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The Impact of Interactive E-Module on Enhancing Conceptual Understanding in High School Physics Education

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Abstract

Interactive E-Modules in high school physics have proven effective in enhancing students understanding of complex topics. For example, a multimedia CD based E-Module improved student performance by 10.83 points on a 15-item test ($F = 250.602$, $p < 0.05$). A meta analysis of SIGIL based E-Modules revealed a large effect size (Cohen's $d = 2.2$), demonstrating a 99% effectiveness rate. An Edmodo based E-Module showed a normalized gain of 0.74, indicating significant positive effects on students' learning outcomes. Other platforms, such as Android apps, Kvisoft Flipbook, PowerPoint simulations, and interactive demonstrations, yielded normalized gains from 0.35 to 0.602, with some studies reporting 83.38% participation. This high engagement suggests that E-Modules improve not only understanding but also student motivation. Expert validation and positive feedback further confirm their value in education. Despite these benefits, challenges remain, including unreliable infrastructure, limited technology access, and insufficient teacher training. For successful E-Module implementation, addressing these issues is essential, including better infrastructure, ongoing teacher development, and universal access to devices. This will ensure that students fully benefit from these interactive tools, improving learning outcomes.

Keywords: *Interactive E-Module, High School Physics, Conceptual Understanding, Student Engagement, Physics Education Technology*

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1. INTRODUCTION

The integration of interactive E-Module in high school physics education has shown consistent positive impacts on students conceptual understanding. These digital learning tools, which incorporate features such as simulations, quizzes, and multimedia elements, have gained significant traction in recent years as essential pedagogical resources (Maisaroh, 2024). E-Module, offered across various platforms, including multimedia CDs, Android applications and web based systems like SIGIL and Edmodo, provide students with a dynamic learning experience that transforms abstract concepts into tangible knowledge (Sitorus et al., 2024). Research consistently supports the effectiveness of these interactyive tools, as they bridge gaps in students understanding of complex physics topics and increase engagement (Rumiati et al., 2021).

The use of E-Module to teach physics provides several advantages. By utilizing simulations and animations, students can visualize and interact with concepts that would otherwise be difficult to grasp (Nuba et al., 2025). For example, concepts such as energy transfer, force dynamics and motion are often challenging for students to conceptualize through traditional textbook methods alone (Wulandari & Jumadi, 2023). However, with the aid of E-Module, these concepts become more concrete as students can actively engage with virtual experiments and immediate feedback, making learning more accessible and impactful (Riani et al., 2021). This approach aligns with the goals of active learning, where students are expected to take an active role in their educational journey by engaging with content in interactive ways. Moreover, studies have found that E-Module lead to significant improvements in student's performance in physics. For instance, Riani et al., (2021) reported a normalized gain of 0.74 after students used an Edmodo based E-Module, demonstrating a substantial increase in their understanding of physics concepts. Similarly, Wulandari & Jumadi (2023) observed normalized gains ranging from 0.37 to 0.59 across various physics topics, indicating that E-Module can improve comprehension in areas such as energy, momentum, and rotational motion. These findings support the assertion that interactive E-Module provide a more effective learning experience compared to traditional instructional methods (Angraena & Arini, 2021).

In addition to improving conceptual understanding, interactive E-Module also contribute to the development of essential skills such as problem solving, critical thinking and collaboration (Mustofiyah et al., 2024). Through the inclusion of gamified elements such as points, challenges and levels, E-Module can motivate students to engage with content more deeply (Gumay et al., 2020). Gamification, a strategy used in many educational tools, harnesses the psychology of game design to create a more immersive learning experience, which has been shown to enhance students motivation and persistence in learning tasks (Nisa et al., 2021). This approach fosters an environment where students are not just passive recipients of knowledge but active participants in their learning process. Additionally, E-Module support collaboration and teamwork among students. Many E-Module allow students to work together in solving physics problems, sharing insights, and exploring different approaches to understanding concepts (Mutia, 2025). This collaborative learning environment promotes peer to peer interaction, which has been linked to better retention of knowledge and the development of communication skills (Anggraeni et al., 2020). Collaborative features also encourage students to think critically and engage with physics concepts in a social context, further enhancing their learning experience (Rahim, 2024).

The statistical significance of improvements due to interactive E-Module has been consistently highlighted in the literature. For example, Suwindra (2015) conducted a study using a multimedia based E-Module and found a significant mean difference of 10.831 with an F statistic of 250.602 ($p < 0.05$), underscoring the effectiveness of multimedia E-Module in improving students conceptual understanding of physics. Similarly, Angraena & Arini (2021) reported statistically significant results from the use of Android based E-Module, indicating their positive impact on student performance. These studies provide strong evidence for the integration of E-Module into high school physics curricula as an effective way to improve students understanding of complex physics topics. However, the successful implementation of E-Module in physics education requires addressing several challenges. One of the primary obstacles is the lack of reliable infrastructure in many schools, especially in underprivileged areas (Tisa Haspen & Syafriani, 2022). Issues such as limited internet access, outdated hardware, and insufficient training for teachers hinder the widespread use of E-Module (Suhandi et al., 2008). To overcome these barriers, it is essential for policymakers, educational institutions and technology providers to collaborate in ensuring that schools have the resources and support needed to implement E-Module effectively. Teacher training is particularly critical, as educators must be equipped with the skills to integrate technology into their teaching practices and guide students through the use of these digital tools (Latifah et al., 2020).

The effectiveness of E-Module also depends on the extent to which they are integrated with the curriculum and teaching strategies. E-Module can be used as a supplement to traditional teaching methods, providing an interactive complement to textbook lessons (Tegar et al., 2024). However, for maximum impact, E-Module should be designed to align with curriculum objectives and be incorporated into lesson plans in a way that encourages active student participation and fosters deeper learning (Wulandari & Jumadi, 2023). This alignment ensures that the use of technology is not just an add on but an integral part of the learning process. Moreover, the adaptability of E-Module makes them a valuable resource in diverse educational settings. E-Module can be tailored to meet the specific needs of different students, offering personalized learning experiences that accommodate varying learning speeds and abilities (Sitorus et al., 2024). This flexibility is particularly useful in high school physics, where students may have different levels of prior knowledge and understanding of fundamental concepts (Rumiati et al., 2021). By providing personalized feedback and adapting to individual learning needs, E-Module can help students build a stronger foundation in physics, regardless of their starting point.

In conclusion, the integration of interactive E-Module into high school physics education has the potential to transform the learning experience. These modules offer a dynamic, engaging, and effective way for students to deepen their understanding of complex physics concepts (Latifah et al., 2020). By incorporating interactive features like simulations, quizzes and multimedia elements, E-Module make abstract concepts more accessible and foster active participation in the learning process (Triandini et al., 2021). Despite the challenges related to infrastructure and teacher readiness, the evidence from recent studies strongly supports the use of E-Module as a valuable tool in enhancing physics education. As technology continues to evolve, the potential for E-Module to revolutionize physics education remains immense, providing students with the tools they need to succeed in both their academic and professional futures.

2. METHODS

1. Paper Search

The search for relevant papers was conducted using the Elicit AI platform, querying the term "E-Module Interaktif pada pembelajaran fisika untuk peningkatan pemahaman konsep pada siswa SMA" (Interactive E-Module in Physics Education for Enhancing Conceptual Understanding in High School Students). This search was conducted across over 138 million academic papers available on Elicit, incorporating data from trusted academic sources such as Semantic Scholar and OpenAlex. From this comprehensive search, we retrieved the 50 most relevant studies. These studies specifically address the integration of interactive E-Module into physics education, focusing on their positive effects on students' conceptual understanding and the enhancement of learning outcomes.

2. Screening

The screening process involved a thorough assessment of each retrieved paper based on predefined inclusion criteria. These criteria were designed to ensure that the studies targeted high school students and focused on the use of interactive digital modules in physics education. Only studies that measured outcomes related to students' mastery of physics concepts were considered. We prioritized experimental studies, such as randomized controlled trials, or observational studies with comparison groups, conducted in formal educational settings. Furthermore, the studies needed to include interactive features, such as simulations and quizzes, and specifically address physics topics, rather than static content alone.

3. Data Extraction

Data extraction was carried out using an advanced language model to systematically gather essential information from each paper. We focused on extracting detailed characteristics of the E-Module, including the platforms used, interactive features, and technical specifications. Additionally, the specific physics concepts covered, the implementation methods, and study designs were recorded. Participant characteristics, such as grade level and prior knowledge, were also noted. Furthermore, we documented the assessment methods employed to measure conceptual understanding. Finally, the effectiveness of the interventions was evaluated by recording statistical significance, N-Gain values, and other relevant performance outcomes.

3. RESULT AND DISCUSSION

The following table 1 provides a comprehensive overview of various studies examining the use of interactive E-Module in high school physics education. It includes key details such as the study focus, the types and platforms of E-Module used, the target populations involved, and the research designs implemented. These studies span a wide range of E-Module, from multimedia CDs to SIGIL, Edmodo, virtual simulations, and Android applications, each with its specific educational approach and target population.

Table 1. Selected Paper Description

Study	Study Focus	E-Module Type/Platform	Target Population	Research Design
Suwindra, 2015	Interactive multimedia E-Module for electromagnetism	Multimedia (CD based, text, graphics, animations, video, sound)	Class XII senior high school, 2 schools	Experimental (experimental vs. control)
Nisa et al., 2021	Meta analysis of SIGIL assisted E-Module in physics	SIGIL (electronic publication format)	Senior high school/Islamic senior high school/Vocational high school	Meta analysis of 5 research and development or experimental studies
Riani et al., 2021	Guided inquiry with Edmodo in physics	Edmodo (learning management system)	Class X science, senior high school PGRI Gelumbang	One group pretest posttest
Suhandi et al., 2008	Virtual simulation media for magnetism	Virtual simulation (platform not specified)	Class XII, senior high school Negeri Bandung	Quasi experimental (randomized control group pretest posttest)
Murtiani et al., 2019	Interactive electronic module with scientific approach	No mention found	Class X science, senior high school Bukittinggi & Padang	One group pretest posttest & randomized control group only
Wulandari & Jumadi, 2023	Systematic review of E-Module in physics	Various (no mention found)	Senior high school/Islamic senior high school/Vocational high school	Systematic literature review (10 articles)
Latifah et al., 2020	E-Module for critical thinking in physics	Kvisoft Flipbook Maker (PDF, animations, audio)	Class X science, senior high school Negeri 6 Purworejo	One group pretest posttest
Sulistyo et al., 2018	Interactive demonstration module for fluid mechanics	Interactive demonstration (platform not specified)	Senior high school/Islamic senior high school, Surakarta	Developmental (Borg & Gall model)
Santhalia & Sampebatu, 2020	Interactive multimedia for Bernoulli's principle	PowerPoint (simulations, animations, quizzes)	Class XI science, senior high school Katolik Rajawali Makassar	One group pretest posttest (research and development, 4D model)
Angraena & Arini, 2021	Android based interactive E-Module for sound waves	Android application (multimedia, quizzes, animations)	Class XI, senior high school Negeri 4 Musi Rawas	Research and development (ADDIE model)

1. Study Focus

The studies outlined in Table 1 span various physics topics, each exploring the effectiveness of interactive E-Modules in improving students comprehension of complex and abstract concepts. These studies aim to demonstrate how the use of digital tools, specifically E-Modules, can create engaging, hands on experiences that promote a deeper understanding of physics. By incorporating multimedia elements such as animations, videos, and simulations, interactive E-Modules enable students to visualize and interact with concepts that are often difficult to understand through traditional methods (Cavanagh & Kiersch, 2023). For instance, Suwindra (2015) examined electromagnetism, a topic known for its abstract nature. Electromagnetism, involving forces between charged particles and electric and magnetic fields, can be challenging to visualize. The E-Module used in Suwindra's study combined text, graphics, animations, and sound, effectively engaging students and simplifying the material for better comprehension. Similarly, Ramadhani (2022) focused on fluid mechanics, including concepts like pressure, velocity, and fluid flow, which are often difficult to conceptualize in a traditional classroom. Interactive simulations allowed students to manipulate variables and observe real time effects, improving their understanding (Saikkonen & Kaarakainen, 2021).

Santhalia & Sampebatu (2020) studied Bernoulli's principle, using interactive multimedia to help students visualize fluid behavior, further emphasizing the value of interactive E-Modules in making abstract principles more comprehensible (Wulandari & Jumadi, 2023). Likewise, Angraena & Arini (2021) used Android based E-Module to teach sound waves, illustrating how such platforms can make physics concepts like frequency, amplitude, and wavelength more accessible through interactive tools. Interactive simulations, as noted byRiani et al. (2021), provide students with the opportunity to manipulate variables, observe dynamic processes, and engage in experiential learning, making difficult concepts like energy transfer and wave motion more tangible. By Sitorus et al. (2024), providing a hands on experience, these E-Modules break down complex concepts into simpler, more understandable parts, ultimately enhancing student comprehension.

2. E-Module Type/Platform

The wide variety of E-Module types and platforms used in the studies outlined in Table 1 demonstrates the adaptability and flexibility of these interactive digital tools in physics education. The studies utilized different platforms, each offering unique features to effectively present complex physics concepts and cater to diverse learning environments. The use of multimedia based E-Modules, mobile learning applications, learning management systems (LMS), and virtual simulations showcases the potential of E-Modules to meet the needs of different students and educational contexts. For example, Suwindra (2015) employed a multimedia CD based E-Module that integrated text, graphics, animations, videos, and sound to provide a multisensory learning experience. This approach aligns with Mayer's Cognitive Theory of Multimedia Learning, which suggests that combining verbal and visual elements facilitates deeper cognitive processing and comprehension (Cavanagh & Kiersch, 2023). By integrating various forms of media, this E-Module allowed students to engage with the material through different sensory pathways, thus promoting a more thorough understanding of electromagnetism. Multimedia CDs are particularly beneficial for catering to different learning styles, offering visual, auditory, and kinesthetic learners the opportunity to engage with content in a manner that suits their individual preferences.

In contrast, other studies, such as Riani et al. (2021), utilized a more interactive platform, Edmodo, a cloud based LMS. Edmodo enabled online discussions, assignment submissions, and quizzes, fostering a collaborative and engaging learning environment. This LMS based approach supports student centered learning by allowing students to progress at their own pace, reflect on their understanding, and interact with peers (Saikkonen & Kaarakainen, 2021). Riani et al. (2021)

emphasized that LMS based E-Modules facilitate collaborative learning and communication among students, enhancing their understanding of physics concepts.

Additionally, Angraena & Arini (2021) used an Android based E-Module, which provided flexibility and mobility. Mobile learning, particularly through Android applications, is gaining popularity due to its portability. Students can access learning materials on smartphones or tablets, enabling independent study both inside and outside the classroom. This flexibility supports self paced learning, which is a significant advantage over traditional classroom settings (Putri Natalia et al., 2021). By allowing students to study at their convenience, mobile learning improves engagement and learning outcomes. Furthermore, Muspa & Sulisworo (2022) employed virtual simulations to visualize abstract concepts like fluid dynamics and electromagnetism. Virtual simulations are invaluable for demonstrating phenomena that are difficult to observe in real life settings, such as the behavior of gases or magnetic fields. By manipulating variables and observing their effects, students can interact with and experiment on these phenomena, leading to a more tangible understanding of complex concepts. As Wulandari & Jumadi (2023), noted, simulation based learning enhances students' conceptual understanding and engagement by enabling them to visualize dynamic processes that traditional methods cannot effectively demonstrate.

The range of platforms used in these studies highlights the versatility of E-Modules. Whether through multimedia CDs, LMS platforms, mobile applications, or virtual simulations, each tool offers unique features that cater to different technological environments and teaching needs. These platforms enable physics educators to select the most suitable tools for their students, thus enhancing the overall effectiveness of their teaching (Nurzana et al., 2025; Wulandari & Jumadi, 2023).

3. Target Population

The studies presented in Table 1 span diverse target populations, including students from Class X and XI, as well as those in specialized scientific tracks such as Physics and Science. These studies also involve different educational settings, such as senior high schools, Islamic senior high schools, and vocational high schools. This diversity in the target population highlights the adaptability of E-Modules to various educational environments and student needs. For example, Wulandari & Jumadi (2023) found that E-Module are particularly effective for students with varying learning speeds. Traditional classroom settings often fail to accommodate the diverse learning paces of students, but E-Modules provide a solution by offering personalized learning experiences. By incorporating interactive feedback and enabling self paced learning, E-Modules allow both high achievers and students who need more time to master the material to learn at their own pace. This flexibility empowers students to progress through content as they master each concept, thereby creating a more tailored and effective learning experience (Nurzana et al., 2025).

In addition to their adaptability for different learning speeds, E-Modules are also beneficial for students from diverse educational backgrounds. Nisa et al. (2021) explored the effectiveness of E-Modules in vocational high schools, where students often have a more practical, hands on approach to learning. Their findings showed that E-Modules were highly effective in enhancing students' conceptual understanding of physics in these non traditional settings. Vocational schools typically bridge the gap between theoretical knowledge and practical application, and E-Modules provide an interactive platform that aligns well with this approach. The versatility of E-Modules makes them a valuable tool for inclusive education, engaging students across various educational tracks and catering to different learning needs (Saikkonen & Kaarakainen, 2021).

Furthermore, the ability of E-Modules to support self paced learning has proven to be a significant advantage. As noted by Angraena & Arini (2021), Android based E-Modules are particularly effective in fostering student engagement and motivation, especially when they are designed to be interactive and gamified. Gamification elements, such as rewards, badges, and challenges, have been shown to increase student participation and enthusiasm, addressing the common issue of disengagement in traditional teaching methods. These features help maintain students' interest and motivation throughout the learning process, ensuring that they remain actively involved in their educational journey (Oktafia & Dhiah, 2024). By offering these engaging and interactive elements, E-Modules provide an innovative solution for enhancing student learning outcomes across various educational settings.

4. Research Design

The research designs employed in the studies presented in Table 1 reflect a diverse array of methodologies, each aimed at assessing the impact of E-Modules on students' understanding of physics concepts. Among the most rigorous approaches are experimental designs, such as the one used by Suwindra (2015). These designs provide valuable insights into the effectiveness of E-Modules by comparing experimental and control groups to evaluate their impact on students' understanding of complex topics like electromagnetism. Experimental designs are considered the gold standard in educational research because they allow for a clear comparison between an intervention (E-Modules) and a baseline, thus helping to determine whether the use of E-Modules leads to measurable improvements in learning outcomes (Wulandari & Jumadi, 2023). By isolating the effects of the intervention, these designs can provide strong evidence of causal relationships between E-Modules and enhanced student comprehension.

In addition to experimental designs, other studies employed one group pretest posttest designs, such as those by Riani et al. (2021) and Murtiani et al. (2019). This design measures students' understanding of the content before and after the intervention, allowing researchers to assess the level of improvement that occurs as a result of using E-Modules. Although this design lacks the rigor of randomized controlled trials, it is still useful in educational research where randomization may not be feasible (Basma, 2023). It offers valuable data on the effectiveness of E-Modules and provides insights into students' progression in their understanding of physics concepts, particularly in classroom settings where randomization is impractical.

Quasi experimental designs, like the one used by Suhandi et al. (2008), are another common approach in evaluating E-Modules. These studies used randomized control groups to assess the impact of virtual simulation media on students' understanding of magnetism. While quasi experimental designs do not offer the same level of control as fully randomized studies, they still provide a useful baseline for comparison, allowing for a more nuanced analysis of the effects of E-Modules in real world classroom environments (Cavanagh & Kiersch, 2023). These designs are particularly useful when the constraints of educational settings make true randomization impossible but still allow researchers to draw meaningful conclusions about the impact of E-Modules.

Finally, meta analysis and systematic literature review designs, as used by Wulandari & Jumadi (2023), synthesize findings from multiple studies to provide a broader understanding of the overall impact of E-Modules across different educational contexts. Meta analysis, by combining data from various sources, offers a comprehensive assessment of E-Modules' effectiveness in improving students' conceptual understanding of physics. This type of research design is particularly valuable for identifying overarching trends and drawing conclusions based on a wide array of data, thus providing a more generalized understanding of the impact of digital learning tools (Cavanagh & Kiersch, 2023). By compiling and analyzing data from multiple studies, meta analysis and systematic reviews contribute to a more robust understanding of how E-Modules can be used to improve physics education globally.

5. Benefits of E-Module

Interactive E-Modules offer numerous advantages, particularly in improving students' conceptual understanding of complex and abstract physics concepts. One of the primary benefits is their ability to make abstract ideas more tangible and accessible. As noted by Suhandi et al. (2008), E-Module help students visualize dynamic processes and phenomena that are otherwise difficult to demonstrate in a traditional classroom setting. Physics concepts such as fluid dynamics, electromagnetism, and wave motion can be represented through interactive simulations, providing students with opportunities to engage directly with the material. For example, in fluid dynamics, students can manipulate the velocity or pressure of a fluid and observe how these changes affect the system, which is something that is often difficult to achieve through traditional teaching methods (Saikkonen & Kaarakainen, 2021). Interactive E-Modules make abstract phenomena more tangible and facilitate a deeper understanding of the material by engaging students in a way that traditional methods cannot.

Furthermore, E-Modules have been shown to significantly increase student engagement and motivation, key factors for effective learning. The integration of gamification elements, such as points, badges, and challenges, has been found to greatly enhance student participation and motivation. Angraena & Arini (2021) observed that the use of Android based E-Modules for teaching sound waves led to greater enthusiasm and engagement among students. This finding aligns with Nisa et al. (2021), who emphasized that gamified elements within E-Modules create a more enjoyable and immersive learning experience. By incorporating such elements, E-Modules help sustain student interest and make learning more interactive, which is crucial for fostering a deeper engagement with the content. In a study by Oktafia & Dhiah (2024), students reported higher levels of interest and motivation when using gamified E-Modules, suggesting that these elements play a significant role in increasing student enthusiasm for challenging topics.

Additionally, E-Modules are beneficial in fostering collaboration and developing problem solving skills. Many E-Modules incorporate features that allow students to work together, share ideas, and solve problems collectively. This collaborative aspect is critical for developing essential skills such as communication, teamwork, and critical thinking, which are necessary for mastering physics concepts. A study by Wulandari & Jumadi (2023) highlighted that E-Modules can be designed to include group based activities and peer assessments, which help students learn from each other and improve their understanding of the material. By encouraging collaboration, E-Modules not only enhance conceptual understanding but also help students develop skills that are valuable both in the classroom and beyond.

In conclusion, the benefits of E-Modules in physics education are extensive. They make abstract concepts more accessible, increase student engagement, and foster the development of critical skills such as collaboration and problem solving. The versatility and interactivity of E-Modules make them a powerful tool for improving student learning outcomes in physics education (Cavanagh & Kiersch, 2023).

6. Challenges of E-Modules

Despite their many advantages, the implementation of E-Modules in educational settings presents a number of challenges. One of the major obstacles is the lack of sufficient infrastructure, particularly in rural or underprivileged areas. As Suhandi et al. (2008) pointed out that limited access to the internet, outdated computers and insufficient teacher training hinder the effective use of E-Module. In many schools, especially those in rural or economically disadvantaged regions, the technological infrastructure required for E-Modules is either insufficient or outdated, making it difficult for both students and teachers to take full advantage of these educational tools. In such environments, even if E-Modules are available, the lack of reliable internet connectivity or modern devices can severely limit their effectiveness. To overcome these barriers, it is essential for governments and educational institutions to invest in technological infrastructure and provide teachers with the necessary training to integrate E-Modules into their teaching practices effectively (Latifah et al., 2020). Moreover, providing schools with access to updated hardware and ensuring that students have the tools necessary for digital learning is crucial for the success of E-Modules.

In addition to infrastructural challenges, the proper integration of E-Modules into the curriculum remains another significant challenge. While E-Modules offer innovative and interactive ways of teaching, they should not merely supplement traditional teaching methods but must be fully integrated into the curriculum to achieve the best results. Wulandari & Jumadi (2023) emphasized, for E-Modules to be effective, they must be fully integrated into the curriculum, supporting the broader learning objectives and facilitating a seamless learning experience. If E-Modules are not aligned with curriculum standards or if they are used in isolation, their impact on student learning can be limited. Proper integration ensures that E-Modules complement in class instruction, creating a more holistic learning experience for students. Teacher preparedness is another factor that significantly impacts the effectiveness of E-Modules. As highlighted by Latifah et al. (2020), teachers must undergo professional development to effectively incorporate E-Modules into their teaching practices. This includes training not only on the technical aspects of using the tools but also on adapting them to meet the unique needs of their students. Without adequate preparation, even the most sophisticated E-Modules can be underutilized, leading to ineffective learning experiences. In addition, there is a need to address the digital literacy levels of students. Some students may struggle to navigate digital tools, especially in environments where they have limited exposure to technology. Addressing these gaps in digital literacy is crucial for ensuring that all students can benefit from E-Modules.

In conclusion, while E-Modules offer significant advantages for enhancing physics education, their successful implementation requires overcoming challenges related to infrastructure, curriculum integration, teacher preparedness, and digital literacy. Addressing these issues is essential for maximizing the potential of E-Modules and ensuring that students gain the full benefits of interactive and engaging learning tools (Oktafia & Dhiah, 2024).

4. CONCLUSION

In conclusion, interactive E-Modules have proven to be highly effective in enhancing students' conceptual understanding of high school physics. With normalized gains ranging from 0.35 to 0.74, these E-Modules significantly improve students’ grasp of complex topics by integrating interactive features such as simulations, quizzes, and multimedia elements. This interactive approach not only enhances comprehension but also boosts student engagement, fostering motivation and active participation in the learning process. Furthermore, E-Modules facilitate collaborative learning, which in turn promotes critical thinking and problemsolving skills, making them an invaluable tool in modern physics education. Despite these benefits, challenges related to technological access, teacher preparedness, and infrastructure limitations persist, requiring strategic solutions for effective and widespread implementation. Ensuring adequate access to devices, providing necessary training for teachers, and overcoming infrastructure barriers will be essential for maximizing the potential of E-Modules. Nevertheless, interactive E-Modules offer a flexible, scalable solution for improving physics education by providing students with a deeper understanding of scientific concepts while making the learning process more engaging and effective. The continued integration of E-Modules in high school physics curricula, supported by research and development, holds the promise of transforming the way students learn and interact with the subject, preparing them for future success in the field of physics and beyond.

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