Animating the excretory system:
An interactive learning tool for eighth grade students

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Abstract: In Biology class, students face problems understanding the material that seems abstract to observe, such as biological system mechanisms. This study was aimed at developing interactive learning media products based on animated videos using the Unity application in the excretory system lesson for eighth grade and determine the response of teachers and students. This study adapted the ADDIE model to develop interactive learning media. The steps in this study are analysis, design, development, implementation, and evaluation. The findings indicate that the content quality and media quality percentages are 83.35% (very feasible category) and 92.75% (very viable category) respectively. Furthermore, students scored the product in average 84.5% (very feasible category). Meanwhile, the science teachers assessed the product in average 91.7% (very viable category) from the teachers. The results of the Wilcoxon signed-rank test also showed a significant difference between the students' pretest and posttest results. It can be concluded that the interactive learning media based on animated videos can be used as an alternative learning media in the excretory system lesson for eighth grade students.

Keywords: *instructional media, interactive media, animated videos, excretory systems, unity.*

INTRODUCTION

The excretory system is a crucial topic in the science curriculum, particularly for Grade VIII students in Indonesia. Understanding how the excretory system works is essential for understanding human biology and how the body removes waste. Traditional teaching methods, such as textbooks and lectures, may not always be effective in engaging students or helping them understand complex concepts (Handy & Polimeni, 2015; Wittwer & Renkl, 2008; Yap, Neo, & Neo, 2016).

Biology is a subject that contains various facts, concepts, theories and mechanisms, and bioprocesses that occur in multiple forms of life. The biology learning process is often faced with problems in the form of student difficulties in understanding the abstract subject matter, especially in material that contains various biological system mechanisms that are difficult to observe directly. Data from research by (Sani, Sari, & Harahap, 2019), which analyzes the factors of the level of learning difficulties of class XI students of SMAN 10 Rantauprapat on Biology material. of the 70 students who became respondents obtained data on the factors causing student learning difficulties of 80.57% because the teacher's explanation was less understandable, 57.92% because the subject matter seemed abstract, and 70.98% because of problems understanding the school handbook. It shows that for material that seems abstract,

students will find it challenging to understand the material if they only hear the explanation or read the guide without any supporting learning media.

Media is part of the learning process that is no less important than learning methods and strategies. Learning media has a role as a tool to convey information to students. (Jalmur, 2016) states that creative use of media will increase the possibility of students gaining better learning experiences and understanding. Another study also found that Media can give students access to a broader range of information than they would otherwise have (Audie, 2019). Similarly, Umarova (2020) has said that media are effective in the educational process.

Video is a type of digital media that combines text, visuals, and audio. Video as a learning media can overcome the problem of differences in the learning styles of students who are scattered in class (Brame, 2016). A study explained that video as a learning medium can make students enjoy the process of teaching and learning (Kamelia, 2019). A systematic literature review by Noetel et al. (2021) also mentioned that videos could engage students in active learning.

In addition, the display of moving images with a flow in the video is very suitable to help explain material containing mechanisms or bioprocesses. In line with a study by Fauzan Khairil, and Safrida (2019), the learning process of motion system material using learning media in the form of videos resulted in an increase in students' cognitive average scores by 28.5% while learning motion systems using the lecture method using school printed books only resulted in an average score increase of 12.87%. It shows that teaching media in videos can help cognitive students better understand concepts in biology subject matter.

With the advancement of technology, interactive learning tools, such as animation videos, have gained popularity in educational settings (Ayuni, Romadon, & Kusuma, 2022; Hapsari & Hanif, 2019; Khalidiyah, 2015). Animation videos have the potential to enhance student engagement, facilitate visual learning, and promote conceptual understanding (Ismail, Othman, Amiruddin, & Ariffin, 2017). Several developments of interactive learning media have been carried out, for example, Albana and Sujarwo (2021) have developed interactive e-modules which are proven to be effective in increasing learning independence in SMK students. Another study related to interactive learning media conducted by Sartono and Laisaroh (2022) found that Augmented reality-based textbooks were proven to be able to increase the activity and learning achievement of fourth-grade elementary school students. However, the development of interactive learning animation videos targeting the excretory system for grade VIII students is limited. The novelty of this research lies in the combination of two crucial elements: the development of an interactive learning animation video and the utilization of the ADDIE (Analysis, Design, Development, Implementation, Evaluation) model, specifically for the topic of the excretory system in Grade VIIIscience education. By developing an interactive learning animation video, this research introduces a novel approach to engage students, promote visual learning, and enhance their understanding of the excretory system. Furthermore, ADDIE model in creating an interactive learning animation video is a unique and innovative use of the model tailored explicitly to the excretory system topic for grade VIII students.

The development of an interactive learning animation video will be designed using the ADDIE model, which involves analyzing the learners' needs, creating the instructional content, developing the animation video, implementing it in the classroom, and evaluating its effectiveness. The research will focus on grade VIII students as the target audience due to

their developmental stage and relevance to the science curriculum. By utilizing an interactive learning animation video using Unity application, the research aims to enhance students' understanding of the excretory system and determine the response of teachers and students towards the animation video.

METHOD

The ADDIE model is a systematic instructional research design framework widely used in educational research (Albana & Sujarwo, 2021; Mahardika, Pertiwi, & Miriam, 2021; Hakim, Lubis, & Khaokhajorn, 2022; Pujiastuti, Haryadi, & Arifin, 2020; Ranuharja, Ganefri, Fajri, Prasetya, & Samala, 2021; Widyastuti, 2019). This model provides a structured approach to designing and developing effective learning materials. By employing the ADDIE model, researchers can ensure that the instructional materials align with the specific needs and characteristics of the target audience. The ADDIE model includes Analysis, Design, Development, Implementation, and Evaluation.

The analysis stage is the initial stage in the learning media development process. At this stage the researcher conducts three types of analysis: needs analysis, learning objectives analysis and material analysis. The design stage aims to create a prototype or initial frame of the media before the media is developed. The development stage is the primary process in realizing the design made at the design stage into actual multimedia. This interactive video-based learning media uses Unity as the leading software, Adobe audition CS5 for audio settings, and Android Software Development Kit (SDK) to convert project files from Unity into an android application. The implementation stage tests interactive video-based learning media developed by implementing or applying it to students' learning activities. The implementation stage involved 58 grade VIII students and 2 teachers from two schools. Those students were from MTsN 1 Cimahi City (30 students) and Assalafiyah Integrated Junior High School (28 students). Then, the stage of development is evaluation. Evaluation stage is a crucial component of the ADDIE model as it helps assess the effectiveness of the instructional program and identify areas for improvement.

The testing for this research is divided into two stages, namely the validity test stage by material experts and media experts on the product before implementation and the product trial stage for students and teachers. The validity test was carried out by lecturers from the Faculty of Tarbiyah and Keguruan UIN Syarif Jakarta as media experts, material experts and instrument validators. The product trial subjects were conducted on Science Teachers and Students of grade VIII MTsN 1 Cimahi City and Science Teachers and Students of grade VIII A SMPT Assalafiyah in the 2021/2022 school year.

The research instruments used are teacher interview guidelines, needs analysis questionnaires, media feasibility validation questionnaires from the experts, teacher and student response questionnaires and cognitive question instruments in the form of pretests and posttests. Furthermore, data in the form of input and suggestions from validators were analyzed qualitatively descriptively for media improvement while the results of filling out the media assessment questionnaire by each validator and the media response questionnaire by respondents were analyzed quantitatively to determine the product feasibility value using the calculation according to (Saputra, 2021) with the formula (1). The results of these calculations are then interpreted with categorization according to (Saputra, 2021) as seen in Table 1.

$$P = \frac{f}{N} \times 100\%$$ (1)

Notes:

P = Feasibility Percentage Score
f   = Raw score obtained
N = Maximum score

Table 1
Product feasibility interpretation

Ratings (%)	Category
81-100	Very Feasible
61-80	Feasible
41-60	Quite Feasible
21-40	Unfeasible
0-20	Very Unfeasible

The paired t-test is a statistical test used to analyze the significant difference between the mean scores of the pretest and posttest within the same group of students (Zientek, Nimon, & Hammack-Brown, 2016) when the data is normally distributed or met the classical assumption. On the other hand, it may be necessary to use a non-parametric test, such as the Wilcoxon signed-rank test. In our study, we are interested in evaluating the effectiveness of interactive excretory animation video learning media on students' learning outcomes. This study used either a paired t-test or Wilcoxon signed-rank test to compare each student's pretest and posttest scores directly. This within-subject comparison is crucial because it considers the inherent variability and individual differences among the students. In other words, the paired t-test allows us to assess how each student's scores change after exposure to the interactive excretory animation video learning media. IBM SPSS Statistics 20 Software was used in this study as a data analysis tool. With a significant level of 5%, and the results obtained were feasible to be used as research samples. Hypothesis statement for the paired t-test that compares the mean scores of the pretest and posttest within the same group of students:
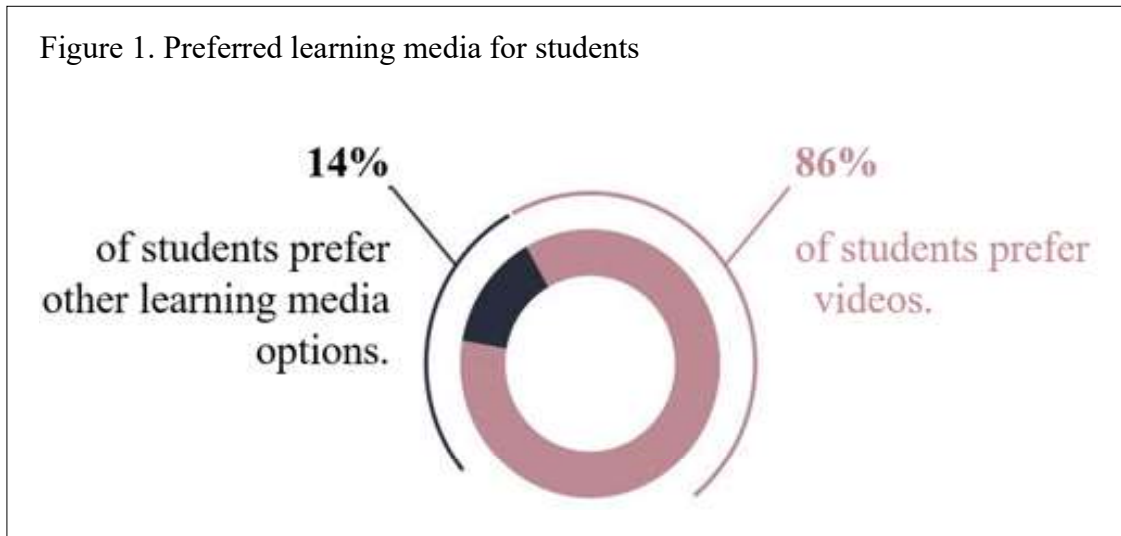
Null Hypothesis (H0): There is no significant difference between the mean scores of the pretest and posttest within the same group of students.

Alternative Hypothesis (Ha): There is a significant difference between the mean scores of the pretest and posttest within the same group of students.

FINDINGS AND DISCUSSION

Description of the results of media development, adjusted to the development model used, namely ADDIE. The stages in this development model are under the acronym Analysis, Design, Development, Implementation and Evaluation.

Analysis. Data from a recent needs analysis suggests a high level of student engagement with video-based learning media. Out of 30 students, 86% expressed a preference for video content, while the remaining 14% preferred other learning approaches (Figure 1). Teachers interviewed also agreed that science materials containing abstract concepts such as body mechanisms and bioprocesses are better assisted by learning media in videos to explain

Figure 1. Preferred learning media for students

14%

86%

of students prefer
other learning media
options.

of students prefer
videos.

parts that cannot be described verbally or in writing alone. Material analysis and learning objectives are conducted to identify the limitations and depth of teaching materials to match the competency standards set for the selected grade level.

Design. The media design process includes several phases, namely making the flow of material (Storyline) and media sketches (storyboard), creating a layout design for user interface, creating a tool design that contains buttons and icons that will be used on the media, and creating a flowchart for multimedia programming.

Development. The media development process using Unity is carried out by the design that has been made before. In contrast, for making animations (moving images), calculating scores on the evaluation menu so that the navigation buttons can run according to the command is set by a C# programming language with a library from Unity to facilitate access to existing functions. The display of the developed media products can be seen in Figure 2.

Figure 2. Example of interactive learning media based on animated video implementation

140
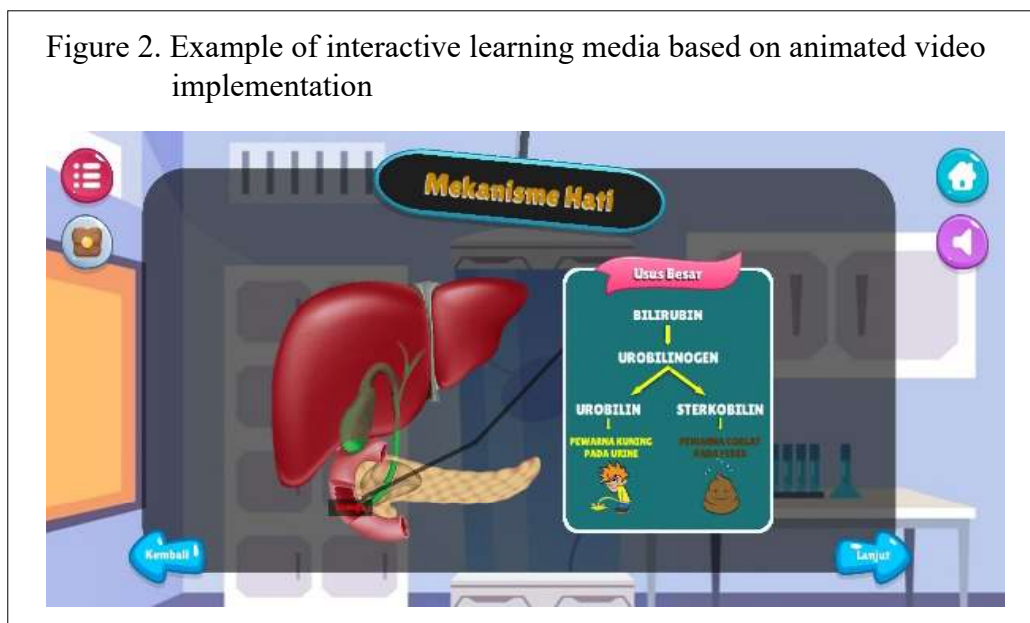
After the product has been developed, the validation process is carried out by experts. This process is a form of evaluation of the media developed to see the feasibility of the media before being tested on students and teachers. The validation stage was carried out by media and material expert validators, each of which consisted of two people.

Based on the results of validation by each material expert validator and media expert, quantitative data in the form of scores obtained through a validation questionnaire and qualitative data in the form of input taken into consideration for media improvement. Table 2 shows the results of the acquisition of feasibility scores from media expert validators and content experts on the developed media.

Table 2
Results of media feasibility assessment by experts

Validator	Score (%)	Category
Media Expert	92.75	Very Feasible
Content Expert	83.35	Very Feasible

This very feasible category shows that the material contained in the learning media has fulfilled the completeness of the content, conformity with the syllabus, and presented in an engaging and good language. This is in line with the criteria for learning media in the Learning Media Development book (Pakpahan et al., 2020) that learning media functions properly when the essence of the message to be conveyed can be appropriately conveyed.

Implementation. The results of the application of the media that has been done, resulting in responses from science teachers to the media for each aspect category can be seen in the Table 3. The results of these calculations are then interpreted with categorization according to (Saputra, 2021).

Table 3
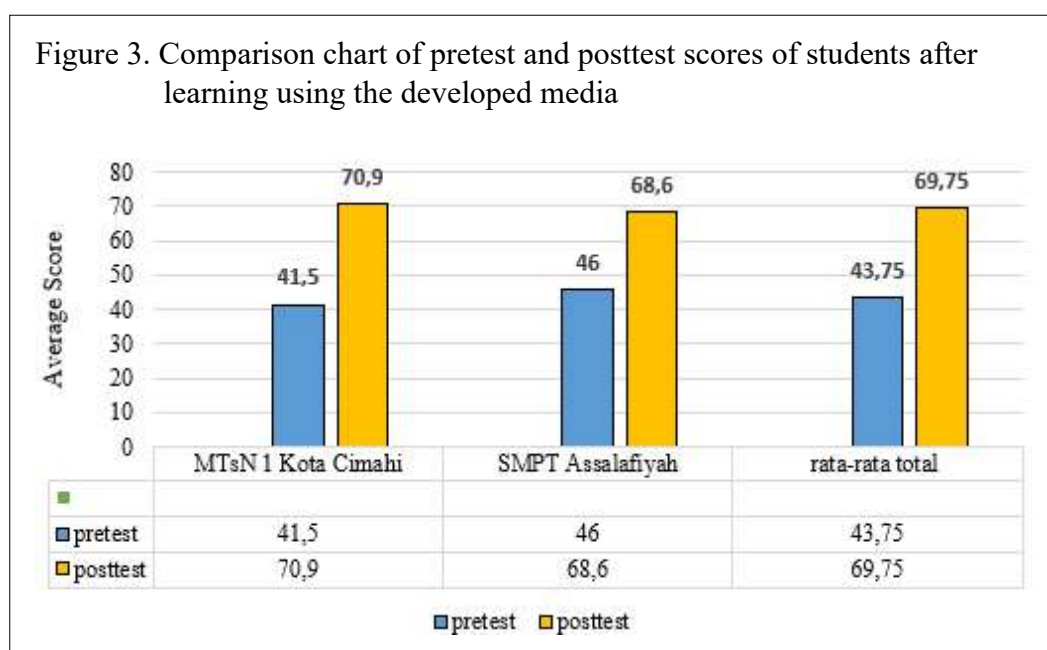*Calculation data of science teacher response questionnaire to the developed media*

No.	Assessment aspect	Percentage	Description
1.	Media display	95.0	Very Feasible
2.	Content quality	86.0	Very Feasible
3.	Quality of evaluation	95.0	Very Feasible
4.	Media accessibility	92.5	Very Feasible
5.	Usability of media	90.0	Very Feasible
	Average	91.7	Very Feasible

Based on the Table 3, the learning media that has been developed has an average response value of 91.7% in the very feasible category. This indicates that according to teacher respondents as teachers who play an important role in the learning process, the media developed is considered very good to be used as an alternative aid to support a more effective learning process. As for the data on student responses to animated video-based interactive learning media can be seen in the Table 4.

Table 4
Calculation data of student response questionnaires to the media developed

School name	Number of respondents	Percentage	Description
MTsN 1 Cimahi	30	84	Very feasible
SMPT Assalafiyah	28	85	Very feasible
Average score		84.5	Very feasible

Evaluation. Evaluation of the learning media developed is not only measured in terms of teacher and learner responses to the media, but researchers try to measure the success of learning using the media that has been developed as its function, namely changes in cognitive behavior from before and after the implementation of the learning process. To measure the level of learning success of students who were the subjects of the study, the researchers conducted written formative tests in the form of pretests and posttest. The test is a preliminary tests so further research still needs to be carried out for larger tests. The results of the pretest and posttest assessment of students can be seen in Figure 3.

Figure 3. Comparison chart of pretest and posttest scores of students after learning using the developed media

	MTsN 1 Kota Cimahi	SMPT Assalafiyah	rata-rata total
pretest	41,5	46	43,75
posttest	70,9	68,6	69,75

The graph shows an increase in the average score of students from each school. Students from MTsN 1 Cimahi City obtained an average pretest score of 41.5 and then experienced an increase in the average score of 29.4% to an average score of 70.9 while for students from SMPT Assalafiyah obtained an average pretest score of 46 and then experienced an increase in the average score of 22.6% to 68.6 so that the average increase in scores from all students was 26% from an average score of 43.75 to an average score of 43.75. Several factors could have contributed to the observed improvement in student scores. *First*, the interactive learning media intervention based on animated videos may have employed effective teaching strategies and engaging activities aligned with student needs and interests.

Second, this intervention may have resulted in a more supportive and stimulating learning environment, motivating students to participate actively in their own educational pursuits. Third, it may have tailored instruction to individual student needs, catering to their varying learning styles and abilities. However, further research is needed to ascertain the factors that have the most profound influence. Since this research focuses solely on the initial development and preliminary evaluation phases, determining the statistical significance of the pretest and post-test differences is the next crucial step. This necessitates the application of a rigorous statistical analysis.

Previously, classical assumption tests such as normality and homogeneity tests have been carried out. The Kolmogorov-Smirnov test was executed because in this current study included a small sample (Razali & Wah, 2011). The result of normality test said that the p-value is 0.021 for the pretest and 0.001 for the posttest which is less than 0.05. It enables us to claim that the data differs significantly from a normal distribution. In this current study, a non-parametric test was executed. The Wilcoxon signed-rank test is used to compare two paired setssuch as before and after measurements (Couch, Kazan, Shi, Bray, & Groce, 2018). Hypothesis testing was conducted using a non-parametric statistical test, The Wilcoxon signed-rank test at a significance level of 0.05. In detail, the results can be seen in the Table 5.

Table 5
Rank posttest-pretest

	N	Mean Rank	Sum of Ranks
Negative Ranks	0[a]	.00	.00
Positive Ranks	58[b]	29.50	1711.00
Ties	0[c]		
Total	58		

Notes: a = Posttest < Pretest; b = Posttest > Pretest; c = Posttest = Pretest

Based on the Table 5, rank output from SPSS, the negative ranks between the pretest and posttest results are 0, meaning there is no decrease in value from the pretest to the posttest value. While Ties or the similarity of pretest and posttest values also shows 0, which means that students obtain no similar values between pretest and posttest. Otherwise, on the positive ranks of pretest and posttest learning outcomes, there are 58 positive data, which means that all 58 students in this study experienced an increase in learning outcomes with an average increase of 29.50, while the number of positive ranks or sum of ranks is 1711.

The results of the Wilcoxon signed-rank test in SPSS version 20.0 showed a p-value/ Sig. (2-tailed) of 0.000, which is less than the significance level (0.05). Therefore, the null hypothesis (H0) was rejected, and the alternative hypothesis (H1) was accepted. This means a significant difference exists between the students' thinking ability scores on the pretest and posttest data. The change in scores is meaningful, suggesting that the interactive learning media has positively impacted the students' learning outcomes. In other words, the interactive learning media effectively improved the grade VIII students' thinking ability to learn the excretory system.

Discussion. This current study on developing an interactive learning animation video for the excretory system in grade VIII science education provides valuable insights related to previous studies in the field. The following discussion highlights the relevance and connections between this research and prior studies.

Previous studies have shown that animation videos can effectively enhance students' understanding and engagement in various educational contexts. Research conducted by (Strømme & Mork, 2021) demonstrated that animations may be superior to static visualizations in supporting students' conceptual understanding in science. Similarly, the study by (Cookson, Kim, & Hartsell, 2020) indicated that animation videos increased student motivation and helped them to remember the material. These findings support the potential effectiveness of the interactive learning animation video developed in this research for the excretory system in grade VIII science education.

The utilization of the ADDIE instructional design model in this research aligns with previous studies emphasizing the importance of systematic instructional design approaches. Studies such as those by (Hidayat, Junaidi, T., & Yakob, 2020; Rustandi, 2021; Sukardi & Rozi, 2019; Wijaya & Arismunandar, 2018) have highlighted the benefits of employing instructional design models in developing educational materials. By following the ADDIE model, the designers of the interactive learning animation video ensured that the video was compelling and aligned with the needs of grade VIII students. The video was developed using a systematic and structured approach, which helped to ensure that it was well-organized and easy to follow. The video also included various activities and assessments to help learners engage with the content and assess their learning.

Initial needs analysis of students at the beginning of this current study is one of the crucial steps before determining what media will help students learn. Previous research has emphasized the significance of learner-centered approaches in educational material development. Studies by (Ratniece, 2018; Yakovleva, 2019) emphasize the importance of considering learners' cognitive development and individual needs. This research adopts a learner-centered approach by customizing the interactive learning animation video for grade VIII students. By incorporating appropriate visuals, language, and instructional strategies, the developed video aims to cater to the unique characteristics and learning needs of grade VIII students, aligning with previous studies emphasizing learner-centered approaches.

The integration of technology, specifically animation videos, in science education has been the focus of previous studies. Research by (Wishart, 2016, 2017; Zanin, 2015) explored the impact of technology integration on student learning outcomes and engagement in science education. This research contributes to this body of literature by specifically targeting the excretory system topic and employing an interactive learning animation video as a technology-based instructional tool.

By connecting this research with previous studies, it becomes evident that developing an interactive learning animation video for the excretory system using the ADDIE model aligns with the established effectiveness of animation videos, instructional design models, learner-centered approaches, and technology integration in science education. The findings of this research build upon the existing knowledge base and provide further insights into the potential benefits of interactive learning resources for Grade VIII students in understanding complex scientific concepts.

CONCLUSION

Interactive learning media based on animated videos is feasible to use as an alternative learning media on the material of the excretory system of grade VIII junior high school students. The findings of this research can have implications for science education, particularly in terms of instructional design and technology integration in the classroom. By exploring the effectiveness of the interactive learning animation video, the research contributes to the existing literature on innovative instructional practices and technology-enhanced learning in science education. It offers insights into how interactive multimedia resources can effectively enhance student learning outcomes and engagement.

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