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Interactive multimedia sound and light waves integrated STEM to develop concept understanding and literacy skills of students

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ABSTRACT
The rapid development of technology in the Industrial Revolution 4.0 has made it necessary for students to master technology and have data literacy and technology literacy skills. However, initial studies show that the data and technology literacy of grade XI high school students is still relatively low. This study aimed to investigate the effectiveness of STEM-integrated light and sound wave interactive multimedia in improving students' concept understanding and literacy skills. The type of research used was a pseudo-experiment with a posttest-only control group design. The subjects of this study were 70 grade XI pupils who were divided into experimental and control classes. The sampling used was cluster random sampling so as to obtain two sample groups with the same ability. The instruments used were written tests for knowledge aspects and performance assessments for data literacy and technology aspects. The collected data were analysed using independent sample *t*-test and z-test. The results of the analysis showed that the knowledge, data literacy, and technology literacy skills of the experimental class were higher than the control class. This can be proven from the t-test value on knowledge which is 4.696>1.995 respectively, t-test on data literacy which is 9.906>1.995, and z-test on technological literacy z=-7.22>1.96. The results of this study suggest that students' knowledge, data literacy, and technological literacy increase using STEM-integrated Physics interactive multimedia. Following up on the findings of this study, the use of STEM interactive multimedia should be optimized to develop students' data and technological literacy.

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Introduction

The Industrial Revolution 4.0 has brought many changes to various fields, including education. Education in this century demands the development of students' mindset and creativity (Indira et al., 2020). To realize the demands of education in this era, a supportive skill is needed such as literacy skills in era 4.0 (Aoun, 2020; Hardhienata et al., 2021; Li, 2019). The skills of the 4.0 era are often known as new literacy skills (Graff, 2022; Yurnetti et al., 2020). By having new literacy skills, students

can compete globally. (Lase, 2019). Thus, new literacy skills are important to improve in the era of revolution 4.0.

New literacies consist of data, technology and human literacies (Yurnetti et al., 2020). Data literacy relates to the ability to read, analyse and make data-driven thinking conclusions with the information obtained (Smolnikova, 2020). Technological literacy is related to the ability to understand how machines work, technology applications and work based on technology products to get maximum results (Abed, 2019; Baker et al., 2012). Human literacy relates to the ability to communicate, and think critically, creatively and innovatively (Azizah et al., 2020; Khoiri et al., 2021; Zakiyah, 2022).

The implementation of learning has now been converted into a digital form that is more effective and efficien than traditional modes (Erdem, 2019). The utilisation of technology is one of the biggest demands of education in facing the challenges of the industrial revolution era 4.0 (Hardhienata et al., 2021). It can help teachers improve the quality of learning, create a pleasant learning atmosphere, and encourage students to learn independently (Sudrajat et al., 2019). By utilizing technology, pupils can be trained to learn independently.

However, the conditions found in the field are different from what is expected. There are several problems found in grade XI high school students in one of the schools in Padang. The first problem is that pupil knowledge is in the sufficient category with an average of 63.28. The second problem is that their data literacy and technological literacy are low with an average of 48.44 and 41.32 respectively. School learners' data literacy and technological literacy can be improved by using STEM-based interactive learning resources (Nurramadhani et al., 2020; Suyatna et al., 2020). STEM integrated in interactive learning resources can encourage students' pupils' mindset, train them to use technology, and build knowledge integrated with of the four aspects of STEM (Science, Technology, Engineering, and Mathematics) in one STEM activity (Ramli, 2017; Widya et al., 2019). The third problem is related to the analysis of the selection of Physics material in class XI SMA semester 2. From the results of the material analysis, it was found that sound and light waves were considered the most difficult material to understand and explain. In addition, this material is difficult for students to understand because of the many equations and abstract concepts. One example is explaining how light propagates. For this reason, interactive learning resources are needed, one of which is interactive multimedia. However, the fourth problem arises, namely the use of interactive multimedia, but it is not yet interesting and interactive and is only made with the help of power point software. Interactive multimedia should be interesting, interactive, can help students learn independently, and can improve students' data literacy and technology skills (Zainuddin et al., 2019). Therefore, STEM-integrated Physics interactive multimedia is needed to increase students' new knowledge and literacy.

Several previous researchers have researched interactive multimedia. Previous researchers were able to that STEM-integrated interactive multimedia can improve learning outcomes, concept mastery, critical thinking skills, and students' creative thinking skills (Asrizal et al., 2022; Djamas et al., 2018; Sumawati et al., 2021; Yulianci et al., 2021). However, previous researchers have not been able to explain the impact of STEM-integrated interactive multimedia on students' new knowledge and literacy in sound and light waves. This interactive multimedia is made with Articulate Storyline 3 software so that it is more practical and attractive. In addition, the material contained in interactive multimedia is relevant to physics learning materials in the 2013 curriculum, namely sound and light waves. This interactive multimedia is also equipped with worksheets as a guide to conduct virtual experiments using PhET Simulation so that it can improve student achievement in aspects of knowledge and skills (data literacy and student technology literacy). This is what can distinguish this research from previous researchers and the reason for conducting this research.

The problem formulation in this research is what is the impact of using STEM-integrated interactive multimedia on students' data and technology literacy knowledge and skills?. This research aims to determine the impact of using STEM-integrated interactive multimedia on students' data and technology literacy knowledge and skills.

Literature Review

Data Literacy and Technology Literacy

The Industrial Revolution 4.0 requires data literacy and technological literacy. Data literacy is a person's ability to read, analyse, and utilise information in the digital world (Domu et al., 2023; Kusumo et al., 2022; Lund & Agbaji, 2023). The data obtained is in the form of quantitative and qualitative data chosen to be analyzed in detail. Data literacy skills involve someone being able to recognise the data they find (Ongena, 2023; Yurnetti et al., 2020). By having data literacy skills, people can read the data found, analyze, and draw conclusions from the results (Asrizal et al., 2023; Smolnikova, 2020).

Technological literacy skills support people in facing technological developments in the era of industrial revolution 4.0. Technological literacy is a person's ability to understand and master technology (Yurnetti et al., 2020). Various studies show that use technology can increase understanding of the material (Indahsari et al., 2023; Utami et al., 2023). The technological literacy skills that people must have include the ability to use the internet, use technology such as computers, interactive multimedia, learning software and Android-based mobile devices (Lund & Agbaji, 2023; Yeşilyurt & Vezne, 2023). Learners must also be able to use virtual laboratories and use electronic learning resources that can support the learning process (Asrizal et al., 2023; Yudha et al., 2023).

Multimedia Interactive

The use of interactive multimedia is very important to support the learning process. Interactive multimedia presents material accompanied by audio, images, animations and videos to make it easier for learners to understand the material presented (Sahronih et al., 2019; Sukariasih et al., 2019). The use of interactive multimedia makes it easier for teachers to deliver learning materials, so that all learning competencies can be achieved well (Fayanto et al., 2019). In addition, the use of interactive multimedia makes it easy for students to learn actively, independently or guided (Tiarasari, 2021; Zainuddin et al., 2019). The use of interactive multimedia can also help teachers to create more interesting, effective and efficient learning so as to increase student interest and motivation in learning.

STEM (Science, Technology, Engineering, and Mathematics)

The learning approach that has been developed in developed countries is the STEM approach. The STEM approach can be used to answer the challenges of the industrial revolution 4.0 era (Mustafa et al., 2021). The characteristics of the STEM approach lie in the integration of STEM components in an effort to solve problems related to students' real lives (Thibaut et al., 2018). The purpose of the STEM approach is to balance students' hard and soft skills and have high creativity (Sunarno, 2018). Through the STEM approach, students will have a logical, systematic and critical mindset (Aspridanel et al., 2020). The STEM approach is useful for creating problem-based learning so that learning will be more meaningful (Chen & Chen, 2021; Prasetyo et al., 2021). With STEM, students will be more interested and feel the benefits of learning in real daily life, especially in learning Physics (Páez et al., 2019). In addition, the STEM approach can increase students' interest in science-related fields (Waluyo & Wahyuni, 2021). Through the STEM approach, students can apply the knowledge learned at school with real-world phenomena (Widayanti et al., 2019). Therefore, STEM integration has good benefits for both educators and students and is a new challenge for teachers in understanding various fields of science.

Interactive Multimedia Physics Integrated with STEM

Interactive multimedia are useful in supporting the effectiveness of achieving learning objectives. Interactive multimedia can be developed using technology with various software (Ahzari

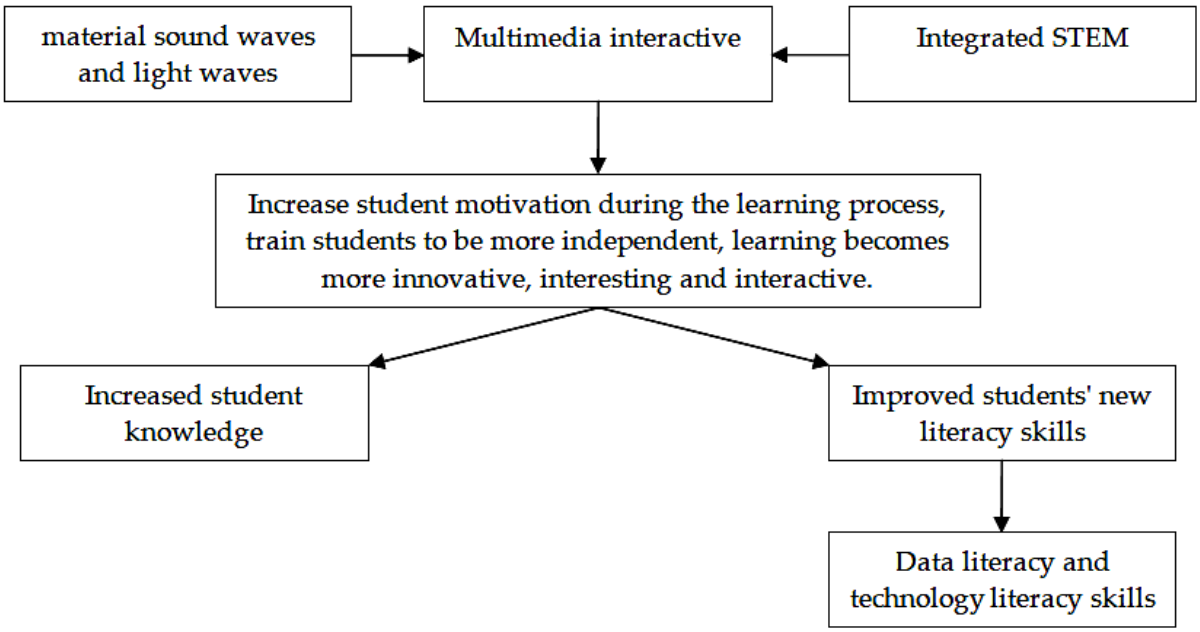
& Asrizal, 2023). In learning Physics, the utilisation of interactive multimedia needs to involve technology and science such as STEM (Sumawati et al., 2021). The presence of STEM in interactive multimedia can stimulate data literacy and technology literacy skills, especially in using software, using the internet, processing data, analyzing data, and making conclusions (Husniyah & Ramli, 2023). STEM can be presented in an integrated manner in interactive multimedia. The integration of STEM in interactive multimedia encourages students to be active in learning, build knowledge and ideas, and train students to collaborate (Arianti et al., 2022).

Conceptual Framwork

STEM-integrated interactive multimedia contains class sound waves and light waves material. Interactive multimedia of sound waves and light waves integrated with STEM is packaged with an attractive display to increase motivation in learning. Increase student motivation during the learning process, train students to be more independent, learning is more innovative, interesting, and interactive. The use of STEM-integrated interactive multimedia can improve students' knowledge, data literacy, and technological literacy. Based on the theoretical studies that have been described, the framework in this research can be stated in Figure 1.

Figure 1

Conceptual framework



Hypothesis

Based on the background that has been stated, it is necessary to have an integrated multimedia interactive STEM applied in sound and light wave materials. Can the use of STEM-integrated interactive multimedia improve students' knowledge and skills in data literacy and technology literacy? For this reason, it is necessary to design a hypothesis about how the influence of interactive multimedia sound waves and light waves integrated STEM on students' knowledge, data literacy, and technological literacy.

Methods

Design Research

This research is classified as a pseudo-experimental research. The pseudo-experiment was conducted to test the products on students' knowledge and literacy skills, especially data and technology literacy. The design of this study used the Posttest Only Control Group Design. The reason for using this design is to see the effect of using STEM integrated interactive multimedia from both sample groups. The second reason for using the posttest value is because the pretest value of the two sample groups comes from the average Mid Semester Examination (MSE) Physics score of students who have the same value, so that treatment can be carried out on both sample groups.

The explanation of this design is that the research consists of two sample classes. The two sample classes are the experimental class and the control class. The experimental class was given treatment in the form of the application of interactive multimedia Physics integrated with STEM. The control class was not applied the STEM-integrated Physics interactive multimedia, but was given the learning media used by teachers at school.

Implementation of Research

This research applies STEM-integrated interactive multimedia to improve students' data and technology literacy knowledge and skills. The resulting product is in the form of STEM-integrated interactive multimedia. This research focuses on the effect of using the product on students' knowledge and literacy skills. STEM is integrated in the experimental activities section of the interactive multimedia. STEM consists of four components including science, technology, engineering, and mathematics. This research product is applied to Physics material, namely sound and light waves for class XI SMA. The duration of time needed to apply this product is for 4 meetings with 2x45 minutes per meeting. The brief procedure carried out in this study consists of three stages. First, preparing everything related to the research. Second, providing similar methods to both sample groups, namely applying a scientific learning approach and providing special treatment for the experimental group in the form of STEM-integrated interactive multimedia. STEM is integrated in the work steps section. Third, making data analysis and making research reports.

Population and Sample

The population in this study consisted of all students of class XI IPA SMAN 1 Guguak who were enrolled in the first semester of the 2021/2022 school year. The sample obtained in this study consisted of two classes, namely the experimental class and the control class. Sampling was carried out using the Cluster Random Sampling technique. The sample selection step starts from collecting material in the form of students' initial ability scores derived from the recapping of MSE Physics class XI high school score documents (Appendix 1). Then, selecting classes that have the same average score, namely class XI IPA 3 and XI IPA 4. This procedure obviates the need to pretest again. After that, conduct a normality test, homogeneity, and *t* test (Appendix 2). From the t test, it was found that the initial abilities of the two sample classes had the same initial abilities. After that, the selection of control and experimental classes was carried out by tossing a coin. The results obtained that XI IPA 3 class as the experimental class and XI IPA 4 as the control class.

Data and Instrument

The data obtained from this study are the results of knowledge and skills analysis. The skills data obtained consisted of two sets, namely data literacy and technology literacy skills. The instrument used for knowledge assessment was a knowledge test sheet. This test sheet consists of 40 objective questions that were tested on a class that had studied sound and light wave material for the initial trial (Appendix 3). The 40 questions were tested for validity, reliability, difficulty level, and

differentiation (Appendix 4). The results of the validity analysis showed that some were divided into low, medium, high, and very high categories and the questions included questions that had a very high level of reliability. In terms of difficulty, the question has easy, medium and difficult categories. Questions are said to be able to be used for posttests if the questions are valid, reliable, and preferably questions that have a level of difficulty in the medium category and have different strengths from the good to very good categories. After testing the validity and reliability of the questions, 25 test questions were obtained which were used as posttest questions (Appendix 5). The instrument used for skills assessment is a student performance assessment sheet. The student performance assessment sheet instrument consists of data literacy and technological literacy. Data literacy skills measured in skills are the ability to read data, collect data, analyze data, and conclude the results of data analysis. Technological literacy skills measured are the ability to use virtual laboratories / experimental sets, use modern tools (computers, smartphones, flashlights), use the internet, and use electronic learning resources (interactive multimedia).

Data Analysis

The data analysis stage in this study starts from the normality test, homogeneity test, and t test. In the hypothesis test, 2 tests were carried out, namely the t test and the Mann-Whitney test. The t-test is performed if the sample is normally distributed. The mann-whitney test is used if the sample is not normally distributed.

Findings

Effect Interactive Multimedia Integrated Stem on Knowledge

The first result is related to the effect of STEM-integrated interactive multimedia on student knowledge. The results of this study were obtained from the posttest scores given to students at the end of the study. The results of the analysis of student knowledge scores in the experimental class and control class can be seen in Table 1.

Table 1

Analysis of students' knowledge scores after using STEM-integrated interactive multimedia

No	Statistical components	Experiment Class	Control Class
1	Number of students	35	35
2	Average	83.94	76.11
3	Calculated normality test	0.125	0.140
4	Tabel normality test	0.150	0.150
5	Calculated homogenity test	1.68	
6	Tabel homogenity test	1.77	
7	t test	4.696	
8	t-table	1.995	

Based on the data in Table 1, the results of the analysis of the use of STEM-integrated interactive multimedia on sound and light waves can be described. The results of the analysis show that students' knowledge in the experimental and control classes differed. This can be seen from the difference in the average scores of the two classes. The average value of the experimental class is 83.94 higher than the average value of the control class 76.11. However, this difference in the mean scores of the two classes was not statistically significant. Therefore, further data analysis needs to be done to see a meaningful influence on the knowledge aspect of students.

The next data analysis is by conducting a normality test, homogeneity test and two mean equality test. Based on the data analysis, it is found that the data is normally distributed, because the value of L_o is smaller than the value of L_t. The analysis results also show that the data has a

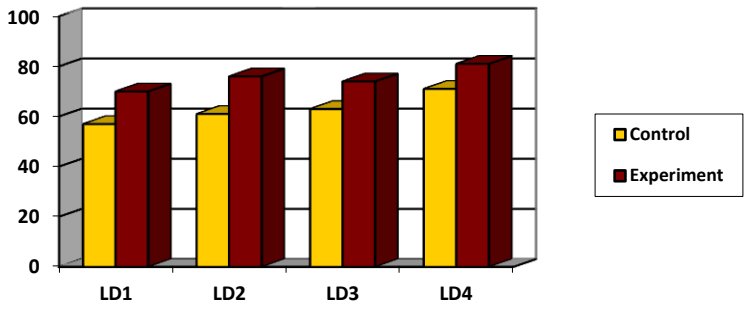
homogeneous variant, because the value of Fh is smaller than the value of Ftl. Because the data is normally distributed and homogeneous, the t-test is used. From the results of the t-test analysis, it was found that th was greater than t_t, namely 4.696>1.995. This shows that the data is in the H_0 rejection area, meaning that there is a significant difference between the knowledge of the experimental class and the control class. Thus, this STEM-integrated interactive multimedia has a significant influence on student knowledge.

Effect Interactive Multimedia Integrated STEM on Data Literacy

The second result is related to the effect of STEM-integrated interactive multimedia on students' data literacy. The results of this study were measured from each practicum activity, namely 4 practicums. There are four indicators of students' data literacy skills that are assessed during learning. The four indicators are reading data (LD1), collecting data (LD2), analyzing data (LD3) and concluding the results of data analysis (LD4). The results of student data literacy plots for each indicator in both classes can be seen in Figure 1.

Figure 1

Results of data literacy skills analysis



It was found that students' data literacy skills in the experimental class were consistently higher than the control class. However, the difference in the average values of the two classes was not statistically significant. Therefore, it is necessary to further analyse the data to see meaningful differences in the aspects of students' data literacy skills. The results of data analysis can be seen in Table 2.

Table 2

Analysis of students' data literacy scores after using STEM-integrated interactive multimedia

No	Statistical components	Experiment Class	Control Class
1	Number of students	35	35
2	Average	75.626	63.169
3	Calculated normality test	0.131	0.149
4	Tabel normality test	0.15	0.15
5	Calculated homogenity test	1.347	
6	Tabel homogenity test	1.772	
7	t test	9.906	
8	t-table	1.995	

The experimental class average score of 75.626 is higher than the control class average score of 61.79. The difference in the mean scores of the two classes cannot show a significant relationship from the effect of STEM-integrated interactive multimedia on student data literacy. The next data analysis is

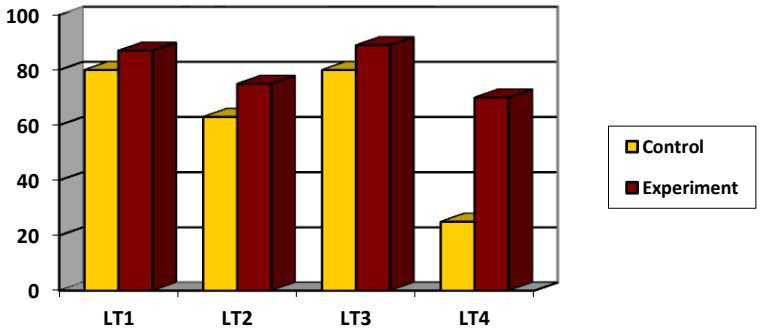
by conducting normality test, homogeneity test and equality test of two means. Based on the data analysis, it is found that the data is normally distributed, because the value of L_o is smaller than the value of L_t. The analysis results also show that the data has a homogeneous variant, because the value of Fh is smaller than the value of Ftl. Because the data is normally distributed and homogeneous, the t-test is used. From the results of the t-test analysis, it was found that th was greater than t_t, namely 9.906>1.995. This shows that the data is in the H_0 rejection area, meaning that there is a significant difference between the data literacy of experimental and control class students. Thus, this STEM-integrated interactive multimedia has a significant effect on students' data literacy.

Effect Interactive Multimedia Integrated STEM on Technology Literacy

The third result is related to the effect of STEM-integrated interactive multimedia on students' technological literacy. The results of this study were measured from each time doing practicum activities, namely 4 times the practicum. There are four indicators of students' technological literacy skills that are assessed during learning. The four indicators are using virtual laboratories/experimental sets (LT1), using modern tools (computers, smartphones, software) (LT2), using the internet (LT3), and using electronic learning resources (interactive multimedia) (LT4). The plot results of students' technological literacy for each indicator in both classes can be seen in Figure 2.

Figure 2

Results of technology literacy skills analysis



Based on the data analysis in Figure 2, the value of students' technological literacy skills per indicator in both sample classes can be stated. The average value per indicator shown shows the difference in the value of students' technological literacy skills between the experimental and control classes. The difference is that students' technological literacy skills in the experimental class are higher than the control class. The difference in the average values of the two classes cannot show a meaningful relationship from the effect of STEM-integrated interactive multimedia in the experimental class on the control class. Therefore, it is necessary to analyze the data to see meaningful differences in the aspects of students' technological literacy skills. The results of data analysis of students' technological literacy skills can be seen in Table 3.

Table 3

Data analysis of students' technological literacy after using STEM-integrated interactive multimedia

No	Statistical components	Experiment Class	Control Class
1	Number of students	35	35
2	Average	80.40	61.79
3	Calculated normality test	0.151	0.158
4	Tabel normality test	0.15	0.15
5	Calculated homogenity test	2.052	
6	Tabel homogenity test	1.772	
7	t test	-7.223	
8	t-table	1.960	

The analysis shows that students' technological literacy in the experimental and control classes has a difference. This can be seen from the difference in the average scores of the two classes. The average value of the experimental class is 80.40 higher than the average value of the control class 61.79. The difference in the average scores of the two classes cannot show a significant relationship from the effect of STEM-integrated interactive multimedia on students' technological literacy. The next data analysis is by conducting normality test, homogeneity test and equality test of two means. Based on data analysis, it is found that the data is not normally distributed, because the value of L_o is greater than the value of L_t. The results of the analysis also show that the data has a homogeneous variant, because the value of Fh is greater than the value of Ftl. Because the data is not normally distributed and not homogeneous, the Mann Withney test is used. From the results of the t-test analysis, it was found that Z_h was greater than Z_t, namely -7.22>1.96. This shows that the data is in the H0 rejection area, meaning that there is a significant difference between the technological literacy of experimental and control class students. Thus, this STEM-integrated interactive multimedia has a significant influence on students' technological literacy.

Discussion

The discussion in this study is related to the results of the analysis of the use of interactive multimedia of sound waves and light waves integrated with STEM. Based on the results that have been obtained here, there are three discussions, namely the effect of using interactive multimedia of sound waves and light waves integrated with STEM on students' knowledge, data literacy skills, and technology literacy skills.

The first result achieved is the increase in student knowledge by using interactive multimedia of sound waves and light waves integrated with STEM. Knowledge is the result of thinking in the form of principles, laws and theories obtained from facts, events and experiences (Andrei et al., 2022). Knowledge can be used as a measure of student success in achieving learning objectives (Nasir et al., 2022). Using this STEM-integrated interactive multimedia, it can increase students' interest and motivation to read the available material so that it will have an impact on students' increased knowledge (Darmawan et al., 2020; Prasetyo et al., 2021). The use of interactive multimedia can increase student enthusiasm in learning so that it has an impact on student learning outcomes that increase (Nurramadhani et al., 2020). The material in STEM-integrated interactive multimedia is equipped with animation, music, and videos that are relevant to the material presented. Videos presented in STEM-integrated interactive multimedia can make it easier for students to understand the material studied, especially abstract material (Azalia et al., 2020; Triwahyuningtyas et al., 2020). This is because videos involve students' senses more in learning (Rahim et al., 2022). In accordance with the theory that the more senses are involved in receiving and processing information, the greater the likelihood that the information is understood and stored in memory (Hochberg et al., 2020; Rahim et al., 2020). This interactive multimedia is also equipped with quizzes and evaluations that are

presented interactively using the kahoot and quiziz applications. These interactive quizzes and evaluations can train students' abilities and become a benchmark for how far they have learned (Roemintoyo et al., 2022). Thus, this interactive multimedia has a significant effect on increasing students' knowledge.

The second result achieved was the increase in students' data literacy using STEM-integrated sound wave and light wave interactive multimedia. This interactive multimedia is equipped with student worksheets to guide students in conducting experiment (Kartika et al., 2021). In line with the theory that experimental activities are important in learning physics to prove the physics concepts that have been learned (Asrizal et al., 2020). This experiment is conducted virtually using PhET Simulation which can encourage students to work independently, seek truth, and draw conclusions from the activities carried out (Tiarasari, 2021). With this PhET-based experiment, it can improve students' data literacy skills (Šlekienė & Lamanauskas, 2020). This PhET-based experiment makes students investigate problems systematically and trained in reading data, collecting data, analyzing data, and concluding the results of data analysis (Smolnikova, 2020). Thus, this interactive multimedia has a significant effect on improving students' data literacy.

The third result achieved is the increase in students' technological literacy using STEM-integrated sound waves and light waves interactive multimedia. STEM-integrated interactive multimedia can be directly accessed on students' smartphones (Baker et al., 2012; Sung et al., 2016). Various studies have shown that the use of technology such as computers, interactive multimedia, learning software, android-based mobile devices can improve understanding of the material (Nasution, 2018). This interactive multimedia is equipped with PhET-based virtual activities that can support the improvement of students' technological literacy skills (Asrizal, 2020; N et al., 2021). Through this interactive multimedia, students can open PhET-based materials and experiments directly using modern tools available at school, namely computers and smartphones (Abed, 2019; Arista & Kuswanto, 2018). This smartphone / computer is also useful for finding other sources of information on the internet as an additional reference source in the learning process (Ali et al., 2022). STEM-integrated interactive multimedia can be an interesting alternative in improving students' technological literacy (Yurnetti et al., 2020). Thus, this interactive multimedia has a significant effect on improving students' technological literacy.

Conclusion and Implications

The success of education is highly dependent on the success of educators in encouraging students to achieve educational goals. One of them is by using the right learning resources such as applying interactive multimedia Physics integrated with STEM in learning to support the achievement of students' knowledge and literacy skills. This can be proven from the results of the research analysis that has been done. Based on the research results that have been presented, three conclusions can be drawn. First, STEM-integrated Physics interactive multimedia has a significant influence on students' knowledge. Second, STEM-integrated Physics interactive multimedia has a significant effect on students' new literacy skills. Third, STEM-integrated Physics interactive multimedia has an effect on improving students' technological literacy skills. Thus, STEM-integrated Physics interactive multimedia has a significant influence on students' knowledge, data literacy, and technological literacy.

The application of STEM-integrated interactive multimedia makes learning more effective. With this interactive multimedia, the problems of students' knowledge and literacy skills can be resolved properly. With this multimedia, learning will be student-centered. with the application of STEM in the experimental work steps can train students to improve data literacy and technology literacy skills. This is evident from the results of this study which reveal that the integration of STEM in interactive multimedia can support students to be active in learning and improve their knowledge and literacy skills. Therefore, this study provides a better understanding of the effect of STEM integration in interactive multimedia on students' knowledge and literacy skills.

The research conducted at this time is inseparable from all shortcomings. The shortcomings of this study include interactive multimedia used only contains one material and only limits the improvement of new literacy skills to data literacy and technological literacy. Future researchers are expected to develop interactive multimedia on other materials and assess all components of students' new literacy. School agencies can conduct training in the development of ICT-based learning resources so that teachers can create more interesting teaching materials and learning media. With the results of this study, it is hoped that it can help teachers in designing STEM-integrated interactive multimedia and implementing it into learning. Teachers must also be more creative and innovative in finding, choosing, and applying appropriate learning methods in the classroom. Teachers can also help students improve mastery of material, data literacy skills, and technological literacy in learning Physics.

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