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Powering Up Learning: How Interactive PowerPoint Transforms Student Engagement and Outcomes in Biology

Dea Andini*, Hasmi Syahputra Harahap & Rusdi Machrizal
Universitas Labuhanbatu, Rantau Prapat, Indonesia
andinidea80@gmail.com *

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ABSTRACT

Innovative learning media, designed to meet students' needs, can boost motivation and improve learning outcomes. One such medium is interactive PowerPoint. This study aims to explore how developing interactive PowerPoint presentations affects students' motivation and their understanding of virus-related biology material. We adopted an experimental approach, comparing the effects on a control group and an experimental group chosen through random sampling. We assessed motivation through questionnaires and learning outcomes with multiple-choice tests, analyzing the data with covariance analysis (ANCOVA) at a significance level of 0.05 using SPSS 21.0. Our findings reveal that interactive PowerPoint significantly enhances both student motivation and learning achievements. Specifically, students learning with interactive PowerPoint (average score of 44.19 ± 13.175) performed significantly better than those in the control group (average score of 34.49 ± 12.433). Furthermore, motivation levels in class X3 (83.38 ± 6.605) were notably higher than in class X4 (82.58 ± 8.866). These results underline the impactful role of interactive PowerPoint in biology education, particularly for virus topics, suggesting it's a valuable addition to the curriculum. This finding offers fresh insight into the ongoing relevance and effectiveness of PowerPoint as an educational tool in biology, demonstrating its substantial benefits in presenting biological concepts in modern teaching strategies.

1. Introduction

In the rapidly changing world of educational technology, educators are constantly seeking new ways to boost student interest, motivation, and achievement. At the heart of these efforts is the belief that the right learning tools can dramatically improve the educational journey, making it more captivating, personalized, easily accessible, and relevant to students' lives. Schools and colleges are not just focusing on enhancing students' knowledge and behaviors as highlighted by De Jong and Den Hartog (2010), but they are also striving to create a nurturing environment where students can thrive throughout their learning journey, as emphasized by Hafidhah (2023), Indriani et al. (2023), and Putri & Nurafni (2021).

Understanding that learning is an ongoing, experiential process that shapes individuals by demanding their active engagement and adherence to educational principles is key (Baharuddin, 2021; The World Bank, 2020). Therefore, blending active learning techniques, constructivist theories, and structured teaching strategies is critical for crafting educational experiences that foster engagement, motivation, and the thorough acquisition of knowledge. By integrating these research-backed practices, teachers can create teaching and learning environments, methods, and materials that meet the varied needs of students, thereby boosting learning outcomes (Oliver & Jacobs, 2007; Müller et al., 2023). The application of constructivist theories and adult learning concepts is particularly important in designing these effective educational settings (Sait & Tombs, 2021; Ruey, 2010).

Teaching biology, with its need for a profound grasp of concepts and long-term memory retention, presents a distinct challenge. Conventional teaching approaches, such as lectures, often do not keep students engaged, highlighting a significant shortfall in educational strategies (Yerdelen, 2014; Wahyuni et al., 2021). The link between engaging learning materials and increased student motivation is well-established, with such materials having the potential to spark intrinsic motivation and make learning more relevant and enjoyable (Bulic, 2020; Aini et al., 2019; Pratama, 2021).

In today's digital era, adapting educational methods to accommodate different learning styles by incorporating technology into learning materials is crucial. Interactive tools, online simulations, and multimedia presentations offer dynamic and engaging learning experiences that significantly boost student motivation (Sahronih et al., 2020; Yasin & Budiana, 2022).

Using interactive PowerPoint slides in classrooms improves student engagement and participation. These slides allow students to engage with a variety of learning materials and technologies, including readings, podcasts, videos, and websites, at their own pace, deepening their content understanding (Pakpour et al., 2021). Additionally, incorporating gaming elements into teaching with interactive PowerPoint slides, a method known as gamification, adds an exciting dimension to learning that encourages participation (Partiyatun & Jazuli, 2023).

Moreover, PowerPoint slides designed with accessibility features help all students, including those with disabilities, by enhancing content comprehension and accessibility (Fichten et al., 2019). The way PowerPoint slides are designed can significantly affect students' performance and preferences in learning contexts (Holstead, 2015). Experts recommend that instructors avoid overloading slides with text to maximize learning and retention (Holstead, 2015). Instead, creating visually appealing and concise slides that support the learning material is suggested to help students understand better (Brock & Joglekar, 2011). Studies have shown that students generally have a positive response to lectures that utilize PowerPoint slides, which simplify content, offer multimedia support, and help in navigating course materials, thus improving the overall learning experience (Ng & Ranti, 2022; Uzun & Kilis, 2022).

Echoing the above explanations, this study investigates the effects of interactive PowerPoint media on the motivation and comprehension of high school students studying viral biology topics. It addresses the educational challenge of engaging students with complex biological concepts through a quantitative research approach, involving an experimental and a control group with Class X students at SMA Negeri 2 Rantau Selatan. The research methodology included pre-tests and post-tests, ensuring the instruments used were validated for reliability and validity (Sugiyono, 2019).

The novelty of this research lies in its examination of how interactive PowerPoint can be used to increase student engagement and understanding in the study of viruses within biology. It uncovers significant gaps in current teaching practices, particularly in presenting challenging and abstract materials effectively. The findings suggest that integrating digital tools like interactive PowerPoint into biology curriculums could revolutionize how students interact with complex scientific concepts. This research not only adds to the academic discussion on the use of educational technology but also provides practical recommendations for educators looking to improve student engagement and learning outcomes in biology. Demonstrating the positive impact of interactive PowerPoint on both student motivation and achievement, this study calls for a reassessment of traditional teaching methods in favor of more innovative approaches suited to today's digital learners.

2. Literature Review

Motivation is essential in driving learner engagement, persistence, and ultimate success in their educational endeavors. The lack of motivation can lead to a motivational crisis, often arising from personal challenges, a disinterest in the subject matter, or unclear goals. Personal struggles such as stress and external pressures can significantly impede a learner's ability to focus and engage with their studies. Deci and Ryan (2000) underscore the importance of fostering intrinsic motivation through autonomy, competence, and relatedness to reignite learners' passion for education. Furthermore, the perception of content as irrelevant can lead to diminished motivation, suggesting the need for educators to incorporate real-world applications, interactive activities, and project-based learning to enhance appeal (Hidi & Renninger, 2006). The lack of clear objectives further contributes to motivational challenges, making the setting of explicit goals, provision of feedback, and cultivation of a supportive educational environment crucial for maintaining motivation and improving learning outcomes (Locke & Latham, 2002).

The quest for improved learning outcomes, characterized by a deeper understanding and retention of information, highlights the importance of learning media, including textbooks, online courses, videos, simulations, and interactive platforms (Prawita, 2019; Wahyuni et al., 2021; Wahyuni & Reswita, 2018). Effective learning media can significantly enhance engagement, cater to diverse learning preferences, and offer interactive experiences. Tailoring learning media to individual preferences and enabling access to materials at any time can make education more inclusive and address barriers to motivation. The integration of practical examples and immediate feedback within learning media can motivate students by demonstrating the relevance of the content to their personal and professional lives, with innovative technologies like virtual reality or gamification adding a dynamic aspect to education (Prasetyaningtyas, 2021).

In the context of biology, these principles of motivation and learning outcomes are particularly pertinent. Biology, with its complex concepts and vast amount of detail, requires a motivated and engaged approach to learning. Addressing motivational challenges through personalized, engaging, and

innovative learning media can significantly impact students' understanding and retention of biological concepts. Active engagement, relevant assessments, and the application of critical thinking in studying biology can transform the learning experience, making it more meaningful and applicable to real-world scenarios. By employing diverse teaching methods and fostering an inclusive learning environment, educators can enhance students' motivation and learning outcomes in biology, preparing them for future challenges and opportunities in the field (Nasution et al., 2023). This holistic approach to biology education seeks to empower students, enabling them to navigate the complexities of biology with confidence and curiosity.

3. Method

3.1. Type of Research and Sampling

This study adopted a quantitative research approach with an experimental design method, focusing on the influence of Interactive PowerPoint on biology learning outcomes. The research encompassed the entire tenth grade at SMA Negeri 2 Rantau Selatan, totaling 252 students, with a selected sample of 68 students. This sample was divided equally into two groups: 34 students in the experimental group and 34 in the control group, for the odd semester of the 2022/2023 academic year. Classes X.3 (experimental) and X.4 (control) were chosen through random sampling from four tenth-grade classes.

This present study aimed to measure the impact of using Interactive PowerPoint media on biology learning outcomes, employing descriptive statistics, normality tests, homogeneity tests, and hypothesis testing for research design. A multiple-choice test, consisting of 25 questions, was used to collect data, requiring validity and reliability testing through the Biserial Point formula and Kuder Richardson formula, respectively, to ensure the questions' appropriateness for research (Sugiyono, 2019).

Table 1. Research Design

Group	Pre-Test	Treatment	Posttest
A	T	X3	T
B	T	X4	T

Table 1 presents the research design, indicating the group, pre-test, treatment, and post-test stages. Group A involved the experimental treatment using Interactive PowerPoint for virus education, whereas Group B served as the control, utilizing conventional teaching methods without Interactive PowerPoint. The focus was on assessing students' critical thinking skills, comparing the effects of experimental (X3) and control (X4) treatments.

3.2. Research Instruments

The study recognized the necessity of precise measuring tools, referred to as research instruments. These instruments included a student motivation questionnaire for gauging learning motivation and a multiple-choice format for assessing learning outcomes, as outlined by Sugiyono (2012).

3.3. Data collection technique

Data collection encompassed a variety of methods, including observation, interviews, questionnaires, pre-tests, post-tests, documentation, and validation sheets, ensuring a comprehensive approach to gathering relevant data.

3.4. Data Analysis Techniques

Data analysis involved two primary stages: requirements testing and hypothesis testing. The process began with converting student scores into a 100-point scale, followed by calculating variable averages. Data testing included a normality check using the *Lilliefors* test to determine the distribution of sample data (Sudjana, 1992). The homogeneity of data was assessed using Fisher's formula, and hypothesis testing was conducted through a t-test to evaluate the effect of the learning media on biology learning outcomes. The analysis utilized descriptive statistical techniques to interpret the findings.

4. Result

This study examines the impact of interactive PowerPoint presentations on high school biology students' motivation and academic achievements, specifically regarding virus-related content. Employing a solid experimental design, we compared the effectiveness of traditional teaching methods with that of PowerPoint-assisted learning in a sample of 68 students, divided into control and experimental groups. Through detailed statistical analysis, our research aimed to confirm that using interactive PowerPoint as an innovative learning tool can significantly enhance the educational experience, resulting in better student motivation and outcomes.

4.1. Description of Research Results

The results of this research were used to see whether the use of interactive learning media Power Point had an effect on the learning outcomes of class X SMA Negeri 2 Rantau Selatan students. The results of descriptive analysis show that the highest learning result is 55 and the lowest is 5 in the pre-test. Meanwhile, in the post-test the highest learning result was 75 and the lowest was 15. The pretest average was 34.49 ±12.433 ($\bar{X}$ ±SD) and the post test average was 44.19 ±13.175 ($\bar{X}$ ± elementary school). The distribution of data can be seen in the table below

Table 2. Statistical Data Analysis of Learning Outcomes

		Statistics	
		Pre-Test	Post Test
N	*Valid*	68	68
	Missing	0	0
Mean		34,49	44,19
Std.Error of mean		1.508	1.598
Median		35.00	45.00
Mode		25	45
Std.Deviation		12.433	13.175
Variance		154.528	173.590
Range		50	60
Minimum		5	15
Maximum		55	75
Sum		2345	3005

The results of the descriptive analysis showed that the highest learning motivation in class X3 was 93 and the lowest was 64. Meanwhile, the highest learning motivation in class X4 was 100 and the lowest was 64. The average learning motivation in class X3 is 83.38 ± 6,605 (elementary school) $\bar{X}$ ±and the average learning motivation in class X4 is 82.58 8,866 (± elementary school) $\bar{X}$± . The distribution of data can be seen in the table below:

Table 2. Statistical Data Analysis of Learning Motivation

		Statistics	
		Pre-Test	Post Test
N	*Valid*	34	34
Missing		0	0
Mean		83.38	82.58
Std.Error of mean		1.132	1.52
Median		84.50	84.00
Mode		83.00	84.00
Std.Deviation		6.605	8.866
Variance		43.637	78.613
Range		29.00	36.00
Minimum		64.00	64.00
Maximum		93.00	100.00
Sum		2835.00	2808.00

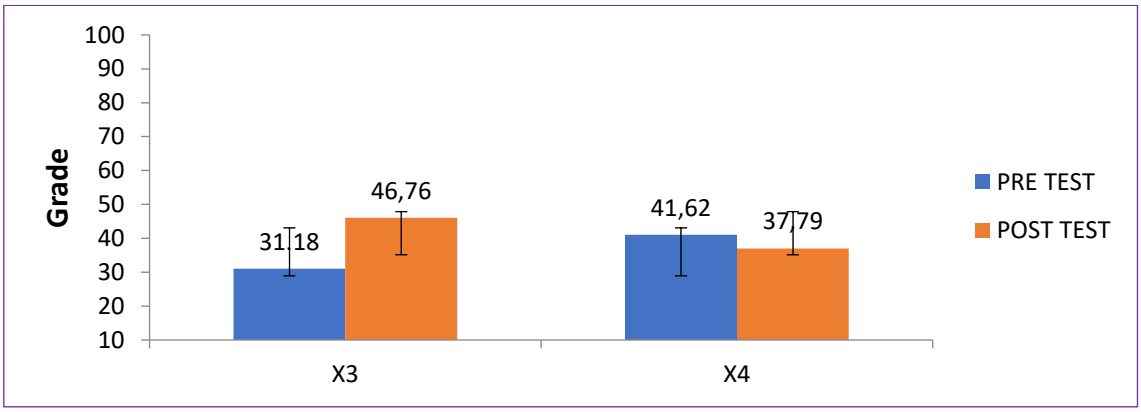

Figure 1. Student Learning Outcomes

Figure 1. The average score of pretest and posttest in class X at SMA Negeri 2 Rantau Selatan with class X3 learning results in pretest 32.18 and posttest results of 47.76. The average score of class X4 learning outcomes on the pretest was 41.62 and the posttest results were 37.79.

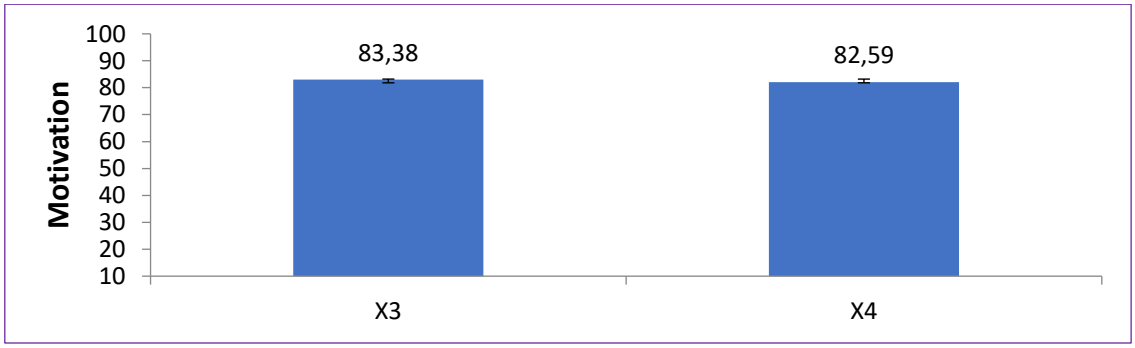

Figure 2. Student Learning Motivation

Figure 2. Bar diagram of the percentage of students' learning motivation in class X at SMA Negeri 2 Rantau Selatan. The average value of learning motivation for class X3 is 83.38 and the average value of learning motivation for class X4 is 82.59.

4.2. Normality Test

The distribution of pretest and posttest data on student learning outcomes using *Power Point* Interactive media can be seen in table 3 below:

Table 3. Learning Outcome Normality Test

	Kolmogorov- Smirnov a			
	Statistic	Df	Sig	Judge
Experiment Class				
Pre-Test	.141	34	.086	Normal
Post Test	.130	34	.160	
Class Control				
Pre-Test	.094	34	.200*	Normal
Post Test	.132	34	.138	

From the table above, that the learning outcomes of testing the normality of data on the pretest and posttest of the ability of student learning outcomes from each class show that the distribution of data is normally distributed (P>0.05). The distribution of student motivation results in learning Biology is carried out using questionnaires and can be seen in table 4 below:

Table 4. Learning Motivation Normality Test

Kolmogorov- Smirnov and Learning Motivation		
Df	*Sig*	*Description*
CLASS X3	*34.005*	*Abnormal*
CLASS X4	*34.112*	*Normal*

From the table above, the motivation to learn data normality testing against class X3 shows abnormal. The ability of student motivation in class X4 shows that the distribution of data is normally distributed (P>0.05).

4.3. Homogeneity Test

The results of the homogeneity test of pretest and posttest data on student learning outcomes can be seen in the following table 5:

Table 5. Test the Homogeneity of Learning Outcomes and Learning Motivation

X Df	*Sig*	*Class Results*	*Description*
Learning Outcomes		132.639	*Normal*
Learning motivation		66.099	*Normal*

The results of the homogeneity test of the pretest data of student learning outcomes of students were declared homogeneous (P = 0.639>0.05) The homogeneity test results of student learning motivation data were declared homogeneous (P = 0.099>0.05)

4.4. Data Analysis

Hypothesis testing was carried out using the Covariate analysis technique (Anacova) for students' critical thinking abilities based on learning outcomes by measuring pretest and posttest data. The results of Covariate analysis (Anacova) with the help of *SPSS 21.0* show that learning methods significantly influence student learning outcomes. Furthermore, the *Tukey* test results show that the learning outcomes of class X students with an average pretest are 34.49 ±12.433 ($\bar{X}$ ±SD) and the post test average was 44.19 ±13.175 ($\bar{X}$ ±elementary school). *Tukey* test results show that learning motivation in class X3 is 83.38 ±6.605 ($\bar{X}$ ±SD) and the average learning motivation in class X4 is 82.58 ±8.866 ($\bar{X}$ ±elementary school).

Test data results *Tukey* stated that student learning outcomes had a significant influence on learning outcomes (P=0.00<0.05). The results of the *Tukey* test data on student learning motivation stated that there was a significant influence (P=0.00<0.05). Therefore, it can be concluded that interactive *Power Point media* has an influence on learning outcomes in Biology lessons on virus material, where the average student learning outcomes in classes that use interactive *Power Point media* are greater than those in control classes.

5. Discussion

The results of this research were used to see whether the use of interactive *Power Point media* had an effect on the learning outcomes of class X students at SMA Negeri 2 Rantau Selatan. The results of descriptive analysis show that the highest learning result is 55 and the lowest is 5 in the pre-test. Meanwhile, in the post-test the highest learning result was 75 and the lowest was 15. The pretest average was 34.49 ±12.433 ($\bar{X}$ ±SD) and the post test average was 44.19 ±13.175 ($\bar{X}$ ±elementary school). The normality test was carried out on the pre-test and post-test data for the experimental class and control class. The normality test is obtained by the *Kolmogrov-Smirnov test* . The normality test is used to assess whether the data meets a normal distribution, as long as the data

meets the standard sig value > 0.05, then it meets the normal distribution. The results of the normality test show the *Kolmogrov-Smirnov sig value* > 0.05 for all learning outcomes of class X pre-test and post-test data. The experimental class in the pre-test sig value. 0.086 > 0.05 and post test 0.160 > 0.05. Meanwhile, for the control class, the pre-test data had a sig value of 0.200 > 0.05 and pre-test 0.138 > 0.05. For learning motivation, the normality test results show a *Kolmogrov-Smirnov sig value* > 0.05 for the experimental class with a sig value. 0.005 > 0.05 means the data is not normal while the control class for learning motivation with sig. 0.112 > 0.05 is normal.

The homogeneity test results show a *sig value* > 0.05 in class X learning outcomes with a sig value. 0.639 > 0.05 with homogeneous value results. In class X learning motivation with a sig value. 0.099 > 0.05 means the data is homogeneous. Because the data was normally distributed, this research was continued using the T-test. The T-test results show that the output pair 1 gets a sig value, (2- *tailed*) 0.000 < 0.05. This means that Ha is accepted and H0 is rejected so it can be interpreted that there is an influence before being given treatment and after being given treatment by showing a significant difference in average student learning outcomes and student motivation. With the data from the T-test results, student learning outcomes were stated to be significantly different (P=0.00<0.05). For student learning motivation, T test data showed that student learning motivation was significantly different (P=0.00<0.05).

The results of research in the experimental class at SMA Negeri 2 Rantau Selatan class This is related to interactive *Power Point media* which can display learning slides that attract students' attention so that students do not feel bored and with interactive *Power Point media learning* in the process is more student-centered so that students are more active in the learning process in class. This is because of the media Interactive *PowerPoint* can be an interesting tool for presenting biology learning in class so as to improve student learning outcomes and shorten the time in the learning process to deliver the material (Indriani et al., 2023; Palittin et al., 2019; Partiyatun & Jazuli, 2023).

Interactive PowerPoint presentations, known for their engaging mix of images, graphics, and multimedia, effectively convey information through voice, text, and visual aids, enhancing learning experiences by facilitating improved information encoding and retrieval, thus leading to better learning outcomes (Nyamboga et al., 2016). Research suggests that these presentations boost comprehension and motivation by incorporating dynamic elements like animation, videos, and sound, making educational content more captivating and supportive of the learning process (Nakıboğlu & Nakiboğlu, 2021; Christensen et al., 2018; Szabó & Hastings, 2000). Additionally, their adaptability in educational settings allows for a versatile delivery platform that caters to various teaching objectives and learning styles, leveraging technology to enhance student engagement and educational results (Rahmah et al., 2022; Nurkhodri & Dafit, 2022).

This study's findings illustrates the significant impact of interactive PowerPoint presentations on enhancing student engagement and learning outcomes in the context of biology education, specifically virus topics. The visual appeal of PowerPoint, encompassing images, graphics, and multimedia, successfully captivates students' attention, rendering the material more engaging and memorable, thus aligning with previous research (Effiong & Ekpo, 2016; Suaib, 2020; Syahadah et al., 2022). The interactive nature of these presentations, characterized by quizzes, polls, and other engaging components, fosters active student participation and accommodates diverse learning styles (Szabó & Hastings, 2000; Anwar et al., 2020). Such customization makes learning experiences more personal and student-centered, supporting a shift from passive information reception to active exploration and critical thinking, a shift that is further enhanced by the provision of immediate feedback through interactive elements (Kusuma & Utomo, 2022; Rochman, 2021; Simanjuntak et al., 2020).

Moreover, the application of interactive PowerPoint in educational settings has been shown to significantly boost both student motivation and academic performance, reinforcing the transformative potential of integrating such technology-enhanced learning tools into the curriculum (Burke & James, 2008; Onivehu & Ohawuiro, 2018). The findings of this research corroborate with contemporary studies, highlighting the efficacy of interactive PowerPoint presentations in fostering an engaging, dynamic, and immersive learning environment that not only caters to individual learner preferences but also facilitates enhanced learning outcomes and knowledge retention (Cahyani & Ganing, 2022; Kusumawardani et al., 2021).

By leveraging the capabilities of interactive PowerPoint presentations, educators can create more engaging, effective, and personalized learning experiences that actively involve students in their learning processes, encourage critical thinking, and ultimately lead to improved educational outcomes. This study underscores the value of integrating interactive multimedia tools into the teaching and learning of complex subjects like biology, suggesting a reevaluation of traditional teaching approaches in favor of innovative methods that resonate with the digital literacy skills of today's students.

This study explores the transformative potential of interactive PowerPoint media in biology education, focusing on virus topics. The novelty of our research lies in the detailed examination of how such media can revolutionize student engagement and comprehension, filling a critical gap in current educational practices by

offering a dynamic and student-centered approach to learning complex subjects. Our findings underscore the significance of visual and interactive elements in capturing student attention, facilitating a deeper understanding through quizzes, polls, and simulations, and tailoring learning experiences to individual student needs, thereby increasing motivation and learning outcomes (Emda, 2018; Hafidhah, 2023; Uno, 2016).

The implications of our research are profound, suggesting that integrating interactive PowerPoint media into the curriculum could significantly enhance the learning experience by making the material more accessible and engaging. This approach not only supports active learning but also provides immediate feedback, which is crucial for assessing understanding and fostering a sense of ownership over the learning process. By leveraging such media, educators can create a more inclusive and responsive learning environment, thereby improving information retention and facilitating better academic achievement.

Looking ahead, we recommend further investigation into the long-term effects of interactive PowerPoint use across different subjects and educational levels. Additionally, there's a need for developing guidelines for effectively integrating such technologies into teaching practices and training educators to maximize their potential benefits. Future research should also explore the scalability of these tools in various educational settings, ensuring that all students, regardless of their learning style or background, can benefit from the enhanced learning experience interactive PowerPoint media offers.

By advancing our understanding of the role of technology in education, this research contributes to the broader discourse on innovative teaching strategies, emphasizing the importance of adapting educational practices to meet the needs of today's digital learners.

6. Conclusions

In light of the comprehensive investigation and analysis undertaken, This study reveals significant insights into the integration of interactive PowerPoint media within high school biology education, particularly focusing on viral material virus material in class X SMA Negeri 2 Rantau Selatan. The key findings underscore a marked improvement in student motivation and learning outcomes, affirming the efficacy of leveraging technology-enhanced learning tools. The novelty of this research lies in its in-depth exploration of interactive PowerPoint's role in not just enhancing educational delivery but also in actively engaging students with complex biological concepts, thereby bridging notable gaps in traditional teaching methodologies.Looking ahead, future research should investigate the long-term impacts of interactive multimedia on educational outcomes and explore strategies for empowering educators to effectively utilize these technologies. Ultimately, our study advocates for the incorporation of interactive PowerPoint and similar tools into curriculums to enhance the learning experience, underscoring the importance of technology in evolving pedagogical practices for the digital age.

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