling limitation (purposive sampling): a purposive sampling technique was employed, selecting participants based on specific characteristics, such as experience with guided inquiry-based learning and use of technology. Although this approach ensured the collection of relevant, in-depth data from knowledgeable students and teachers, the findings may not be generalizable to the broader population of high school students or physics teachers in

Indonesia, who may have different levels of technological exposure or pedagogical backgrounds.

b. Research design limitation (descriptive survey): the study utilizes a descriptive survey design, which is effective for identifying current status, needs, and preferences. However, this design only establishes trends and patterns in perceptions and does not allow for causal inferences regarding the impact of e-modules on the development of HOTS or SRL. Future experimental or intervention studies are recommended to verify the direct effects of e-module implementation on student outcomes.

4. Challenges and Barriers to Implementing Interactive E-Modules in High School Physics Learning

Implementing interactive e-modules in high school physics instruction poses significant challenges, both technological and pedagogical. One of the main challenges lies in student engagement and motivation. Physics, known for its abstract nature, often makes it difficult for students to understand the material, decreasing their interest in the subject. The continued dominance of traditional teaching methods exacerbates this situation because technology is not use in the teaching and learning process. Although interactive e-modules can increase student engagement with a more multimedia approach, maintaining student interest throughout the learning process remains a significant challenge (Verawati & Nisrina, 2025). Furthermore, self-regulated learning is also a barrier, with many students struggling to manage their study time and motivate themselves. Many students are unfamiliar with the self-directed learning environment offered by e-modules, making it difficult to effectively engage with the material presented (DeVore et al., 2017).

On the other hand, teacher readiness and training are also significant challenges. Despite their desire to use technology in their learning, many teachers lack sufficient training to make the most of e-modules. This leads to ineffective teaching practices, diminishing the positive impact of using e-modules in physics learning. Most teachers acknowledge that they need further training to best integrate technology into their teaching (Verawati & Nisrina, 2025). In addition to training, ongoing professional development is crucial for improving teachers' pedagogical and technological skills. However, this professional development is often neglected or insufficiently encouraged, even though it is vital to increasing the effectiveness of technology-based teaching.

Beyond pedagogical and training issues, resource disparity is the biggest challenge in implementing interactive e-modules. Access to adequate technology remains a major issue, especially in schools with limited budgets. Many students lack adequate access to digital devices such as computers or tablets, or even struggle to access a stable internet, which undoubtedly hinders the effectiveness of interactive e-modules. Another challenge of implementation is resistance to change within the existing education system. Traditional method-based examination systems are often incompatible with technology-based learning, leading to resistance to the use of e-modules in the classroom. An education system that does not support this technological innovation slows the integration of interactive e-modules into high school physics learning (Verawati & Nisrina, 2025).

While these challenges are significant, some educators argue that the potential benefits of interactive e-modules, such as increased student engagement and improved learning outcomes, may outweigh the existing barriers. Therefore, greater efforts are needed to provide adequate support, including teacher training, technological infrastructure improvements, and educational policy changes to address these barriers. If these challenges can be overcome, the potential for interactive e-modules to enhance high school physics learning is significant.

CONCLUSIONS AND SUGGESTIONS

Conclusion

The findings of this study indicate that both students and teachers have clear needs regarding the development of interactive e-modules for high school physics learning. Students expect e-modules that help them overcome difficulties in understanding physics material through interactive features such as animations, videos, and clearer explanations, thereby enhancing their motivation and engagement. Meanwhile, teachers require more intensive training to optimize the use of interactive e-modules in the classroom, as well as e-modules that support student time management and provide more effective feedback.

Suggestion

Based on these conclusions, it is recommended that the development of interactive e-modules should focus on ease of access, deeper interactivity, and integration with more flexible learning approaches. In addition, support for teacher training and improvements in school technology infrastructure are essential to address existing challenges and ensure the effective implementation of e-modules in meeting the needs of both students and teachers in physics learning.

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