



The Effectiveness of Digital Media in Physics Learning: A Systematic Literature Review

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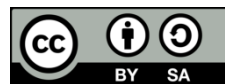
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ABSTRAK

This study aims to systematically examine the influence of digital media in physics learning during the period 2015-2025. This study was conducted to determine how the impact of the implementation digital media on learning both from the implementation digital media. The method used is Systematic Literature Review (SLR). The Data were collected from ERIC database, Sains Direct database and Google Scholar using the keywords "Digital Media", "Effectiveness", "Physics Learning". The results of the analysis showed that the use of digital media can improve hot thinking skills, cognitive abilities, communication skills, improve learning outcomes, learning interests, learning quality, understanding of student concepts and proven effective and efficient in helping facilitate the learning process of students. These findings indicate that the use of digital media has a significant impact on the learning process.

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1. INTRODUCTION

Physics is one of the main branches of science that studies natural phenomena and the laws that govern them, from the smallest scales such as subatomic particles to the largest scales such as galaxies and the universe (Wulff, 2023; Zochling et al., 2022). Physics plays an important role in helping humans understand the basic principles of various natural phenomena, such as motion, energy, force and matter (Lavrynenko et al., 2020). Through a systematic scientific approach, physics not only explains how the universe works, but is also the basis for the development of modern technology from electricity, computers, to space technology (Jindra & Obrazovanje, 2010). By studying physics, we not only improve our scientific insight, but also develop the ability to think logically, analytically and critically in dealing with various problems in daily life (Koopal & Vlieghe, 2022; Songsil et al., 2019).

Physics is known as one of the branches of science that has an important role in the advancement of human civilization (Dignam et al., 2024; Sutradhar, 2022). However, despite its strategic role, physics is often perceived as a difficult, boring and irrelevant subject to everyday life by most people (Çetin, 2016; M. Vijaya & Buncha, 2017). This disinterest in

physics does not only occur among students, but also extends to the general public (Bello et al., 2018; Saka et al., 2024). Many people feel intimidated by complex formulas and abstract concepts that are difficult to understand without in-depth explanations (Boublil et al., 2024; Kincanon, 2022; Kortemeyer, 2023; Sodré & Mattos, 2022). As a result, interest in physics tends to be low, and this results in a lack of appreciation for science and technology rooted in the principles of physics (Moloi & Motlhabane, 2023). This is a concern for the sustainability of innovation in the future (James W, Elston D, 2018; Yildiz, 2023).

Modern era filled with technological advancements, it is ironic that physics as the main foundation of many of these innovations is less and less in demand (Carleo et al., 2019; Green & Programme, 2022; Xiii et al., 2024). The younger generation's interest in physics continues to decline, as seen by the low number of students and college students who choose this field as a study or career path (Dou et al., 2016; Stefanidou et al., 2022; Whitcomb et al., 2023). In fact, physics plays an important role in understanding the laws of nature and driving the development of technology that underpins everyday life (Korur et al., 2021; Kotoka & Kriek, 2023; Kumaş, 2022). Concerns have begun to emerge among educators and scientists. If this trend is allowed to continue, it is not impossible that the world will experience a crisis of scientific understanding that can hinder innovation and the progress of civilization (Horta & Jung, 2024; Shrout & Rodgers, 2018). Therefore, the role of educators is needed for this problem.

The era of rapid development of Science and Technology today can pave the way for educators to innovate in the process of delivering physics material (Bao & Koenig, 2019; Khatri et al., 2016; Resty C. Samosa, 2021). So that learning physics is not only considered an abstract theory and complex formulas (Holovatch et al., 2017). One of them is the utilization of e-Learning in learning. The development of information and communication technology has brought great changes in various aspects of life, including in the world of education (Stefanidou et al., 2022; Whitcomb et al., 2023). One of the innovations that is now increasingly popular is e-Learning, which is a learning method that utilizes digital media and internet networks as the main means in the teaching and learning process (Kumar Basak et al., 2018; Wang, 2024).

E-Learning allows learners to access learning materials anytime and anywhere, without being bound by time and space as in conventional learning systems (Alqahtani & Rajkhan, 2020; Kisanjara & Maguya, 2024; York, 2024). With the flexibility and ease of access offered, e-Learning becomes a modern education solution that is adaptive to the needs of the times (Erlangga, 2022; Maslov et al., 2021; Vardar et al., 2024). By utilizing interactive technology, virtual simulation, and flexible online learning access, e-learning can help simplify complex physics concepts and increase students' interest in learning (Bayu Wijayanto, Sumarmi & Handoyo, Budi, 2023; Palvia et al., 2018; Syafruddin et al., 2024). The need for e-learning in physics learning is increasingly urgent, especially in the context of distance or hybrid learning, which demands more innovative, adaptive, and accessible teaching methods (Efird-Green et al., 2024; Rawashdeh et al., 2021).

The use of digital media in physics learning has a significant influence on students (Gray & Diloreto, 2016; Guo, 2024). Starting from more effective and efficient learning to improving critical reasoning skills for the learners themselves (Alenezi et al., 2024; Bellés-Calvera, 2022; Eren & Öztuğ, 2020). In this article, we will discuss what are the effects when we apply e-Learning in physics learning for students. What are the effects and is it effective to apply e-Learning in physics learning, or vice versa? Let's discuss it in more depth.

2. METHODS

The method used in this research is a systematic literature review approach. Systematic Literature Review (SLR) is defined as the process of identifying, assessing, and interpreting all available research evidence with the aim of providing answers to specific research questions (Simonnet et al., 2025). The stages involved include planning, data collection, analysis, and discussion as can be seen in the figure below.



Figure 1 Stages of Sistematic Literature review

In this study, researchers collected journal articles on Google Scholar and ERIC databases with the keywords “Digital Media”, “Effectiveness” and “Physics Learning”. The articles collected were only articles published within the last 10 years or from 2015 to 2025 and in English. From the various articles, researchers selected 20 articles closely related to the keywords used.

In the next step, the researcher categorized and tabulated in a table consisting of three criteria. The criteria included the research model used, the digital media, the results or effects obtained after implementing the digital media, and also the school level that became the object of research. In each criterion, a table was formed stating the number of articles from each criterion. After that, the researcher reviewed and analyzed the articles in depth especially regarding the research results presented in the discussion section and conclusion section. In the final part of the study, the researcher compared the findings presented in the articles and gave conclusions.

3. HASIL DAN PEMBAHASAN

3.1. Result

The data in the article is divided into 3 criteria. These criteria include the research model used in the development and implementation of digital media, the effect produced when implementing digital media on physics learning, and the school level that is the object of research.

3.1.1. Research Model Used in the Development and Implementation of Digital Media

Aplication of digital media in physics learning is divided into two, namely development and implementation. In development and implementation, there are different approach models. The selection of this model is very important in the application of digital media so that the objectives of the research can be fulfilled. The selection of models in the application of digital media in physics learning can be seen in *Table 1*.

Table 1 Research Model Used in the Development and Implementation of Digital Media

NO	AUTHOR	APLICATION OF RESEARCH	MODEL	FREQUE NCY
1	(Afrianti, 2021; Azairok & Fathurohman, 2023; Mardiana & Kuswanto, 2017; Mustari et al., 2019; Saraswati et al., 2018)	Development	Borg and Gall	4
2	(Pahlawan et al., 2021; Sury et al., 2020)		Allesi and Trollip	2

3	(Azairok & Fathurohman, 2023)	Implementation	Dick and Carey	1
4	(Handri et al., 2022; Novitra, 2021)		PLOMP	2
5	(Harahap & Hakim, 2024; Prihata et al., 2020; Risniawati et al., 2020; Yusuf et al., 2020)		ADDIE	4
6	(Fayanto et al., 2019a; Hunaidah & Mahdiannur, 2022)		Quantitative mode	2
7	(Elisa et al., 2022; Qalbi & Sari, 2023; Yusuf, Irfan; Widyaningsih, Sri wahyu; Br Sebayang, 2018)		Quasi Experiment	3
8	(Widyaningsih & Yusuf, 2020)		Study Leason	1
9	(Hero et al., 2021)		Descriptive Correlation	1

3.1.2. Effect Produced when Implementing Digital Media on Physics Learning

The use of Digital Media has a significant impact on students. Starting from the effectiveness of digital media in learning, making the teaching and learning process easier so that students experience improvement in various aspects. Some aspects that experienced improvement are students' critical thinking skills, HOTS thinking skills, increased student understanding of learning materials, and many others. The table of the effect of using digital media on physics learning can be seen in *Table 2*.

Table 2 Effect Produced when Implementing digital media on Physics Learning

No	REFERENCES	IMPACT	FREQUENCY
1	(Mardiana & Kuswanto, 2017; Yusuf, Irfan; Widyaningsih, Sri wahyu; Br Sebayang, 2018)	Improve HOTS thinking skills	2
2	(Pahlawan et al., 2021; Qalbi & Sari, 2023)	Improve students' cognitive abilities	2
3	(Azairok & Fathurohman, 2023; Handri et al., 2022; Hero et al., 2021; Novitra, 2021; Pahlawan et al., 2021; Yusuf et al., 2020)	Effective. and efficient learning	6
4	(Afrianti, 2021; Harahap & Hakim, 2024; Mustari et al., 2019; Saraswati et al., 2018)	Help make it easier for students	4
5	(Elisa et al., 2022; Fayanto et al., 2019b; Hunaidah & Mahdiannur, 2022)	Improve student learning outcomes	3
6	(Sury et al., 2020)	Improve students' communication skills	1

7	(Fayanto et al., 2019b; Hero et al., 2021)	Increase students' interest in learning	2
8	(Widyaningsih & Yusuf, 2020)	Improve learning quality	1
9	(Prihata et al., 2020; Saraswati et al., 2018)	Improve concept understanding and science literacy	2

3.1.3. School Level That is the Object of Research

The level of education that becomes the object of research on the utilization of digital media for physics learning starts from junior high school, high school, and university levels. High school level is the level that has the highest frequency of 16 articles because the implementation of physics learning is widely applied at the high school level. Followed by college level with 3 articles and junior high school level with 1 article. The classification of digital media influence on physics learning by school level can be seen in Table 4.

Table 3 School Level That is The Object of Research

NO	LEVEL OF EDUCATION	FRECUENCY
1	Junior High School	1
2	Senior High School	16
3	Higher Education	3

3.2. DISCUSSION

Application of e-learning in learning is divided into two basic things, namely the development of e-learning and also the experimentation of e-learning application into learning. Development is focusing on making e-learning that has renewal from existing findings. Meanwhile, implementation is the utilization of e-learning to influence learning. Development and implementation have differences in their methods. In development, it is divided into methods of Borg and Gall, Allesi and Trollip, Dick and Carey, Plomp, ADDIE, and so on. Meanwhile, implementation is divided into several methods, namely quantitative mode, Quasi Experiment, Study Leason, Descriptive Correlation, and many more.

Borg and Gall method is one of the methods used in Research and Devolopment (R&D). The development of e-Learning using the Borg and Gall method in physics learning has an impact on significantly improving divergent thinking skills and HOTS (Afrianti, 2021; Mardiana & Kuswanto, 2017) in the development of Android-assisted Physics Mobile Learning and e-Learning Basic Chemical Law Materials, helping to facilitate students in learning (Afrianti, 2021; Mustari et al., 2019) in the development of e-Learning Basic Chemical Law Materials and E-Learning Based Blogs on Global Warming Subject, and also improving students' concept understanding (Saraswati et al., 2018) in web-based and e-learning media for physics learning materials. The four articles describing the development using the Borg and Gall method have been validated by material experts and media experts, therefore this e-Learning development can be implemented to students. However, the e-learning has several shortcomings, among others, it only focuses on certain topics per subject, has not been tested for the entire curriculum, testing is still small scale, teacher involvement is only as a facilitator, not all students have qualified facilities.

Two studies systematically analyzed in this review contribute significantly to the development of e-learning based on STEM and digital interactive approaches in physics learning at the secondary school level. Research by (Sury et al., 2020) showed that the

application of STEM-based e-learning in physics learning can effectively improve students' communication skills. Using the Alessi and Trollip development model, the developed learning media was tested through a pre-experiment approach with a one-group pretest-posttest design. The results showed significant improvement in all indicators of communication skills, with an average n-gain value of 0.62 in the medium category and the highest improvement in oral communication (n-gain: 0.74). This research highlights the importance of integrating the four STEM domains in the learning process as well as the contribution of e-learning to 21st century skills, particularly communication, collaboration and critical thinking.

In contrast, studies by (Pahlawan et al., 2021) focuses on developing interactive digital handouts as Articulate Storyline application-based teaching materials for momentum and impulse materials. The use of Alessi and Trollip development models is also used here, but the main focus is on improving the cognitive learning outcomes of students. This research uses development method with expert validation test, practical test by students, and effectiveness test through pretest and posttest. The results showed an increase in the average score from 48.93 to 81.27 with an n-gain of 0.70 in the medium category. This study emphasizes that the use of interactive digital media tailored to the characteristics of Generation Z students can increase learning motivation, understanding of physics concepts, and the effectiveness of the overall learning process.

The two studies both adopted the Alessi and Trollip models, but had differences in focus (Sury et al., 2020). focusing on improving affective aspects in the form of communication skills as part of 4C competencies, while (Pahlawan et al., 2021). more highlights the achievement of cognitive learning outcomes. Another difference lies in the form of e-learning used: (Sury et al., 2020) using a platform-based Learning Management System (LMS), while the (Pahlawan et al., 2021) developing teaching materials in the form of digital handouts with visual interactive elements. However, both underscore the important role of digital technology in answering the educational challenges of the Industrial Revolution era 4.0 and the needs of the digital generation that requires a visual and flexible approach to learning. While both studies have successfully demonstrated the effectiveness of e-learning in improving learning outcomes and communication skills, there are a number of gaps that have not been fully addressed.

Research by (Azairok & Fathurohman, 2023) expands insights in the development of e-learning-based physics learning media using the Chamilo platform and The Dick and Carey model. This study is designed to improve the understanding of high school students in Class XII on the material of static electricity. With validation from material, media, and learning experts, this medium was declared very viable with an average validity score of more than 85% in all aspects. Chamilo provides an interactive learning experience through video features, evaluations, and learning resources in the form of digital documents that can be accessed flexibly by students. The advantages of this platform lie in the user-friendly interface design, completeness of content, as well as the ability to present structured and efficient learning. This study not only demonstrates the potential of Chamilo in strengthening digital learning, but also shows how Dick and Carey's systematic approach is able to direct the entire instructional design process to the revision stage based on expert validation.

Research conducted by (Novitra, 2021) developed an Online learning model-based Inquiry Learning to improve the skills of 21st Century High School students in physics learning. The development of this model uses a Research and Development (R&D) approach with the Plomp model framework, which consists of three main phases: preliminary research, prototyping, and assessment.. Validation includes aspects of content, construction, and language with the average result being in the "very high"category. The final phase, the assessment phase, is conducted through limited and field trials to assess the practicality and effectiveness of the model in improving 21st century skills. This learning Model is designed to

balance the scientific approach with the use of ICT information and communication technologies. The results showed that the model developed was very valid, practical, and effective, with an increase in the 21st century skills of students in the medium to high category (average N-Gain = 0.63). Overall, the use of the Plomp model allows the development process to be systematic and structured, resulting in a learning model that is not only contextual but also able to answer the educational needs of the 21st century in a concrete way.

Research with the same model is also carried out by (Handri et al., 2022) namely the development of e-learning media based on Rotary Guided Discovery Learning for electrolyte and nonelectrolyte solution materials at the high school level. The researcher used Educational Design Research (EDR) approach with Plomp development model, which consists of three stages: initial investigation, design/prototyping, and assessment. Validation by three experts resulted in an Aiken's V value of 0.87 indicating a valid category. The practicality test by the students also resulted in an average score of 81%, classified as very practical. The results show that e-learning is feasible for online Chemistry learning, especially in distance learning conditions that demand flexible and independent interaction. This research provides an important contribution in the utilization of LMS-based learning technology.

Research that discusses the development of digital-based physics learning media, especially e-modules and e-learning with the Moodle platform, shows a positive trend in physics learning innovation at the high school and college levels. The first research by (Harahap & Hakim, 2024) who developed an interactive physics e-module for high school class X students using the ADDIE model, with expert validation showing the feasibility of the product in terms of material, media and language. However, this study was limited to product validation without empirical learning effectiveness tests in the classroom. The second study by (Prihata et al., 2020) who developed an interactive e-book on the topic of energy for students of Class XII high school, also used the ADDIE model and expert validation, with highly valid design results and appropriate independent learning needs and the development of critical thinking skills. However, this study has not conducted implementation trials and evaluation of the impact on student learning outcomes directly.

The third study by (Risniawati et al., 2020) who developed Moodle-based e-learning media to improve the science literacy of high school students in Class X, with expert validation and limited trials that showed an increase in science literacy in the medium category. The study already included trials and initial evaluations, but was still limited to a single school and without a control group so the generalization of the results and the strength of the effectiveness claims still need to be strengthened. The fourth study by (Yusuf et al., 2020) which developed Moodle-based e-learning media for physics learning in higher education, with good validation and positive responses from students, but the trial was only on 13 students and the measurement of effectiveness was still limited to perception, not supported by quantitative data on improving learning outcomes.

Methodologically, research conducted by (Harahap & Hakim, 2024; Prihata et al., 2020; Risniawati et al., 2020; Yusuf et al., 2020) these all use a systematic ADDIE model in the development of digital Learning media. Product validation by experts is an important step that is done consistently. However, the main gap that arises is the lack of research that proceeds to the stage of broad implementation and strong empirical evaluation of the effectiveness of the media in improving learning outcomes and critical thinking skills of students quantitatively and with more robust research designs (for example, with control groups and larger samples). In addition, most studies have not addressed in-depth technical challenges and implementation barriers, such as internet access, user readiness, and supporting infrastructure, which are crucial in the context of online learning, especially in areas with technological limitations.

In the implementation of e-learning to learning, there is one method used is the quantitative method. The first study by (Fayanto et al., 2019) examined the effectiveness of the use of Moodle-based e-learning in learning straight motion in high school. This study used a pretest-posttest design on one group of students, with the results showing a significant improvement in learning outcomes and student learning interests. The value of N-gain showed a high increase, and most students agreed to the use of Moodle in the process of learning physics. This study emphasizes on the practical benefits of Moodle in delivering material, providing practice questions, and facilitating interaction between teachers and students.

However, there are gaps that need to be noted. Study by (Fayanto et al., 2019) using one class with a small sample (10 students) and limited to one physics topic. In addition, Moodle is used in a relatively conventional form without a special pedagogical approach. This shows the need for the development of digital Learning media that are more interactive, systematic, and based on learning models designed to increase student cognitive engagement in greater depth. This is where the second study by (Hunaidah & Mahdiannur, 2022) offers a different and significant contribution, namely by developing CinQASE model-based e-modules that integrate collaborative strategies such as questioning, analyzing, synthesizing, and evaluating.

The study by (Hunaidah & Mahdiannur, 2022) used a design of three pretest-posttest groups with a total of 85 students studying three different physics concepts. The E-module developed is equipped with interactive multimedia and the results of the analysis showed an increase in learning outcomes in the medium category with high significance based on the t-test. In addition, CinQASE's approach has been shown to be effective in improving understanding of concepts, active involvement of students, and enabling more independent learning. Thus, this study not only expands the scope of digital intervention in physics learning, but also closes the gap from previous studies by applying pedagogical models that are more structured and based on 21st century learning principles.

Research with quasi-experimental methods to test the effectiveness of the application of Technology-Based Learning media in improving the learning outcomes of physics students. Research conducted by (Elisa et al., 2022) using the design of non-equivalent control group with two classes in high school, where the experimental class using an interactive e-learning module while the control class using e-module-based digital books. Pre-test and post-test were used to measure the initial ability and learning outcomes after treatment, with statistical analysis including normality, homogeneity, and t-test to compare the results of both groups.

Research conducted by (Qalbi & Sari, 2023) using a quasi-experimental design with posttest only control group design in two high school classes, where the experimental class uses the Schoology platform as an e-learning learning medium, while the control class learns conventionally. Data analysis includes normality test, homogeneity, t-test, and regression and correlation to measure the effect of the use of Schoology on learning outcomes and student attitudes. Research conducted by (Yusuf, Irfan; Widyaningsih, Sri wahyu; Br Sebayang, 2018) using one group pretest-posttest design on students of Physics Education Study program with a small sample, which measures the ability of Higher Order Thinking Skills (HOTS) through essay questions and student response questionnaires. Data analysis using N-gain Test, effect size, Wilcoxon test, and Rasch modeling to assess the effectiveness of STEM-based e-learning in quantum physics courses.

The results of the three studies showed a significant increase in learning outcomes or hots ability of learners who use e-learning-based learning media compared to conventional methods or before treatment. In a study by (Elisa et al., 2022) the average experimental class post-test score was higher with a moderate N-gain category which showed the effectiveness of the e-learning module in improving understanding of physics. Research by (Qalbi & Sari, 2023) showed significant differences between classes using Schoology and conventional classes with

much higher experimental class post-test average scores and increased students' positive attitudes toward learning. Meanwhile, research by (Yusuf, Irfan; Widyaningsih, Sri wahyu; Br Sebayang, 2018) showed an increase in the ability of HOTS students with high N-gain and effect size, as well as a very positive student response to STEM-based e-learning. A complete statistical analysis of all three articles reinforces the validity of the results obtained.

Overall, the three studies showed strong continuity between methods, results, and discussions. The quasi-experimental method used is able to produce valid and accountable data. Significant research results support the hypothesis that e-learning-based learning media are effective in improving learning outcomes and critical thinking skills of learners. In-depth discussions connect research findings with the context of physics learning and provide practical recommendations for the development of technology-based learning in the future. Thus, these three articles complement each other and provide a comprehensive overview of the benefits of implementing e-learning in physics learning.

The research by (Widyaningsih & Yusuf, 2020) entitled "Implementation of Project-Based Learning (PjBL) Assisted by E-Learning through Lesson Study Activities to Improve the Quality of Learning in Physics Learning Planning Courses" in detail reviews the experience of fifth semester students in the physics learning Planning Course at the University of Papua in participating in project-based learning (PjBL) supported by e-learning through Google Classroom and integrated with lesson study activities. This study uses a qualitative approach with three main stages of lesson study, namely Plan, Do, and See, which involves the collaboration of the lecturer team in designing, implementing, and reflecting on the learning process. The results of observations and questionnaires showed that most students felt more understanding of the material, more confident in discussions, and better prepared for the world of work. Thus, the student experience in the implementation of PjBL assisted by e-learning and lesson study not only improves learning outcomes, but also shapes 21st century skills such as communication, collaboration, and problem solving that are very important for prospective physics teachers.

The research conducted by (Hero et al., 2021) examines the integration of e-learning systems and their correlation to the learning habits and participation of Junior High School students. This study uses descriptive-correlational method with quantitative approach. The research instrument is a standardized questionnaire that is divided into three parts: assessment of e-learning system integration, student learning habits, and student participation. The selection of respondents using universal sampling technique involved 112 Junior High School students from Philippines. The methodology used is quite comprehensive and the results showed that the e-learning system is rated functional (4.14), reliable (4.08), can be used well (4.17), and efficient (4.20) based on Student Assessment. This finding indicates that the implementation of the e-learning system at the school has succeeded in providing an adequate learning platform, especially during the pandemic. This study also revealed a significant correlation between the integration of e-learning systems with learning habits and student participation.

4. CONCLUSION

This study has provided information about the effect of digital media in physics learning. This paper focuses on revealing the use of development and implementation models and the influence of digital media on students at various school levels. The research method used in e-learning is in the development of models Borg & Gall, Allesi and Trollip, Dick & Carey, PLOMP, and ADDIE. In the implementation there are models of quantitative mode, quasi experiment, study leason, and descriptive correlation. The influences obtained include the ability to think divergent and HOTS, improve students' cognitive abilities, effective and

efficient in learning, and help facilitate the teaching and learning process, improve learning outcomes, cognitive abilities, learning interests, learning quality, understanding of concepts and scientific literacy of students. It can be concluded that the use of e-learning in physics learning has a significant impact. Thus, although the development and application of digital media in physics learning shows great potential, more comprehensive follow-up research is still needed to test its effectiveness empirically in the field, overcome technical obstacles, and develop adaptive implementation strategies so that the media can really improve the quality of physics learning significantly.

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