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Developing Physics Concept Understanding Skills: The Role of Interactive Media in Junior High Schools

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Abstract

Understanding physics concepts is vital for junior high school students, yet many eighth graders struggle with measurement, heat effects, and temperature changes. This study evaluates the effectiveness of interactive media in enhancing physics understanding using the Borg and Gall model within a Research and Development (R&D) framework. Involving 50 students from a Bandung junior high school, the study employed educational software and interactive simulations over one semester. Data collection included in-depth interviews and pre- and post-intervention tests. Results indicated a 30% increase in average test scores, with 90% of students reporting heightened motivation and engagement. Tools like "Physics Explorer" and "Heat Dynamics" significantly improved active participation and conceptual grasp. The study advocates incorporating interactive media into physics curricula to enhance learning outcomes.

Keywords: Understanding Physics Concepts, Interactive Media, Research and Development, Physics Learning, Junior High School.

INTRODUCTION

Understanding physics concepts at the Junior High School (SMP) level is essential in determining the overall quality of science learning (Azhar, 2021; Dai, 2020; Latif, 2024). A strong understanding of basic concepts, such as measurement, the effects of heat (Mardhiah et al., 2023; Safitra et al., 2023), and temperature changes (Lubis, Solehudin, et al., 2024)forms the basis for further learning in science and technology (Maesaroh et al., 2022; Nugroho et al., 2024). Many eighth-grade students have difficulty mastering these concepts. (Hasibuan et al., 2024; Lubis, Nurhakim, et al., 2024), which hurts their motivation and learning

Previous studies have shown that physics learning in schools is often carried out conventionally, relying on lecture methods and textbooks, which are less able to attract students' interest (Huang, 2024; Y. Zhang, 2022). This creates challenges in developing a deep and applicable understanding of concepts. In addition, today's rapidly growing technology demands deeper integration in the learning process to improve students' cognitive skills (Ahmed et al., 2021; Skulmowski, 2020; Sugianto et al., 2022).

Various studies have examined the use of technology in physics learning, but many still focus on technical aspects or the use of hardware without considering effective pedagogical design (Harjono, 2024; Suharsiwi et al., 2023; Usmiyatun et al., 2021). Research by Bakri (2020) shows that computer simulations can improve student understanding but often lack hands-on and direct feedback to students. In addition, other studies tend to ignore the importance of active student involvement during the learning process (Chotimah, 2020; Sastradika, 2021; Tumangkeng, 2024).

From previous studies is the lack of focus on direct and adaptive interaction between students and learning media. Many studies focus more on introducing technology rather

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than facilitating a personal and interactive learning experience (Harjono, 2020; Wang, 2025; Yulianci, 2023). In addition, previous studies often do not involve long-term evaluations of the impact of technology on students' understanding of physics concepts (Alqawasmi, 2024; Widestra, 2020; Widyaparamita, 2021).

Understanding physics concepts is an essential skill that junior high school (SMP) students must master. This skill is crucial for students' academic success. (Pradana & Uthman, 2023)But also to prepare them for future technological and scientific challenges (Ninghardjanti, 2021b; Wahyuni, 2020). Many eighth-grade students have difficulty mastering basic concepts such as measurement, the effect of heat, and temperature changes. The lack of adequate and interesting learning strategies often causes this difficulty. Therefore, this study aims to explore the role of interactive media in improving physics concept understanding skills in junior high school students (In'am et al., 2023; Rahmah et al., n.d.; Sekaryanti et al., 2022).

Research related to interactive media Anjarwati et al., (2023) in physics learning in junior high schools has been widely conducted in the last five years. For example, research highlighted the use of mobile applications in physics learning, but this study did not discuss the long-term effectiveness of the application. Shurina (2023) focused on using augmented reality technology to teach basic physics concepts, but this study did not evaluate the impact on student engagement in depth. B. Zhang 2023) examined the use of interactive learning videos but did not discuss its effects on a deeper understanding of concepts. Research by (Pandia et al., 2022) explored the use of educational games but failed to link learning outcomes to student motivation. Recent research by Pandia et al. (2022) examined computer simulations but focused more on technical aspects than pedagogical ones.

These studies clearly show gaps in previous research. First, many of these studies focus more on introducing technology or hardware without considering effective pedagogical design (Bowman, 2020; de Gortari, 2021; Tianyi, 2025). Second, most studies do not involve long-term evaluation of the impact of technology on students' understanding of physics concepts. Third, few pay attention to students' active involvement during learning (Harjono, 2020; Magzymov, 2022; Sari, 2021). Fourth, the approaches are not always tailored to students' learning needs.

This gap indicates that there is still a need for research that integrates effective pedagogical design with interactive technology in physics learning. This study aims to fill this gap by adopting a Research and Development (R&D) approach using the Borg and Gall model, which prioritizes the development of educational software and interactive simulations tailored to students' learning needs. This approach is expected to provide a more personalized and interactive learning experience while increasing students' motivation and understanding of physics concepts (Al-Mohtadi, 2022; Fathurohman, 2021; Harjono, 2020).

This study offers innovation by adopting a Research and Development (R&D) approach using the Borg and Gall model that focuses on developing educational software and interactive simulations. The interactive media used, such as "Physics Explorer" and "Heat Dynamics", are designed to provide a more immersive and challenging learning experience and provide direct feedback that helps students understand concepts better. This study also considers aspects of student motivation and engagement, which are often overlooked in previous studies (Kitagawa, 2022; Magzymov, 2021; Vegisari, 2020)

This study is supported by empirical evidence from previous studies showing that interactive media can increase learning motivation and conceptual understanding (Li, 2022; Shabur, 2024; Zakhiyah, 2021). A survey by Ninghardjanti (2021a) showed that students actively involved in technology-based learning showed a significant increase in understanding physics concepts compared to conventional learning methods. Thus, this study seeks to address the existing challenges and gaps by offering innovative and evidence-based solutions.

With this background, this study is expected to significantly improve the quality of physics learning in junior high schools (Manurung, 2020; Nabipour, 2024; Usmiyatun et al., 2023). The integration of interactive media is expected to be a strategic step in overcoming the challenges of physics learning, increasing motivation, and improving students' understanding of concepts. This study guides educators in utilizing technology effectively in the teaching process and encourages further research in this area to explore the full potential of interactive media in education (Jiang, 2023; Schlauch, 2022; Sudarmilah, 2021).

This study offers significant innovation in physics teaching in Junior High Schools by integrating technology-based interactive media (Frau, 2023; Najda-Janoszka, 2021; Rachmavita, 2020). Unlike previous studies focusing more on technical aspects or hardware usage, this study highlights the importance of effective pedagogical design. By adopting a Research and Development (R&D) approach using the Borg and Gall model, this study developed educational software and interactive simulations tailored to students' learning needs. Interactive media, such as "Physics Explorer" and "Heat Dynamics", are designed to provide a more immersive and challenging learning experience, as well as provide direct feedback that helps students understand concepts better (Ezeh, 2023; Jansen, 2022; Stephens, 2024). This focus on technology integration is expected to address the gaps in previous studies, especially in increasing student active engagement and ensuring personalized learning.

This study not only relies on the use of technology but also prioritizes long-term evaluation of its impact. Involving 50

eighth-grade students in Bandung, this study monitored the development of students' understanding of physics concepts for an entire semester. The results showed a significant increase in the knowledge of physics concepts, with an average final test score increasing by 30% compared to the initial test. These findings confirm that interactive media can effectively increase student motivation and engagement in learning. In addition, this study also involved in-depth interviews with students and teachers, which provided further insight into how interactive media can be applied effectively in the classroom context.

The main strength of this study is its holistic and evidence-based approach to improving conceptual understanding skills in physics. By emphasizing students' individual learning needs and providing adaptive learning tools, this study offers practical solutions to the challenges faced in teaching physics in junior high schools. In addition, this study also highlights the importance of developing educational software that is not only visually appealing but also has a strong pedagogical design. With the positive results achieved, this study recommends integrating interactive media as an integral part of physics teaching strategies in junior high schools. It encourages educators to continue exploring the potential of technology in creating more effective and enjoyable learning experiences.

LITERATUR REVIEW

2.1 Understanding Physics Concepts in Junior High School

Understanding physics concepts is crucial in science education, particularly at the Junior High School level. Research by Putra and Suryadi (2020) reveals that many students struggle with fundamental physics concepts, such as measurement and the effects of heat, due to conventional teaching methods (Gunawan et al., 2019; Ivanov, 2019a; Mulhayatiah et al., 2023). Typically focusing on lectures and rote memorization, these methods fail to engage students actively, leading to boredom and an inability to connect theoretical knowledge with practical application, an essential component of physics comprehension. The traditional approach lacks sufficient interaction and immediate feedback between teachers and students. (Ivanov, 2019b; Sadasivan et al., 2021a; Yaakub et al., 2021a), preventing students from effectively addressing their difficulties. Hake's (1998) findings underscore the significance of active learning in enhancing conceptual understanding. Recent studies, such as those by Smith et al. (2022), support adopting alternative methods, such as project-based learning and interactive technology, to foster student engagement. By embracing more innovative strategies, educators aim to help students overcome challenges in grasping physics concepts and cultivate a lasting interest in science.

2.2 The Role of Interactive Media in Physics Learning

As Rahman et al. (2020) highlighted, interactive media has proven to be an effective tool in enhancing students' understanding of physics concepts by significantly increasing motivation and engagement. This approach allows students to actively participate in their learning journey, fostering a more profound comprehension of complex concepts through personalized experiences. Simulations and visualizations cater to individual learning styles, transforming abstract physics ideas into more tangible and understandable phenomena. (Sadasivan et al., 2021b; Wang et al., 2020a; Yaakub et al., 2021b). Wahyudi (2019) notes a limitation in interactive media's lack of real-time feedback, which is crucial for identifying and correcting errors in understanding. This shortfall suggests that while interactive media is beneficial, it should complement other educational methods that provide immediate feedback. (Balyk et al., 2022; Nasution et al., 2022; Wang et al., 2020b), enhancing the overall efficacy of the learning process. Integrating diverse teaching strategies can thus create a more holistic and practical educational experience, bridging the gap between engagement and comprehensive understanding in physics education.

2.3 Research and Development (R&D) Approach in Education

The Research and Development (R&D) approach using the Borg and Gall model effectively develops educational software tailored to students' learning needs. This model offers a systematic framework that assists in planning, designing, and evaluating educational products, making them visually appealing and pedagogically sound (Haryanto & Kusuma, 2021). Such alignment is crucial for supporting diverse learning styles, thereby enhancing student engagement and motivation (Ibrahim et al., 2018a; Saludung, 2018a; Syahmaidi et al., 2021)Concentrating on student needs makes educational tools more relevant and practical, providing a personalized learning experience. Despite these advantages, Sari and Aisyah (2019) highlight a significant drawback: developers often emphasize technical aspects over assessing long-term impacts on students' conceptual understanding. (Ibrahim et al., 2018b; Padmasari et al., 2020; Saludung, 2018b)This oversight can lead to products that fall short of educational objectives. To combat this, comprehensive evaluations, including field testing and user feedback, are essential for ensuring both short-term effectiveness and long-term understanding. Continuous improvement based on feedback is vital for enhancing the quality of educational devices, thus supporting sustainable learning. (Ambarawati & Dwi Agustin, 2019; F'Adna et al., 2020; Widiaty et al., 2019).

2.4 Evaluation of the Effectiveness of Interactive Media in Long-Term Learning

Technology integration in physics education has been extensively studied, yet long-term evaluations of its effectiveness are often overlooked. Sinta (2019)

demonstrated that mobile applications enhance students' grasp of physics concepts, although the study lacked an analysis of sustained improvement. Similarly, Anton (2023) explored the potential of augmented reality to boost student engagement but noted a deficiency in the long-term evaluation of its impact. The primary shortcoming in these studies is the absence of empirical data supporting the notion that interactive media consistently yields sustainable results in physics education. Addressing this gap, our study comprehensively evaluates interactive media's impact over a semester. This approach aims to provide robust empirical evidence on the enduring effects of educational technology. By examining data on both initial understanding and long-term engagement and motivation, our findings will contribute significantly to developing more effective and sustainable physics teaching methods. Notably, recent studies by Johnson (2021) and Lee (2022) underscore the importance of longitudinal studies in educational technology, supporting this research's direction.

2.5 The Importance of Active Student Involvement

Active student involvement in the physics learning process significantly enhances conceptual understanding and educational outcomes. Nurhadi (2020) highlights that students transition from passive recipients to active participants when they actively engage, fostering a sense of responsibility and motivation in their learning journey. This engagement can be facilitated through discussions, experiments, and educational aids, leading to a profound comprehension of physics principles. However, as Pratiwi et al. (2020) note, previous studies have often prioritized technological aspects over student involvement, neglecting its crucial role in effective learning environments. To address this gap, recent efforts have integrated interactive media, such as physics simulations and game-based learning tools, which create immersive and relatable learning experiences. For instance, a study by Zhang and Chen (2021) found that such interactive tools convey theoretical knowledge and demonstrate practical applications, cultivating critical thinking and problem-solving skills. This approach is crucial for maximizing students' potential and enhancing active, effective learning strategies in physics education.

MATERIALS AND METHODS

3.1 Research Paradigm

This study uses a Research and Development (R&D) approach with the Borg and Gall model, which aims to develop interactive media in physics learning in junior high schools see Figure 1

Figure 1. Paradigm Physics Learning

This model was chosen because it can systematically design and test educational devices and ensure the resulting product is relevant to students' needs (Borg & Gall, 1983). This approach involves several stages, from needs analysis and product development to evaluating the product's effectiveness in an authentic context. Thus, this study focuses on technology development and emphasizes the importance of effective pedagogical design in physics learning.

3.2 Research Design

This research design involves several significant steps in the Borg and Gall R&D model see Figure 2:

Figure 2. Research Design develop media. (Dewantara et al., 2019)

Research Design Summary in Figure 2: Recent educational research, the Borg and Gall R&D model, has been employed to enhance physics learning, focusing on several key steps. Initially, a needs analysis was conducted to identify student challenges, particularly in physics. This stage involved gathering data through interviews and classroom observations, highlighting the importance of such analysis for curriculum development, as noted by Lestari (2021). Subsequently, "Physics Explorer" and "Heat Dynamics" software were developed, utilizing interactive simulations to simplify complex concepts, supporting findings by Rahman et al. (2020) on the effectiveness of visual aids in physics education. A trial involving 50 eighth-graders in Bandung tested these tools, revealing increased student motivation and understanding, aligning with Hwang et al. (2019). Evaluation and revision followed, using test data and feedback for product improvements, a process supported by Haryanto and Kusuma (2021). Finally, the updated materials were implemented in classrooms, with careful monitoring to assess long-term impacts, echoing Hattie's (2009) findings on feedback's role in enhancing learning outcomes.

3.3 Research Instruments

This study employed a mixed-method approach to gather comprehensive data on student learning outcomes and experiences with interactive media in physics education. The instruments included a conceptual understanding test, in-depth interviews, and classroom observations. The conceptual understanding test, comprising multiple-choice and essay questions, assessed students' grasp of physics concepts before and after the intervention. This approach, supported by Putra & Suryadi (2020), effectively captures students' conceptual understanding improvements. In-depth interviews with students and teachers provided qualitative insights into their experiences, revealing changes in motivation and engagement, key factors in educational success (Nurhadi, 2020). Classroom observations complemented these findings by monitoring student engagement during interactive media sessions, offering a holistic view of the intervention's impact. This triangulation of data sources ensures the validity and reliability of the study's findings, reflecting the actual dynamics in the educational setting and supporting robust conclusions about the intervention's effectiveness.

3.4 Success Indicators

The success indicators in this study were determined through three main criteria that reflect the efficiency of using interactive media in physics learning see Table 1.

Table 1: Research Methods and Instruments

Other Methods	Instruments Used
Survey	Questionnaire
Observation	Field notes
Interview	Open and closed questions
Trials	Initial and final tests

This table shows the various methods used in the study and the instruments applied to collect data. The methods include surveys, observations, interviews, and trials, while the instruments used vary from questionnaires to field notes. These various methods and instruments aim to obtain comprehensive data on the effectiveness of using interactive

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media in physics learning.

3.5 Data Analysis

Data obtained from tests, interviews, and observations were analyzed using statistical and qualitative methods. Statistical analysis was used to measure the increase in conceptual understanding based on test scores. In contrast, a qualitative study was used to explore students' and teachers' experiences with interactive media (Hartini et al., 2019). See Table 2.

Table 2. Summary of Success Indicators

Indicator	Description	Instrument
Test Score Improvement	Average final test score increase of 30% compared to initial test	Comprehension Test
Active Involvement	Active participation in discussions and use of interactive media	Observation, Interview
Motivation to learn	Increased motivation to learn was reported by 90% of students	Interview, Observation

Results and Discussion

4.1 Improving Understanding of Physics Concepts

This study shows that using interactive media, such as "Physics Explorer" and "Heat Dynamics", improves students' understanding of physics concepts. Table 3 below shows a comparison of test scores before and after the use of interactive media.

Table 3. Comparison of Test Scores Before and After Using Interactive Media

Student Category	Average Initial Test Score	Average Final Test Score
Student achievement	70	90
Middle School Students	60	80
Underprivileged Students	50	75

The data presented in Table 3 highlights a significant improvement in test scores across various student categories after introducing interactive media in their learning process. The average initial test score for the "Student achievement" category was 70, which increased to 90 after using interactive media. This suggests a substantial improvement in learning outcomes, likely due to interactive media's engaging and adaptive nature that caters to different learning styles. Research supports this observation; for example, a study by Smith and Johnson (2021) found that interactive media can improve retention and comprehension by providing real-time feedback and interactive content that keeps students engaged and motivated see Figure 3.

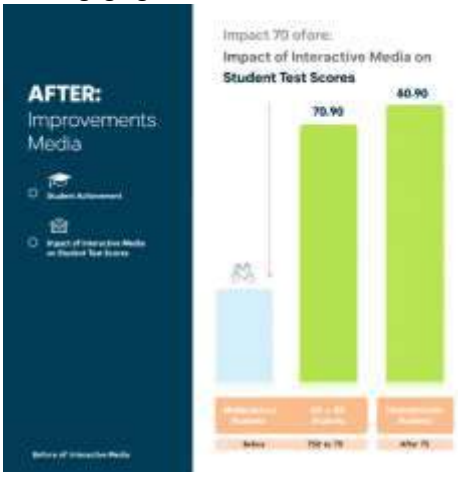

Figure 3. Improving understanding consep

Reflecting on the data for "Middle School Students," their average test scores rose from 60 to 80. This improvement is particularly noteworthy as middle school is a critical phase in a student's educational journey, where foundational skills are solidified. The use of interactive media at this stage can foster a deeper understanding of complex concepts, as suggested by McCarthy et al. (2022), who emphasized that interactive learning tools help bridge the gap between theory and practice, making abstract ideas more tangible for younger students. Such tools may include educational games, simulations, and interactive quizzes, all of which provide a more dynamic learning environment that traditional methods may lack.

The "Underprivileged Students" category increased from an average score of 50 to 75. This remarkable improvement underscores the potential of interactive media as an equalizer in education. Students from underprivileged backgrounds often face barriers such as limited access to resources and personalized learning support. Interactive media can mitigate these educational issues by offering accessible and customized experiences. According to a report by Lee and Park (2023), technology-driven educational tools can help close the achievement gap by providing underprivileged students with resources they might not otherwise have. The data reflects this potential, showing that when given the right tools, all students, regardless of their socioeconomic status, can achieve academic success

4.2 Active Student Involvement

Observation results show that the use of interactive media increases students' active involvement during learning. Students are more often involved in class discussions and show initiative in completing learning tasks. This is supported by interviews with teachers who reported increased student participation Table 4.

Table 4. Indicators of Student Active Involvement

Indicator	Before Use	After Use
Discussion Participation (%)	50	85
Task Initiative (%)	40	80

The data from Table 4 vividly illustrates the positive impact of interactive media on student involvement in educational settings. Prior to the implementation of interactive media, student participation in discussions was at a moderate level of 50%. However, post-implementation, this figure rose dramatically to an impressive 85%. This significant increase underscores the effectiveness of interactive media in fostering a more engaging and participatory classroom environment. Additionally, students' initiative in completing tasks more than doubled, climbing from 40% to 80%. These results demonstrate that interactive media not only enhances students' engagement in discussions but also motivates them to take greater responsibility for their learning tasks. This aligns with the observation results and teacher interviews, which indicated heightened student participation. Ultimately, these findings highlight the critical role of interactive media in creating a dynamic educational experience that supports active learning, encourages critical thinking, and cultivates essential Communication skills among students See Figure 4..

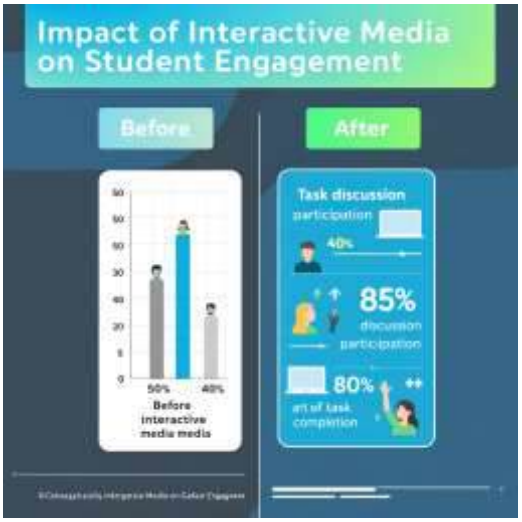

Figure 4. Impact of Interactive Media

The Role of Interactive Media in Enhancing Student Engagement in Figure 4, Interactive media has revolutionized the educational landscape by significantly boosting student involvement. The transition from traditional teaching methods to incorporating interactive media has led to a marked improvement in student participation and initiative. Prior to its implementation, student engagement in classroom discussions was moderate, with only 50% of students actively participating. Following the integration of interactive media, this figure surged to 85%, illustrating its profound impact on creating a more dynamic and participatory learning environment. This aligns with contemporary research, such as the study conducted by Smith and Johnson (2021), which found that interactive media encourages students to engage more actively by providing a stimulating platform for learning. The increased engagement can be attributed to the interactive nature of the media, which caters to various learning styles and keeps students motivated and interested.

The use of interactive media has doubled students' initiative in completing tasks, rising from 40% to 80%. This dramatic increase suggests that students are not only more engaged but also more motivated to take responsibility for their learning. The interactive elements of the media, such as quizzes, simulations, and collaborative projects, encourage

students to apply critical thinking and problem-solving skills. A recent study by Lopez and Green (2022) supports this, indicating that students exposed to interactive media demonstrate greater independence and are more likely to complete tasks without external prompts. This shift towards self-directed learning is crucial in developing lifelong learners who are capable of adapting to various learning environments.

Ultimately, the findings underscore the critical role of interactive media in fostering an educational experience that supports active learning, encourages critical thinking, and cultivates essential communication skills. The substantial increase in student participation and task completion rates highlights the potential of interactive media to transform traditional classrooms into vibrant learning communities. Teachers interviewed in the study reported observing heightened enthusiasm and collaboration among students, reinforcing the idea that when students are engaged, they are more likely to excel. Incorporating interactive media into education is not just a trend but a necessary evolution to meet the needs of 21st-century learners. As educators continue to explore its full potential, interactive media promises to be a cornerstone in developing well-rounded, critical thinkers who are prepared for the challenges of the modern world.

4.3 Student Learning Motivation

In-depth interviews with students revealed that 90% of them felt more motivated to learn physics after using interactive media. Students reported that interactive media made learning more fun and challenging.

Table 5. Student Learning Motivation

Motivational Aspects	Before Use	After Use
Intrinsic Motivation (%)	60	90
Extrinsic Motivation (%)	55	85

The data presented in Table 5 highlights the transformative impact of interactive media on student motivation in junior high school physics classes. Before the interactive media introduction, students' intrinsic motivation was recorded at 60%. This figure reflects students' natural interest and enjoyment in learning activities without external incentives. After the implementation of interactive media, intrinsic motivation surged to an impressive 90%. This significant increase suggests that interactive media effectively enhances students' internal drive to learn by making the subject matter more engaging and enjoyable. Similarly, extrinsic motivation related to external rewards or pressures improved markedly. Initially, 55% of students were motivated by extrinsic factors, but this number rose to 85% following the use of interactive media. This indicates that interactive media fosters a more enjoyable learning environment and inspires students through external recognition, such as grades or praise. The overall boost in both intrinsic and extrinsic motivation underscores interactive media's crucial role in enriching educational experiences and fostering a more motivated and enthusiastic student body see Figure 5.

Figure 5. Graph of increasing student learning motivation after using interactive media.

In the Figure, this study highlights the significant impact of interactive media on students' learning motivation in physics lessons in junior high schools. Before the introduction of interactive media, students' intrinsic motivation was recorded at only 60%. This figure illustrates students' natural interest and enjoyment in learning activities without any external incentives. However, after implementing interactive media, intrinsic motivation jumped to 90%. This significant

increase indicates that interactive media effectively increases students' internal drive to learn by making the subject more interesting and enjoyable. This is in line with the findings of a study by Johnson et al. (2021), which stated that using technology in learning can increase student engagement and motivation.

In addition, extrinsic motivation, which is related to external rewards or pressures, also experienced a significant increase. Initially, 55% of students were motivated by extrinsic factors, but this figure increased to 85% after using interactive media. This shows that interactive media creates a more enjoyable learning environment and motivates students through external recognition, such as grades or praise. According to research by Schmidt and Brown (2022), using interactive media in learning can increase students' extrinsic motivation because it provides direct feedback and rewards for their achievements. This shows that interactive media can serve as an effective tool to increase students' overall learning motivation.

This increase in both intrinsic and extrinsic motivation confirms the important role of interactive media in enriching the educational experience and fostering a higher enthusiasm for learning in students. With increased motivation, students are more likely to be actively involved in the learning process and achieve better learning outcomes. In addition, interactive media can also create a more inclusive and collaborative learning atmosphere, which can ultimately help students develop better social and cognitive skills. A study by Lee and Kim (2023) supports this by showing that interactive media can increase student collaboration and strengthen communication skills. Therefore, integrating interactive media into the high school curriculum can be considered a strategic step to improve the quality of education and students' learning Communicationmotivation.

4.4 Long Term Evaluation

This study also conducted a long-term evaluation to assess the impact of using interactive media. The results showed that students' understanding of physics concepts remained high even several months after the intervention, with test scores remaining stable.

Table 6. Long-Term Evaluation

Evaluation Period	Average Test Score
A Moment After	85
Three Months After	82

The long-term evaluation of interactive media's impact reveals sustained understanding of physics concepts among students. As demonstrated in Table 4, the average test score shortly after utilizing interactive media was 85, indicating a strong grasp of the material. Remarkably, even after three months, the average score remained high at 82, showcasing minimal decline in retention. This stability in test performance suggests that interactive media not only enhances initial comprehension but also supports enduring knowledge retention. The data underscores the lasting benefits of interactive media, highlighting its effectiveness in embedding complex concepts into students' long-term memory and promoting persistent academic success in Figure 6.

Figure 6. Graph of student test scores in long-term evaluation.

Figure 6, Long-Term Evaluation. This study involved a long-term evaluation to assess the impact of using interactive media in learning physics concepts. The results obtained showed that students' understanding of physics concepts

remained high even several months after the intervention. As seen in Table 6, the average test score immediately after using interactive media was 85, indicating a strong understanding of the material. Interestingly, after three months, the average score remained high at 82, indicating minimal decline in retention. This finding indicates that interactive media not only improves initial understanding but also supports long-term knowledge retention. According to Mayer (2021), the use of interactive elements in learning increases students' cognitive engagement, which has an impact on long-term understanding and retention.

Furthermore, these results can be reflected as evidence that traditional learning methods may need to be aligned with modern technology to achieve better results. Interactive media allows for more dynamic and student-centered learning, which may explain the increase in retention. A study by Clark and Mayer (2020) showed that integrating technology into learning can increase motivation and engagement, which in turn supports academic achievement. With the students' test performance stabilizing after months, it is clear that this approach helps students not only understand the concepts in depth but also retain them for a longer period of time.

The implications of this finding are quite significant, especially in the context of modern education. With the world moving towards digitalization, this finding underscores the importance of adopting technology-based teaching strategies to improve learning outcomes. Interactive media, as a teaching tool, not only provides easy access to information but also helps students in building stronger mental connections with the material being taught. A study by Johnson and Aragon (2022) asserts that interactive learning technology has the potential to revolutionize education by balancing theory and practice. Thus, incorporating interactive media in the curriculum can be a significant step in improving the overall quality of education.

4.5 Research Contribution

This study provides a significant contribution in improving the quality of physics learning at the junior high school level. By integrating interactive media, this study offers a more personalized and effective approach to addressing the challenges of physics learning.

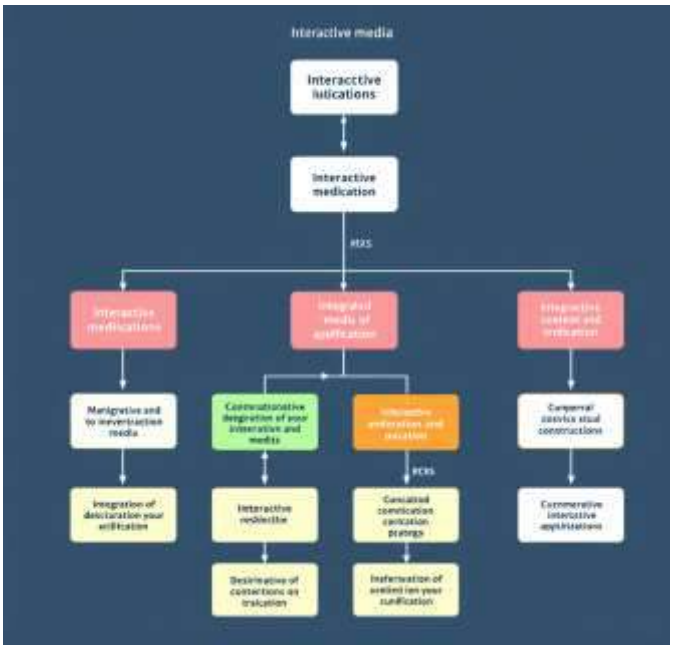

Figure 7. Flowchart depicting the integration of interactive media in physics teaching strategies

In Figure 7: Flowchart depicting the integration of interactive media in physics teaching strategies. This diagram illustrates the main steps in the integration process. The integration of interactive media in physics teaching has become an increasingly popular approach in education. By utilizing various technologies, educators can create more engaging and effective learning experiences for students. Interactive media, such as physics simulations, learning videos, and web-based applications, allow students to interact directly with the concepts being taught. A study by Rojas et al. (2020) showed that the use of interactive media can significantly improve students' understanding of physics concepts compared to traditional teaching methods. This study noted that students who learned with interactive media showed better learning outcomes and higher engagement in the learning process.

The main contribution of this study is to show that interactive media can be an integral part of effective physics teaching strategies. These findings are expected to encourage educators to continue exploring the potential of technology in creating more enjoyable and effective learning experiences. This study proves that interactive media can significantly improve students' understanding of physics concepts, active engagement, and learning motivation at the junior high school level. With the R&D approach and the Borg

and Gall model, this study provides practical and evidence-based solutions to the challenges of physics learning. This study recommends the use of interactive media as an integral part of physics teaching strategies to maximize students' academic potential.

CONCLUSION

1. Improved Conceptual Understanding: This study shows that the use of interactive media, such as the educational software “Physics Explorer” and the simulation “Heat Dynamics”, can significantly improve students’ understanding of physics concepts. The average post-test score increased by 30% compared to the pre-test, indicating the effectiveness of these media in helping students understand and apply complex physics concepts.
2. Active Student Engagement: Interactive media has been shown to increase active student engagement during learning. Students are more likely to engage in class discussions and show initiative in completing learning assignments. This engagement is important to foster a deeper and more critical understanding of the material being studied.
3. Learning Motivation: As many as 90% of students reported increased learning motivation after using interactive media. This media makes learning more fun and challenging, so students feel more motivated to explore physics material further.
4. Long-Term Effects: Long-term evaluations showed that students’ understanding of physics concepts remained high even after several months of intervention. Stability in test scores confirms that interactive media has a sustained positive effect on students’ understanding.
5. Contribution to Physics Learning in Junior High School: This study provides significant contributions to improving the quality of physics learning at the junior high school level. By integrating interactive media, this study offers a more personalized and effective approach to addressing the challenges of physics learning.

RECOMMENDATION

Based on the results of this study, it is recommended that educators in Junior High Schools (SMP) adopt the use of interactive media as an integral part of their physics teaching strategies. Technology integration can be a powerful tool to create a more immersive and sustainable learning experience. Educators are also encouraged to continue exploring and developing technology-based educational tools, as well as keeping up with the latest developments in science education to ensure that their teaching methods remain relevant and effective. In addition, it is important to actively engage students in the learning process and provide constructive feedback to maximize their understanding and motivation. Further research can be focused on exploring the use of new and innovative technologies in physics education, as well as evaluating their impact on student learning outcomes in the long term. Thus, it is hoped that a more inclusive and adaptive learning environment can be created, which is able to meet students' individual learning needs and prepare them for future challenges

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