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Enhancing physics learning through the 7E learning cycle model: A systematic literature review

Maryam Musfiroh[1], Irma Rahma Suwarma[2], Ridwan Efendi[3*]
[1,2,3]Department of Physics Education, Universitas Pendidikan Indonesia, Bandung, Indonesia

* *Corresponding author:* ridwanefendi@upi.edu

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ABSTRACT

This study aims to explore the application of the 7E learning cycle model (Elicit, Engage, Explore, Explain, Elaborate, Evaluate, and Extend) in physics education to enhance learning effectiveness. The method employed is a systematic literature review, with articles sourced from the Scopus database. A total of 16 articles were selected through screening using the PRISMA protocol. The analysis results indicate that the 7E learning cycle model significantly improves various student skills, including science process skills, motivation, critical and creative thinking skills, self-efficacy, conceptual understanding, and scientific literacy. Popular topics discussed include temperature and heat, static fluids, work and energy, the solar system, and Earth's systems. Additionally, this model can be integrated with other teaching methods and innovative learning media to boost student interest and motivation. In conclusion, the 7E learning cycle model is an effective approach that contributes to enhancing the quality of physics education. This study's implications provide practical guidance for educators in applying the 7E learning cycle model.

Implementasi model pembelajaran siklus 7E dalam pembelajaran fisika: Tinjauan pustaka sistematis

Kata Kunci:

model pembelajaran siklus 7E, pembelajaran fisika, tinjauan pustaka sistematis,

ABSTRAK

*Penelitian ini bertujuan untuk mengeksplorasi penerapan model pembelajaran siklus 7E (*Elicit, Engage, Explore, Explain, Elaborate, Evaluate, and Extend*) dalam pembelajaran fisika guna meningkatkan efektivitas pembelajaran. Metode yang digunakan adalah tinjauan pustaka sistematis dengan pencarian artikel pada database Scopus. Sebanyak 16 artikel dipilih melalui penyaringan menggunakan protokol PRISMA. Hasil analisis menunjukkan bahwa model pembelajaran siklus 7E secara signifikan dapat meningkatkan berbagai kemampuan siswa, termasuk keterampilan proses sains, motivasi, keterampilan berpikir kritis dan kreatif, self-efficacy, pemahaman konseptual, serta literasi sains. Topik populer yang banyak dibahas meliputi suhu dan kalor, fluida statis, usaha dan energi, tata surya, dan sistem bumi. Selain itu, model ini dapat diintegrasikan dengan model pembelajaran lain dan media inovatif untuk meningkatkan minat dan motivasi siswa. Kesimpulannya, model siklus 7E adalah pendekatan efektif yang berkontribusi pada peningkatan kualitas pembelajaran fisika. Implikasi penelitian ini memberikan panduan praktis bagi pendidik dalam mengaplikasikan model siklus 7E.*

Contribution to the literature

This research contributes to:

- Filling the gap in the literature that lacks systematic analysis of the 7E learning cycle model in physics education.
- Integrating empirical findings from various studies to provide a comprehensive overview of the effectiveness and practical application of the 7E cycle model.
- Providing a deeper and more thorough understanding of the effectiveness of the 7E model in supporting learning.

1. INTRODUCTION

In the current era of technology and information, the development of students' critical and analytical thinking skills is very important [1]. To achieve this, physics education has a significant role because physics not only teaches scientific concepts but also trains students to think logically and systematically [2]. However, there are still great challenges in teaching physics, especially when dealing with abstract concepts that are often difficult for students to understand [3]. This becomes even more complex when we consider that many students have difficulty linking theory to practice, often resulting in confusion and incomprehension. Similarly, the lack of motivation to learn is a challenge that needs to be addressed by educational actors [4]. Various challenges often hinder the achievement of optimal learning outcomes in traditional physics teaching. Conventional teaching, which often relies on lectures from the teacher and the center of attention on the teacher, is not very effective in improving students' understanding of concepts and critical thinking skills [5]. The low interest and motivation of students in learning physics are due to their difficulty in internalizing abstract concepts. In addition, the application of non-interactive teaching methods often fails to motivate students to actively participate, which is very important in developing deep understanding and analytical skills. In this situation, there is a critical need to develop and implement more creative and interesting learning methods that can stimulate students' curiosity and interest in physics [6].

One promising approach to addressing this challenge is the implementation of a recent learning model known as the 7E cycle model. This model focuses not only on teaching content but also on the learning process that actively engages students [7]. In the context of physics education, the 7E cycle learning model offers an innovative way to bridge the gap between theory and practice. The model consists of seven stages: Elicit, Engage, Explore, Explain, Elaborate, Evaluate, and Extend [8]. Each stage is designed to gradually build students' understanding, from extracting prior knowledge to applying concepts in a broader context. With this approach, students are not only recipients of information but also active researchers involved in the learning process. This allows them to develop critical and analytical thinking skills that are much needed in today's modern world [9].

The 7E cycle model has been proven effective in improving interactivity and meaningfulness in the physics learning process [10]. Based on constructivism, this model emphasizes students' active participation in the learning process, providing opportunities for students to construct their knowledge through exploration and reflection. In the context of physics education, this model is very relevant as it can help students understand complex concepts better. For example, at the Engage stage, students are invited to engage in discussions or activities that spark their curiosity. In contrast, at the Explore stage, they are given the opportunity to conduct experiments and observations [11]. In this way, students not only learn theoretically but also gain in-depth practical experience. This model is also able to overcome the weaknesses of traditional learning methods that tend to be passive and lack student interest [12]. Thus, the application of the 7E cycle model is expected to significantly improve student learning outcomes in physics.

The purpose of this study is to conduct a comprehensive investigation into the application of the 7E cycle learning model in physics education, as well as assess the achievements made through its implementation. In conducting this literature review systematically, we hope to identify the advantages and disadvantages of the 7E cycle learning model by taking into account empirical findings from a number of published studies. In addition, the aim of this study is also to provide practical suggestions for educators to adopt and improve the effectiveness of the learning model in physics classrooms. In doing so, it is hoped that this research will contribute significantly to the development of more successful and creative methods of teaching physics, as well as to the overall level of physics education.

While there have been many studies on various aspects of the 7E learning cycle model in physics education, there are some limitations that point to the need for more in-depth studies. This is also the research gap in this study. Results from previous studies are often difficult to generalize due to the focus on implementing the model in specific contexts and with limited samples. In addition, many studies adopted a variety of methodological designs, creating variations in findings that are difficult to fully synthesize. Not all studies have done a thorough deep dive to explore how each stage in the 7E cycle can impact students' concept understanding and critical thinking skills. The existing literature lacks systematic analyses that combine these findings to provide a comprehensive picture of the effectiveness of the 7E cycle learning model. This research aims to fill this gap by conducting a thorough and systematic literature review, which will not only identify key findings but will also integrate empirical evidence from various studies to provide a more in-depth and reliable understanding.

Previous studies have been conducted on the application of the 7E learning cycle model in physics education using various approaches. These include the development of 7E-based student worksheets to enhance students' science process skills [13], the integration of the 7E model with Google Classroom to improve student's critical thinking skills [14], the development of high school physics teaching materials through the 7E learning cycle model [15], and the implementation of a STEM-based 7E cycle model to foster students' creative thinking skills on the topic of temperature and heat [16]. However, most of these studies focus on the implementation of the model in specific contexts or populations without providing a comprehensive and systematic analysis of its effectiveness and practical application across diverse learning environments.

This study aims to systematically examine the application of the 7E learning cycle model in physics education through a literature review that encompasses a comprehensive analysis of empirical findings from various studies. The findings contribute significantly to providing a deeper synthesis of knowledge regarding the effectiveness of the 7E model while offering practical recommendations for educators to optimize its implementation. Moreover, this study highlights opportunities for developing more integrated learning innovations using technology and other learning media to improve the quality of physics education.

2. METHOD

Systematic Literature Review (SLR) is an important methodological approach in systematically and transparently identifying, assessing, and synthesizing research findings on a specific research question [17]. In the context of this study, SLR aims to comprehensively assess the applicability and effectiveness of the 7E cycle learning model in physics learning. This research will not only provide evidence-based guidance for educators but also direct future research to improve the effectiveness of the 7E cycle learning model in physics teaching. After receiving ethics approval, the research was conducted.

The study applied stringent inclusion and exclusion criteria to ensure the quality and relevance of the literature analyzed. Inclusive criteria include: (1) the literature used should be opensource articles that all researchers and practitioners can access; (2) the literature used must have been published between 2018 and 2024 in order to ensure recent information; (3) type of literature required is journal papers or conference proceedings, which normally undergo strict peer-review process; as well as (4) taken articles touch on the 7E cycle learning model in physics learning. Conversely, exclusive criteria consist of (1) inaccessible literature; (2) publication years before 2018; (3) reports, books, and theses that may not possess the same level of validity as journal articles or conference papers in terms of peer-review as well as other requirements for content types like things like dissertations, monographs, etc.; also number four is articles on something else other than 7E-cycle teaching model. By applying these criteria, the research aims to ensure that the analysis is based on relevant, high-quality, and up-to-date literature.

To ensure the comprehensiveness and accuracy of the literature search results, this study uses the Scopus database, which is well-known as one of the databases with a high reputation and coverage of quality articles [18]. This literature search was conducted using Boolean operators to obtain the most complete papers. The keywords used were TITLE-ABS-KEY ("Learning Cycle 7E" OR "7E Learning Cycle" OR "7E model"). On June 6, 2024, at 18:55, this search was conducted. This strategy was designed to identify the most relevant articles and interesting news about recent physics 7E cycle learning. With a similar approach, it is expected that comprehensive and up-to-date literature will be obtained on which to base robust analyses in this study. The study selection process herein follows the PRISMA workflow (Preferred Reporting Items for Systematic Reviews and Meta-Analyses), which encompasses several crucial stages to ensure that only relevant and high-quality literature is included in the analysis [19].

At the identification stage, an initial search using pre-determined keywords (TITLE-ABS-KEY("Learning Cycle 7E" OR "7E Learning Cycle" OR "7E model")) in the Scopus database yielded 74 articles. All of these articles were then documented for further steps. The screening stage involves sifting through articles based on predefined inclusion and exclusion criteria. Out of 74 initial articles, some of them were excluded from further consideration because they did not meet certain criteria: 13 publications before 2018, 22 without open access, and one non-journal article or conference/proceedings paper. After this screening process, 38 papers were remaining for the next phase.

The remaining articles are checked manually at the eligibility stage to verify their relevance to the research topic: the 7E learning cycle model in physics teaching. This process requires researchers to read abstracts and, if necessary, full texts of each article. The result was that 22 articles were not relevant to the topic, and therefore, they had to be excluded. The final stage included producing sixteen articles that met all inclusion criteria and were pertinent to the research topic. These articles were then subjected to an in-depth analysis in this SLR so as to identify trends, key findings, and gaps in literature related to 7E learning cycle models in physics education. The extracted data included basic bibliographic information such as author and year of publication, and the main results of each study were also recorded relating to the application of the 7E cycle learning model in physics learning. The research stages can be described in a PRISMA diagram (Figure 1).

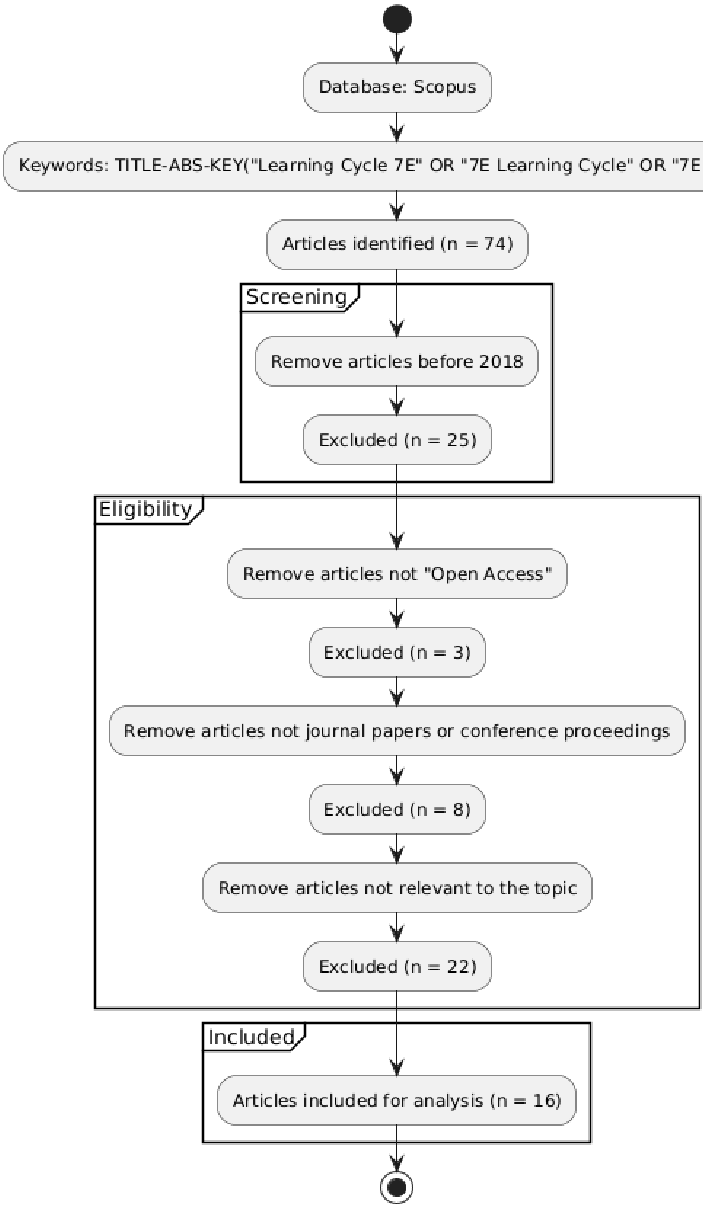

Figure 1. Flow Diagram Detailing the Application of PRISMA to Studies Published Between 2018 and 2024

3. RESULTS AND DISCUSSION

In this section, we present the key findings of our research in terms of the 7E cycle model implemented in physics learning and its implications for students' learning outcomes. The analysis provides an overview of how the 7E cycle model (Table 1) is applied in physics learning and its influence on students' ideas and achievement regarding the taught physics concepts.

Table 1. Result of Analysis

No	Title	Main Findings
1	Development of Student Worksheet Based on Learning Cycle 7E to Improve Science Skills of 7 Th Grade Junior High School Students	The use of Learning Cycle 7E-based worksheets significantly improved students' science skills.
2	Potential 7E Learning Cycle Model for Improving Critical Thinking Integrated with Google Classroom	The results showed that implementing the 7E Learning Cycle model integrated with Google

		Classroom can significantly improve students' critical thinking skills.
3	Application of Learning Model (Lc) 7E with Technology-Based Constructivist Teaching (TBCT) And Constructivist Teaching (CT) Approach as Efforts to Improve Student Cognitive Ability in Static Fluid Concepts	significant improvement in the cognitive abilities of students taught with the LC 7E model and the TBCT and CT approaches compared to the control group using conventional methods.
4	Development of 7E Model Lesson on Earth Systems: A Lesson Study	The application of the 7E model in earth system learning can increase student engagement and concept understanding.
5	The Influence of Stem-Based 7E Learning Cycle on Students Critical and Creative Thinking Skills in Physics	There is a significant increase in students' critical and creative thinking skills after the implementation of the STEM-based 7E learning cycle.
6	Developing the Innovative Inquiry-Based Lesson Plan Through Lesson Study	The use of inquiry-based approaches in lesson plans can increase student motivation and engagement. In addition, the authors also found that collaboration among teachers during the lesson study process is essential for professional development and improving teaching quality.
7	The 7E Learning Cycle Approach to Understand Thermal Phenomena	The 7E approach is effective in improving students' understanding of thermal phenomena.
8	The Influence of Stem-Integrated 7E Learning Cycle on Students' Creative Thinking Skills in The Topic of Temperature and Heat	There is a significant increase in the creative thinking skills of students taught using the 7E integrated STEM learning model.
9	Developing High School Physics Teaching Materials Through 7E Learning Cycle Model	The teaching materials developed through the 7E model received positive responses from students and teachers. Students felt more interested and motivated to learn physics, while teachers felt that the teaching materials helped them deliver the material more effectively.
10	The Effectiveness of the 7E Learning Cycle Model to Improve Student Motivation in Work and Energy Topic	The 7e cycle learning model is effective in increasing student motivation
11	Effect Size Test of 7E Learning Cycle Model: Conceptual Understanding and Science Process Skills on Senior High School Students	The effect size obtained shows that the 7E Learning Cycle model has a large impact on concept understanding and science process skills.
12	Analysis of Science Process Skills Using Learning Cycle 7E	The 7e cycle learning model is effective in improving students' science process skills
13	The Effectiveness of The Learning Cycle Model (5E And 7E) in Learning to Build Flat Side Sides Viewed from Student Self-Efficacy	There was a significant increase in students' self-efficacy after the implementation of the 5E and 7E learning models. However, a greater increase was seen in the group using the 7E model.
14	Development of Lesson Plan Learning Cycle 7E Models Integrated Web Formative Assessment and Self-efficacy	The application of the 7E cycle learning model integrated with web-based formative assessment can significantly improve students' understanding and self-efficacy.
15	Development of Teaching Material Solar System Using Learning Cycle 7E Model Completed with Augmented Reality	The developed teaching materials succeeded in increasing students' interest and understanding. Augmented reality provides an interactive learning experience and allows students to see objects directly.
16	Exploration of Students' Scientific Literacy in Work and Energy Through Stem-Based 7E Learning Cycle with Formative Assessment	The implementation of the STEM-based 7E learning cycle significantly improved students' scientific literacy. Formative assessment provides constructive feedback for students so they can evaluate their understanding continuously.

Based on the results obtained, the application of the 7E cycle learning model can consistently improve student learning outcomes in physics subjects, especially by promoting several aspects such as science process skills, concept understanding, critical and creative thinking skills, and learning motivation. Some studies also show that the 7E cycle learning model is effective in creating an interactive and student-centered learning environment. The following is a synthesis of some relevant studies:

3.1 Improved Science Process Skills

The application of the 7E Cycle learning model in physics has shown significant results in improving science process skills [13]. According to research conducted by Widodo and Hazimah, students who learned using Cycle 7E-based worksheets showed significant improvement in their science skills [20]. The study found that the use of this model improved not only concept understanding but also practical skills in conducting experiments and analysis. The data showed that 85% of students experienced an increase in science process skills after participating in learning with this model. The results of Khairani prove that the 7E cycle learning model is able to improve students' science process skills with high effectiveness, especially in terms of asking questions, formulating hypotheses, and finding patterns and relationships [21]. Meanwhile, the findings by Hartini show results stating that although the teaching materials used are practical, their effectiveness still needs to be improved in order to achieve the minimum completeness criteria. However, further practice is needed so that the component "can conclude the results" can improve well [15].

3.2 Conceptual Understanding and Mastery of Material

The application of the 7E cycle model in physics learning has shown significant improvements in conceptual understanding and mastery of the material among students. Statistics showing the effectiveness of this model are also reinforced by Utami and Widowati [14], who state that students involved in learning using the 7E model showed better results in conceptual understanding tests compared to students learning with traditional methods. This shows that the application of this model can create a more interactive and interesting learning environment so that students are better able to understand complex physics concepts. Another relevant case example can be seen in the research of Miadi, who applied the 7E model in learning static fluid concepts. The results showed that students who learned with this model had a better understanding of the basic principles of fluid compared to the conventional method [22]. In addition, students also showed improvement in the ability to analyze and synthesize information, which is an important indicator of deep conceptual understanding. Parno found that the application of the STEM-based 7E model can explore physics concepts independently and collaboratively, which in turn strengthens their understanding of the material [16]. Furthermore, research by Komikesari showed that the 7E model has a positive influence on conceptual understanding, showing a significant improvement in their learning outcomes, as measured through conceptual understanding tests and science process skills [13]. Overall, the application of the 7E cycle model in physics learning is proven to be effective in improving students' conceptual understanding and material mastery.

3.3 Improved Learning Motivation

The application of the 7E cycle model in physics learning has proven to be effective in increasing student learning motivation. According to Anisah, students involved in learning using this model showed a significant increase in learning motivation, especially on the topic of work and energy [23]. The increase in motivation score from 59.86 to 89.54 with an N-gain of 0.72 indicates a high increase in motivation. This can be explained through several factors that support student engagement, such as a more interesting learning experience and the relevance of the material taught to everyday life. One important aspect of the 7E cycle model is the Engage phase, where students are invited to be actively involved in the learning process from the beginning. In this phase, teachers can use various strategies, such as provocative questions or interesting demonstrations, to attract students' attention. Research results show that students who feel interested and involved in learning tend to have higher motivation [20]. For example, when students are given the opportunity to conduct simple experiments related to physics concepts, they are more motivated to learn further.

The Explore phase in this model also plays an important role in increasing motivation. In this phase, students are given the opportunity to investigate and explore independently or in groups. Research by Miadi *et al.* [22] shows that students who engage in active exploration tend to be more excited and motivated in learning. For example, students who conduct experiments on Archimedes' law will better understand the concept and feel more confident in their abilities. Furthermore, the Explain phase provides an opportunity for students to discuss their findings and get explanations from the teacher. This discussion process not only improves concept understanding but also gives students a sense of ownership of their learning process. According to Utami and Widowati [14], group discussions can increase student engagement and foster their interest in the subject matter. By understanding that their opinions are valued, students will be more motivated to actively participate in learning. The Elaborate and Evaluative phases also contribute significantly to increasing learning motivation. In the Elaborate phase, students are invited to relate the concepts they have learned to real situations or more complex problems. This helps students see the relevance of physics in everyday life, which in turn increases their motivation to learn more deeply. Meanwhile, the evaluation phase allows students to reflect on their learning process and see the progress they have made. According to Parno *et al.* [16], this reflection is important to build students' confidence and motivation in learning.

3.4 Creativity and Critical Thinking Skills

The implementation of the 7E cycle model in physics learning has been proven to have a positive impact on improving students' creativity and critical thinking skills. Research by Parno *et al.* [16] showed that the implementation of this model can significantly improve students' critical thinking skills, especially in the context of complex physics learning. In the study, students involved in learning with the 7E cycle model showed improvements in the ability to analyze and synthesize information, which are key components of critical thinking. One important aspect of the 7E cycle model is its ability to create a collaborative learning environment. In a study conducted by Utami and Widowati [14], students who learned in small groups using this model were better able to express their opinions and creative ideas. Group discussions that occur during the Explore and Elaborate stages allow students to learn from each other and develop new ideas, which in turn enhances their creativity. The data showed that students who engaged in this collaboration-based learning scored higher in the creativity assessment compared to students who studied individually.

In addition, the 7E cycle model also provides opportunities for students to explore physics concepts in depth. In a study by Miadi *et al.* [22], it was found that when students were given the opportunity to conduct experiments and investigate physics phenomena directly, they not only understood the concepts better but were also able to develop more complex questions. This shows that active exploration encourages students to think critically and creatively as they have to formulate hypotheses, design experiments, and analyze the results. Statistics obtained from several studies show a significant increase in students' critical thinking skills after the application of the 7E cycle model. For example, in a study by Putri [24], students involved in STEM-based learning with the 7E model showed a 25% increase in the average score on the critical thinking skills test after following the learning. This improvement shows that the 7E cycle model is not only effective in improving conceptual understanding but also in honing critical thinking skills that are crucial in today's information age.

3.5 Learning Tool Development with Innovation and Technology

The development of technology-based learning tools to support the 7E Cycle model is very diverse. One example is the development of student worksheets (LKS) specifically designed to implement each stage in the 7E model. Widodo and Hazimah [20] found that the use of LKS based on the 7E Cycle model can improve students' science skills. This study showed that students who used 7E-based worksheets had better learning outcomes compared to students who used conventional methods. In addition to the LKS, the use of online learning platforms such as Google Classroom has been proven effective in supporting the 7E model. Utami and Widowati [14] showed that the integration of the 7E model with Google Classroom can improve students' critical thinking skills. In the study, students who learned through this platform showed significant improvement in critical thinking skills compared to traditional methods. This shows that technology can be a powerful tool in supporting physics learning.

The development of learning tools with technological innovation can include the use of visual aids, interactive simulations, and web-based applications that support physics learning. For example, the use of augmented reality (AR) in physics learning has been shown to improve students' understanding of abstract concepts such as the solar system [25]. With AR technology, students can see three-dimensional models of the planets and understand the relationships between them more engagingly and intuitively. This is in line with research showing that technology-based learning can increase student engagement and strengthen concept understanding [15].

Innovation in the development of learning tools is not only limited to the use of technology but also includes creative pedagogical approaches. For example, Miadi *et al.* [22] developed a technology-based learning model with a constructivist approach integrated with the 7E model. This study showed that students who engaged in constructivist learning with technology support had better cognitive abilities in understanding the concept of static fluid. This shows that innovation in learning approaches can improve the effectiveness of physics learning. In addition, research by Parno *et al.* [16] showed that the application of the 7E model based on STEM (Science, Technology, Engineering, and Mathematics) can improve students' critical and creative thinking skills. In this study, students who followed STEM-based learning showed a significant increase in critical and creative thinking skills compared to students who did not follow the model. Parno *et al.* [26] also found that the use of STEM-based learning modules integrated with the 7E cycle helped them link physics concepts with real-world applications. By linking physics learning with other disciplines, students can see the relevance of physics in everyday life and develop more holistic skills. By connecting physics to real-life applications, students gain relevance, holistic skills, and greater motivation to learn.

Prill *et al.* [27], in their research, showed that the development of inquiry-based lesson plans through lesson study can improve students' concept understanding in physics. The results showed that students involved in inquiry-based learning showed a significant increase in concept understanding. In the context of implementing the 7E model, it is also important to involve students in the learning process. The development of learning tools that encourage collaboration and discussion among students can enrich their learning experience. The use of lesson study as a method of developing learning tools allows teachers to collaborate in designing learning plans that are more effective and in accordance with student needs. Through this collaboration, teachers can exchange ideas and best practices, ultimately improving the quality of physics teaching.

In addition, research by Hartini *et al.* [15] showed that the development of physics teaching materials using the 7E model can increase students' interest and motivation in learning physics. In this study, students who used teaching materials based on the 7E model showed a higher level of interest compared to students who used conventional teaching materials. In addition, the integration of formative assessment in learning tools is also important to support the 7E cycle. Formative assessment allows teachers to get quick feedback on students' understanding and adjust their teaching as needed. For example, Mustikasari *et al.* [28] showed that the use of formative assessment in the 7E model can improve students' self-efficacy and their learning outcomes. By providing constructive feedback, students can better understand their strengths and weaknesses in learning physics, which in turn can increase their motivation to learn further. This shows that a well-developed learning tool can increase students' motivation to learn physics.

3.6 Challenges of Implementation

Based on the results and analysis table, education can significantly develop students' abilities by implementing a learning model that requires students to be active in stages, namely Elicit, Engage, Explore, Explain, Elaborate, Extend, and Evaluate. The learning model is based on the theory of constructivism by Karplus in the 1960s and means that this model makes students construct knowledge by themselves by students in their minds [29]. This view indicates that students become the center of learning (student-centered). The syntax in the 7E Learning Cycle Model is as follows.

Table 2. Syntax of 7E Learning Cycle Model

Syntax	Activity
Elicit	The teacher raises students' initial understanding.
Engage	Teachers start learning by generating student interest so students are motivated.
Explore	The teacher helps students dig deeper into the material.
Explain	Students find the results of their findings related to the material being studied.
Elaborate	Allows students to implement the new understanding they have gained.
Evaluate	The teacher evaluates the student regarding the material being studied.
Extend	Think, seek, convey, and explain examples of the application of the material that has been studied.

While many studies have shown positive results, some challenges still need to be overcome. One of the main challenges in implementing the 7E cycle model is the readiness of teachers to implement this method. Teachers need to have a strong understanding of each phase in the cycle and how to integrate it into the existing curriculum. According to research by Komikesari *et al.* [13] and Miadi *et al.* [22], a lack of training and understanding of this learning model can result in a lack of effectiveness in teaching. For example, in a case study of several junior high schools, it was found that teachers who were unfamiliar with constructivist approaches had difficulty in managing interactive classroom discussions, which is an important element in the Engage and Explore phases. According to Canalita *et al.* [27], many teachers are still accustomed to traditional learning approaches that focus more on direct teaching. This can hinder the adaptation process to the 7E model, which requires students' active involvement in the learning process. In addition, the limited time in the curriculum can also be an obstacle. With so much material to teach, teachers often feel pressured to complete all topics in the allotted time. This can result in neglecting some of the steps in the 7E model, thus reducing the effectiveness of learning. Anisah and Syukri [23] emphasized the importance of good time management so that all stages in the cycle can be implemented properly.

Educational infrastructure is also a factor that cannot be ignored. Maskur *et al.* [30] noted that not all schools have facilities that support the implementation of experiment-based learning, which is an integral part of the Explore stage in the 7E model. Limited teaching aids and adequate laboratory space can reduce the effectiveness of physics learning. In addition, in today's digital era, the utilization of technology in physics learning is very important, especially in phases that involve exploration and elaboration. However, not all schools have adequate access to the necessary technology. Utami and Widowati [14] and Khairani *et al.* [21] pointed out that limited access to hardware and software can hinder the implementation of this model. For example, in some remote areas, schools do not have adequate physics laboratories, so students cannot conduct the experiments required for the Explore phase. This has implications for students' low motivation and interest in physics.

Student engagement is a key factor in the successful implementation of the 7E cycle model. However, not all students have the same motivation to actively participate in learning. Parno *et al.* [26] showed that students often feel anxious or lack confidence when asked to participate in activities that require critical thinking and creativity. Research by Parno *et al.* [16] also shows that students who lack confidence are often reluctant to engage in group discussions or experiments. Another challenge is the difference in students' level of understanding. In one class, students may have widely varying backgrounds and abilities. This makes it difficult for teachers to customize learning to suit the needs of each student. Puspita and Fardillah [29] found that differences in student abilities can affect the effectiveness of the 7E cycle model. If teachers cannot identify and respond to these differences, some students may feel left behind or not engaged in the learning process. In this context, teachers need to design activities that can boost students' confidence and encourage them to contribute. For example, the use of technology such as Google Classroom can help create a more inclusive learning environment where students feel more comfortable sharing ideas and asking questions. Research shows that students who engage in 7E cycle-based learning show significant improvement in information analysis and synthesis skills [31]. Thus, despite the challenges, efforts to address these issues may result in a generation of students who are better prepared to face future challenges.

Evaluation in the 7E cycle model is also a challenge. Traditional assessments often do not reflect students' true understanding. Therefore, teachers need to design evaluation instruments that are more holistic and cover various aspects, such as critical thinking skills and creativity. Widodo and Hazimah [20] emphasized the importance of using clear and measurable assessment rubrics for each phase in the cycle. For example, in the evaluation phase, students can be assessed not only based on the experimental results but also on their thinking process in solving complex physics problems.

In order to optimize the implementation of the 7E cycle model, collaboration between teachers, students, and school authorities is necessary. Continuous training for teachers, improvement of technological infrastructure, and development of innovative evaluation methods are steps that must be taken to ensure the success of this model. With the right approach, the 7E cycle model can not only improve students' understanding of physics but also equip them with the skills needed to succeed in an increasingly complex world.

4. CONCLUSION

Based on the results of the research that has been reviewed, the application of the 7E cycle learning model is consistently able to improve student learning outcomes in physics subjects, especially in the aspects of science process skills, concept understanding, critical and creative thinking skills, and learning motivation. The model is also effective in creating an interactive and student-centered learning environment. Although there are challenges in implementation, such as teacher readiness and infrastructure limitations, research shows that with the support of adequate training, innovation of learning tools, and use of technology, the 7E cycle model can have a significant positive impact on physics learning. Collaborative support from the school and innovation in the assessment is also needed to optimize the implementation of this model so that students not only understand physics concepts deeply but are also skilled in facing the challenges of the 21st century. This study has implications in providing practical guidance for educators to improve the quality of physics learning through the application of the 7E cycle model.

AUTHOR CONTRIBUTION STATEMENT

MM contributed to the writing of the article, the analysis of research methods, data collection and processing, data analysis, and the preparation of the results and discussion sections. IRS contributed to providing direction and guidance in topic development, writing and editing, as well as offering input on references and relevant literature. RE contributed to providing direction and guidance in topic development and writing and editing.

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