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Implementation of Game-Assisted Interactive Demonstration on Students' Problem-Solving Skills and Digital Literacy in the Immune System

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ABSTRACT

This study aims to ascertain whether there is an impact on students' problem-solving skills and digital literacy. The research method uses Matching Only Pretest-Posttest Control Group Design. Fifteen students each from the experimental class and the control class made samples. The experimental class received an Interactive Demonstration model with the help of games. Tests of problem-solving skills and digital literacy and surveys asking respondents about their responses were used to obtain data. The analysis findings suggest that game-assisted Interactive Demonstration models can support and significantly influence high school students' capacity for problem-solving and digital literacy regarding immune system materials. The results showed that students in experimental classes on immune system content had high problem-solving skills, as seen by an average post-test score of 82, with an average N-Gain score of 0.74. According to the results of the hypothesis test, H1 is accepted because the significance value of Sig (2-tailed) is 0.000. The average score for digital literacy at level 4 is 56.77, with criteria usually meeting expectations. The average score on the response questionnaire was 69.33, which is excellent. The instrumental results in this study show how interactive demonstrations through games increase students' capacity for problem-solving regarding immune system content.

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1. INTRODUCTION

The existence of the 21st century is shaped by the era of the industrial revolution 4.0, which makes the 21st century a century of openness and globalization. Where education has a significant impact on learning in the 21st century. Improving the quality of human resources through education, ranging from primary and secondary to higher education is the key to continuing the development of the Industrial Revolution 4.0 (Lase, 2020).

This 21st-century learning applies the skills of Creativity, critical thinking, collaboration, problem-solving, communication, community, and character. Problem-solving ability refers to overcoming problems encountered in the teaching and learning process when the student's ability to solve the problem means the student's ability to think critically (Mardhiyah et al., 2021).

NEA believes that the 4Cs are 21st-century skills that students must have, specifically Creativity and innovation, communication, critical thinking and problem-solving, and collaboration (Junedi et al., 2020). The Indonesian government is working to implement this KTP curriculum for the 2013 school year. The improvement of the 2013 curriculum continues to be pursued so that the 2017 curriculum revision of 2013 is formed, which contains several important points as the government's main objectives, namely Strengthening Character Education (PPK), 4C skills, literacy, and Higher Order Thinking Skills (Pratama et al., 2020). In the initial observation made by researchers at MAN 2 Sukabumi City that the results of interviews with biology subject teachers, the majority of grade XI students in MAN 2 Sukabumi City that students' problem-solving abilities are in the sufficient category but there is still a need for improvement in students' problem-solving abilities. And also, digital literacy skills that are still lacking in some students have not been able to maximize problem-solving skills and digital literacy in biology subjects, as evidenced by learning outcomes that are still less than class standard scores and activeness in solving problems during classroom learning. And also, there has not been massive learning that applies interactive learning media and there has never been learning that uses media such as games. And also, in the trial class most of the students liked and played games and many agreed to apply games to learning, especially in biology subjects.

Therefore, a learning model is needed to stimulate and improve students' problem-solving skills. Students' problem-solving ability can deal with complex and non-routine problems. Students will be able to understand such complex issues and develop plans to solve them so that, eventually, students will be able to identify solutions to such complex and non-routine problems. According to Polya, the four steps students take in dealing with issues include: understanding the problem, designing strategies to address them, implementing Problem-Solving strategies, and revalidating solutions that have been developed. It is generally said that a person with problem-solving skills, such as a person who can understand everything about a problem from a general point of view and use this information in developing strategies to solve problems (Polya, 2010).

As Polya Dewey in Rothstein and Pamela (1990), To determine the number of possible solutions, set out five main steps in solving the problem 1: presenting the problem: no problem-solving strategy is needed if it is not a problem; 2: defining the problem: the problem-solving strategy emphasizes the importance of representing the situation to determine the number of possible solutions; 3: develop multiple hypotheses: a hypothesis is an alternative solution to problem-solving; 4: evaluate various theories to assess their weaknesses and strengths; 5: choosing the best approach (Jainuri, 2014). According to Asghar in Hanifah et al. (2021), problem-solving skills are fundamental and helpful when facing a problem, finding a solution, considering the situation, and choosing the best solution. Problem-solving skills are cognitive processes that apply knowledge-based behaviors, consequences, and actions.

According to UNESCO, Digital literacy is the ability to use information and communication technology (ICT) to find, evaluate, utilize, create, and communicate content or information with cognitive, ethical, social, emotional, and technical or technological aspects (Restianty, 2018). Martin emphasized that to identify, access, manage, integrate, assess, analyze, synthesize, and communicate new Digital Resources, build new knowledge, and generate media and communication expression, Digital Literacy is the understanding, attitude, or ability of a person to utilize appropriate electronic equipment and facilities. To facilitate constructive social action with others in situations of particular relevance; and to assess the process chain (Koltay, 2011). According to Shamshida & Hamida, they were also told that digital literacy requires students to think critically and creatively to build their knowledge, solve problems they face, and find meaning in the learning process. Emphasize the need (Masropah et al., 2022). In Anggia et al. (2022), Digital literacy is not only about the intelligent use of technology and information but also the ability to read and understand text and other multimedia forms of information. This digital competence is necessary to make sense of all digital information.

Interactive Demonstration is a learning tool supported by the LOI model, which promotes research activities. Slekiene &; Reguliene explained that Interactive Demonstration is a teacher demonstration activity about experiments that interact interactively to make students predict and explain. The teacher facilitates students and guides them in interactive demonstrations, while students are more involved in mind exercises and hand activities (Susiana et al., 2018).

It is essential to develop problem-solving skills in science learning, especially biology. But students don't master problem-solving skills. Many students still need to be more optimal in facing problems. Therefore, researchers conducted a study to determine the effect of interactive demonstration models on the problem-solving ability & digital literacy of grade XI high school students on the body's defense system material. At present, students are very interested in games as evidenced by a survey to students at MAN 2 Sukabumi City. They love games and play them in their spare time, and agree that interactive games can be applied to classroom learning.

A game can be played with specific rules so that some win and some lose, usually in a non-serious context or with the purpose of refreshing. Learning methods are used to analyze interactions between several stakeholders and individuals who present rational strategies. Pathogen Attack is an educational game developed by GTAC (*Gene Technology Access Centre*) in Australia. The game aims to teach players about the human immune system and how it fights various pathogens such as viruses, bacteria, and parasites.

Material about the body's defense system is widely chosen for research because it is tough to understand, so it can only rely on explanations from teachers who are mere trainers to gain understanding. The study aims to identify problem-solving skills and digital literacy using game-assisted *Interactive Demonstration* models. Games assist Interactive Demonstration in an educational process where students can achieve the desired results and goals based on the explanation that has been given.

2. RESEARCH METHOD

This study employs a quasi-experimental (pseudo-experimental) research design known as the Matching Only Pretest-Posttest Control Group Design. Due to the diverse approaches taken with the two classes, there are variations in the students' cognitive learning outcomes. Two groups are chosen and defined in this design. Then a pretest is administered to determine whether there is a difference between the experimental group and the control group's initial state. The pretest results are good when the experimental group scores are not statistically different. Students who utilized the Pathogen Attack Game continuously received therapy for the experimental class variables, which included learning through interactive demonstrations supported by video games. Post-tests on the experimental and control classes were conducted in the control classes using the most recent conventional model.

This study was conducted in MAN 2 Sukabumi City on Sukakarya street, Warudoyong District, Palasari No. 14, Sukabumi City, West Java 43135. The time for doing this research will be in June 2023. The study focuses on class XI IPA MAN 2 Sukabumi City students enrolled in the even semester of the 2022–2023 academic year. XI Science 2 and XI Science 4 were chosen for this investigation.

Data collection was carried out by giving pretest & post-test test techniques, providing observation sheets, and response questionnaires, so there were three research instruments used as tools in collecting data in this study consisting 1) student problem-solving ability questions consisting of 8 multiple-choice questions and two essay questions used to measure students problem-solving abilities; 2) questionnaires of student responses to the application of the game-assisted Interactive Demonstration learning model in equipping problem-solving skills consisting of 22 statement items (positive and negative statements each consisting of 11 statements); and 3) digital literacy observation sheets that measure students' digital literacy skills, consisting of 22 statements (11 positive statements, 11 negative statements). four indicators of advanced problem-solving skills. The four signs are (1) employing imagination to combine skills, (2) creating models, (3) carrying out studies, and (4) assessing data and drawing conclusions.

Before data collection, the problem-solving research tool is vetted by subject-matter experts. Additionally, outside experiments were conducted in several schools with students in the same grade level who had been given information about the immune system or the body's defense system. Researchers created 16 multiple-choice questions and two essay questions on problem-solving abilities. The trial's findings were then examined using the Anates application to gather information about the validity, reliability, degree of difficulty, and discriminating knowledge of the trial's questions. Based on the outcomes of these tests, it is known that the researchers' collection of problem-solving skills tests can be used to gather research data.

Statistical data analysis was done on the research findings using SPSS and Microsoft Excel software for the pretest and post-test question instruments, problem-solving skills, digital literacy, and student response questionnaires. The processing of pre-and post-test score data includes the N-Gain test, prerequisite test, parametric analysis (normality and homogeneity test), and hypothesis testing, which is assessed using the t-test (independent t-test). A Likert scale with five possible responses—strongly agree, agree, neutral, disagree, and strongly disagree—was used to examine the data from student response surveys (Sugiyono, 2014).

3. RESULT AND DISCUSSION

The data used in this study came from examinations of problem-solving skills administered to experimental and control classes in the form of a *pretest and a post-test*, student response survey samples given to experimental class students of 15 students consisting of 12 female students and three male students, and digital literacy observation sheets administered to both classes. The experimental class (XI Science 2) used a game-assisted *Interactive Demonstration* learning model to teach the body's defensive mechanism (Immune). In contrast, the control class received instruction using the *Discovery Learning* learning model. The pretest's purpose, administered prior to learning (and before treatment), is to ascertain the degree of students' starting abilities in both experimental and control classes. *The post-test* is administered following the completion of the learning process to determine the degree of students' problem-solving skills following treatment and the impact of the game-assisted *Interactive Demonstration* learning model on the students in the experimental class. The data gathered will provide a broad overview of the data gained.

Kurniawan and Taqwa (2018) developed a set of multiple-choice questions to assess students' problem-solving skills in the context of the immune system, which is the body's defense mechanism. These questions were based on four indicators of advanced problem-solving skills that Butterworth and Thwaites (2013) described. The four signs are (1) employing imagination to combine skills, (2) creating models, (3) carrying out studies, and (4) assessing data and drawing conclusions.

These indicators determine how the eight multiple-choice and two essay questions are loaded. Table 1 displays the outcomes for the experimental class and control class from the *pretest and post-test.*

Table 1. Recapitulation of Pretest and Posttest Score Data Based on N-Gain Calculation

Class	**Average rating**			**Criteria**
	Pretest	***Post-test***	***N-Gain***	
Experimen	33	82	0,74	High
Control	35	49	0,21	Low

Because the two classes' N-Gain scores differ, the results in the experimental and control classes have distinct criteria. The experimental class's N-Gain score was higher than the control class's N-Gain score. The experimental class's N-Gain score was 0.74 with High criteria, while the control class's N-Gain score was 0.21 with Low criteria. This is consistent with Meltzer & David's (2002) analysis in Kurniawan & Hidayah (2020) divide the N-Gain score into three categories In table 2.

Table 2. N-Gain Criteria

Criteria	Point Gain
High	$g > 0.7$
Keep	$0.3 < g \leq 0.7$
Low	$g \leq 0.3$

Additionally, homogeneity and normality tests were run on the pre-and post-test results from both classes as prerequisites for parametric analysis. A normality test is conducted to ascertain if the population's data is regularly distributed. Once the data is known to be normally distributed, a homogeneity test is run to see if the variance data is homogeneous or not. The necessary analytical test is completed once the data have been checked for normality and homogeneity and data that are normally distributed and homogeneous variations have been acquired. This allows for the independent sample t-test, a parametric hypothesis test, to be performed. Data from the experimental and control classes' post-test results were used in this study's hypothesis test. SPSS 29 was used to investigate this necessary parametric analysis and hypothesis test. Table 3 below displays the analysis's recapitulation findings.

Table 3. Recapitulation of Normality, Homogeneity, and Hypothesis Tests.

Testing	Class	Description	Score (Sig.)	Information
Normality Test (Shapiro-Wilk)	Experiment	Pretest	0,057	Normally distributed data
		Post-test	0,015	
	Control	Pretest	0,489	
		Posttest	0,146	
Homogenity Test	Experiments and Controls	Based on mean	0,084	Homogeneously distributed data
		Based on Median	0,163	
		Based on the median with adjusted	0,164	
		Based on trimmed mean	0,110	
Hypothesis Test (*Independent Sample T-test*)	Experiment	Pretest (Sig (2-tailed))	0,443	
		Posttest (Sig (2-tailed))	0,000	Significantly different

Because the study sample is fewer than 30, the Shapiro-Wilk test's results for determining normality reveal that the experimental and control classes have a significance value of more than 0.05 (sig > 0.05), indicating that the data in both types are normally distributed. Once it is established that the data in both categories is normally distributed, a homogeneity test is conducted. Based on Table 3 above, the homogeneity test results indicate values of 0.084 > 0.05, indicating that the data is uniformly distributed because the resulting significance value is higher than 0.05. After obtaining normal and homogeneously distributed data, an independent sample t-test was used to test the hypothesis. This results in the pretest value having a significance value of Sig (2-tailed) 0.443 thus the pretest data shows no significant difference from the control class and the study can be continued then testing the hypothesis on the posttest data significance value of Sig (2-tailed) 0.000, indicating that the experimental class's *post-test* data were significantly different from those of the control class because the significance value was less than 0.05 (0.000 < 0.05), indicating that the H0 hypothesis had been rejected and the H1 hypothesis had been accepted. Therefore, the Interactive Demonstration learning approach substantially impacts students' capacity to solve problems related to the body's immune system (Immune) material. In line with research, according to Febrianti et al. (2016), the Levels of Inquiry interactive demonstration model enhances students' scientific problem-solving skills by creating interactive interaction between students through the exchange of ideas and learning from each other, thereby increasing knowledge and understanding.

According to the outcomes of the data processing described above, students' capacity to solve problems is impacted by learning in the experimental class utilizing the Interactive Demonstration learning approach. The interactive demonstration learning model can enhance students' ability to solve problems more independently find solutions to problems. In this study, students are trained to observe Game Pathogens Attack, demonstrated by the teacher and done in LKPD (Lembar Kerja Peserta Didik) or Student Worksheets, in line with Hayuana et al., (2023) research Student problem solving is powered through observation and analysis of real problems from articles on student worksheets. He pours what he obtains from his observations, encouraging students to look for solutions. The problem-solving skills of students in the experimental class are more improved than those of the control class. Students are thus taught how to discover fresh concepts on their own.

This is consistent with the study by Stice published in Azizah et al. (2017) claimed that as compared to traditional learning, students' problem-solving skills improved. Lectures, conversations, and presentations of discussion findings are all common components of the learning process used in traditional classroom settings. According to Muyassaroh's interactive demonstration research, students' problem-solving skills are higher with inquiry-interactive Demonstration learning than with inquiry-discovery learning. This is reflected in learning steps that help students explain and make predictions, enabling teachers to recognize and address student conceptions (Azizah et al., 2017).

After gathering information on the outcomes of the pretest and post-test in the experimental and control class, the problem-solving skills of the students on each indicator were examined. The N-Gain test was then conducted to ascertain the difference between the post-test and pretest scores to ascertain the problem-solving skills of the students who demonstrated the influence of learning in the experimental class following teacher-led learning. Table 4 below shows the results of the N-Gain test on the outcomes of the pretest and post-test.

Table 4. Recapitulation of Pretest and Post-test Score Data Based on N-Gain Calculation per question indicator

No.	**Problem-solving Ability Indicator**	**Average Score of Experiment class (15 Students)**			**The average score of the Control Class (15 Students)**		
		Pretest	**Post**	**N-Gain**	**Pretest**	**Post**	**N-Gain**
1.	Conducting investigations	73,33	80,00	0,25	66,66	90,00	0,70
2.	Develop a model	0,00	70,67	0,68	2,66	16,00	0,14
3.	Combining skills using imagination	62,67	73,33	0,29	64,00	73,33	0,26
4.	Analyze the data and conclude	66,67	93,33	0,80	60,00	86,66	0,67

According to Table 4 above, both the experimental and control classes' average *pretest and post-test* scores increased for each indication. When comparing the experimental class to the control class, the average pretest and post-test scores of the experimental class increased more than those of the control class, resulting in a higher N-Gain score for the the experimental class. The analysis of the data above is shown in Figure 1 below as a graphic to help make it more understandable.

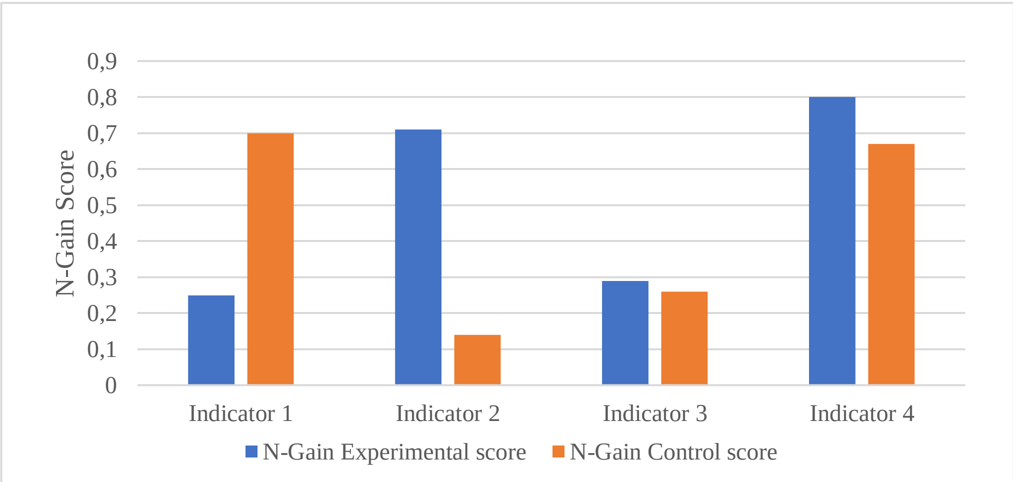

Figure 1. Diagrams of problem-solving capabilities on each indicator

Based on Table 4 and Figure 1 above, it is evident that the experimental class's N-Gain scores for indicators 2, 3, and 4 are superior to those of the control class. In contrast, the control class outperforms the experiment in indication 1. This demonstrates that pupils in the experimental class are better at solving problems than those in the control class. The results showed that indicator 4 in the experimental class had the highest average N-Gain score on problem-solving ability with an N-Gain score of 0.80 ($0.70 \leq g \leq 1.00$) with high criteria. This indicated that students were able to analyze the data and draw conclusions by describing efforts to maintain the immune system in the body, as well as the outcomes obtained by the control class, even though indicator 4's N-Gain score was 0.67 ($0.30 \leq g < 0.70$ While the first indicator in the experimental class had the lowest average score on the problem-solving ability indicator, with an N-Gain score of 0.25 ($0.30 \leq g < 0.70$) with low criterion. With an N-

Gain score of 0.214 (0.00 < g < 0.30) and low criteria, the second indicator of the problem-solving ability indicator in the control class had the lowest average score in the control group. Figure 1 above illustrates that the experimental class students' problem-solving capacity displays pretty good criteria, with N-Gain scores typically on medium measures. This is since in the experimental class, researchers using the Interactive Demonstration learning model carried out steps to guide students to enter a simulation by asking students to observe the game demonstrated by the teacher, predict what will happen, and then present. Students were then allowed to pour the results of their observations in LKPD as widely as possible according to what they obtained from their statements.

It is also evident from Table 4 and Figure 1 above that the experimental and control classes' N-Gain scores on each measure of problem-solving skill differ. This is because each student has a unique comprehension pattern, which causes variations in each indicator. The first clue is to analyze antigens and antibodies in the human body using a problem-solving test, specifically by looking at antigens and antibodies produced by the immune system or the body's defense mechanism. In contrast, to the control class, where the average N-Gain score was 0.70 with the high category, the experimental class's average N-Gain score was 0.25 with the low category. This demonstrates that the experimental class students have not been able to analyze antigens and antibodies very well, but the experimental class's average pretest and post-test score, which is relatively high at 80.00, demonstrates that students have, on the whole, at least mastered these indicators. The experimental class's pupils' poor performance on this indicator can be attributed to their inexperience with the games being utilized and the Interactive Demonstration model, which expects students to predict every detail concerning antigen and antibody analysis. The exploration process to forecast what happens needs to be better established in the control class, where pupils are used to researching independently in books and online. According to Jana and Fatmawati's (2020) research, the Discovery Learning model can be applied to teach students how to work together and discuss in a group. Through group sharing, this discussion helps students develop their abilities to explain lessons or material they already know to friends who do not understand. Students can benefit from a teacher's introduction of the content and a quick explanation of it as well.

The second indicator in the problem-solving ability test requires students to create a straightforward model of the body's defensive mechanism as a concept map. In the experimental class, the average N-Gain score for this indicator was 0.68 in the medium category, compared to 0.14 in the low category in the control class. The use of game-assisted Interactive Demonstration learning models equipped with problem-solving LKPD in experimental classes emphasizes students to be more independent in predicting and discovering new ideas and knowledge so that students can develop models and analyze a problem or, in this case, learners can develop models of the body's defense mechanisms. This causes a difference in categories in the average results of N-Gain scores in the experimental and control classes. This is consistent with (Saputri & Suyudi (2020) by Rohendi et al. Demonstrations in the classroom help students build their knowledge, although instructor engagement in instruction is still solid. Students can gain a clear understanding of phenomena thanks to this education.

The third indicator conceptualizes how vaccinations affect the body's immune system by blending knowledge and imagination. In this indicator, the control class's average N-Gain score was 0.26 in the low category, compared to the experimental class's average N-Gain score of 0.29 in the low category. Despite this, the value obtained is both high and low. These findings demonstrate that students in the experimental class have a better understanding of how vaccinations affect the body's defense mechanism. This is because the game-assisted Interactive Demonstration learning paradigm used in the experimental class had very little impact. Demonstration-based learning, according to Miller et al. (Puspita et al., 2017), can also assist students in gaining conceptual mastery and making connections between concepts and the real world.

The fourth indicator involves data analysis, followed by a discussion of steps taken to keep the body's immune system functioning. On this indication, the experimental class's average N-Gain score was 0.80 in the high category, compared to the control class's average N-Gain score of 0.67 in the medium group. The Interactive Demonstration model's influence on the experimental class is what accounts for their strong problem-solving skills. According to Wianti (2016), interactive demonstrations are a great way to help students develop their conceptual comprehension and analytical skills. Interactive demonstrations in the experimental class and discovery learning in the control class are inquiry learning models, in line with Daryanto in Susilowati & Wahyudi (2020), so they are a series of learning activities that emphasize the process of critical and analytical thinking itself say there is search and find answers to the problems in question.

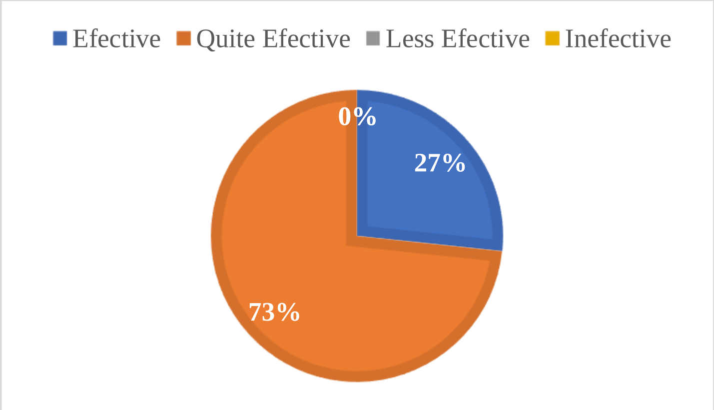

Figure 2. Recapitulation of N-Gain Effectiveness in Experimental Class

In Figure 2, 27% of respondents indicated that the Interactive Demonstration learning paradigm helps improve problem-solving skills, while 73% stated it is quite effective. This study examined students' problem-solving abilities and digital literacy, as reflected in 22 statements from Digital Literacy Across the Curriculum (2009), 11 of which were favorable and 11 of which were negative. Figure 3 illustrates the findings of the data recapitulation and analysis on digital literacy using a scale of assessment of media using scores 1-6 following the hierarchy of response measurement for media proposed by Chris M. Worsnop (1996) in Juditha (2013)

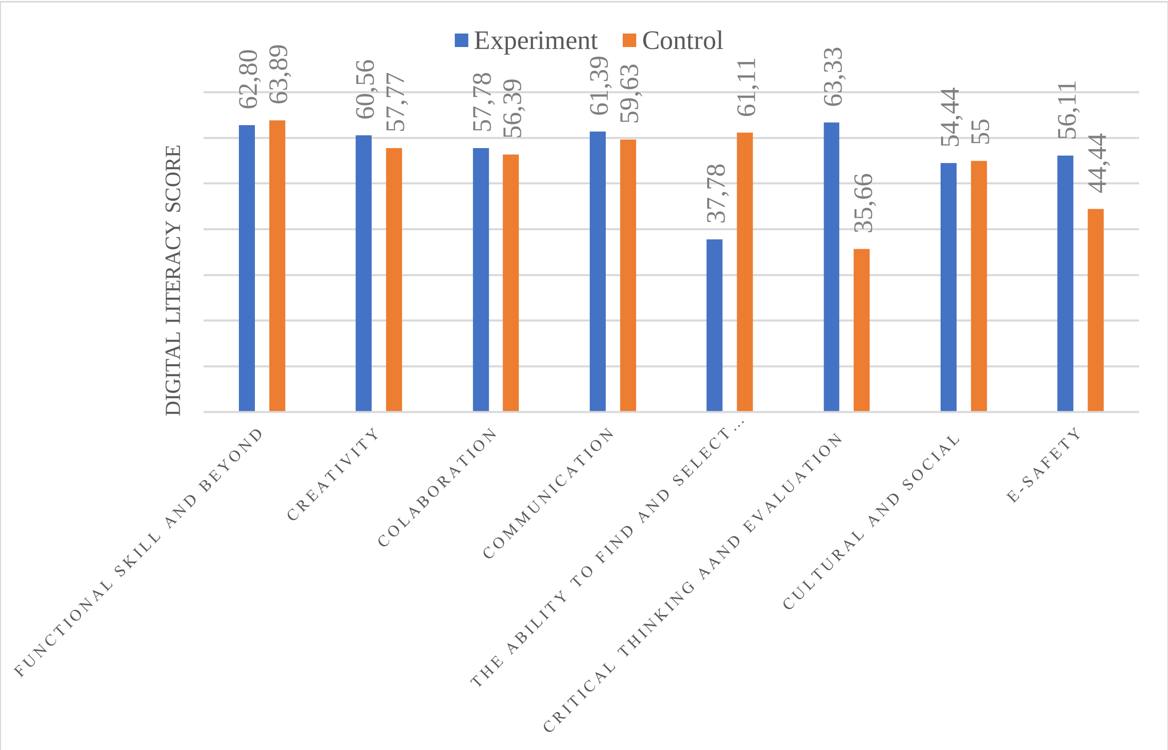

Figure 3. Digital literacy graph in experimental and control classes

The average comparison value of digital literacy in the experimental and control classes can be seen in table 5.

Table 5. Average comparison of Digital literacy in experimental and control classes

Indicator	Experiment	Criterion	Control	Criterion
Functional Skill and Beyond	62,80	Level 5	63,89	Level 5
Creativity	60,56	Level 4	57,77	Level 4
Collaboration	57,78	Level 4	56,39	Level 4
Communication	61,39	Level 5	59,63	Level 4
The Ability to find and select Infomation	37,78	Level 3	61,11	Level 5
Critical Thinking and Evaluation	63,33	Level 5	35,66	Level 3
Cultural and Social Understanding	54,44	Level 4	55,00	Level 4
E-safety	56,11	Level 4	44,44	Level 4

The purpose of the observation sheet is to examine students' proficiency in digital literacy. The evaluation standards are based on the media response measurement scale that Chris M. Worsnop created in 1996 in Juditha (2013).

Level	Information	Criterion
Level 1	The user's remark must be more meaningful, transparent, and substance.	Don't Understand:
Level 2	User behaviour suggests a low engagement with or devotion to text and media. There may be poor, disconnected, or no personal responses to the content.	Did not meet expectations
Level 3	The user only passes allusions to their sentiments or experiences when they recount, paraphrase, or identify the device.	Consistently meet expectations
Level 4	Users only create cursory connections to text when investigating personal emotions, experiences, hopes, concerns, thoughts, or beliefs.	Usually meets expectations
Level 5	Users connect text with their emotions, memories, hopes, fears, reflections, and beliefs. Personal comments refer to the text, demonstrating comprehension and a limited understanding of its subtexts.	Consistently meet/sometimes exceed expectations.
Level 6	Users incorporate text with their emotions, past events, hopes, anxieties, and reflections. Personal reactions have a solid textual foundation, a thorough knowledge of the text's central theme and supporting subtexts, and they draw parallels with other readers.	Exceeded expectations

Figure 4. Media literacy assessment scale according to Worsnop 1996.

With an average Functional skill and beyond indicator score of 62.80 for the experimental class and 63.83 for the control class in Figure 3, the intermediate experimental class is marginally better than the control class. There were 57.77 control courses and 60.56 experimental classes in terms of Creativity. The collaboration involved 56.39 control classes and 57.78 experimental classes. 61.39 experimental classes and 59.63 control classes were involved in communication. E-Safety had 56.11 experimental and 44.44 control classes, whereas Critical Thinking and Evaluation had 63.33 experimental and 35.66 control classes. On the indicators for the ability to locate and choose information (37.78 experimental classes vs. 61.11 control classes) and cultural and social understanding (54.44 experimental classes vs. 55.00 in control courses), experimental groups performed marginally worse than control classes, according to Hague & Payton's analysis in Nugraha (2022). Digital literacy consists of eight elements. 1.) The following eight skills comprise functional skills, or the capacity to use digital devices as needed. 2.) Creativity, namely the capacity to generate, construct, and creatively convey information, 3.) Critical thinking and the capacity for evaluation, precisely the capacity to transform, analyze, or process information, data, or ideas received through reasoning, entails the process of questioning, analyzing, researching, and evaluating, as well as the capacity to present arguments about them, 4.) Cultural and social awareness, or the knowledge that words spoken and deeds done can be interpreted differently in various social and cultural contexts, as well as the knowledge that each person's understanding and learning can be influenced by the social, cultural, and historical circumstances around him, 5.) Collaboration is the comprehension, use, and optimization of digital technology in collaborative tasks or teamwork. 6.) The capacity to look for and choose pertinent, trustworthy information, 7.) critical thinking and evaluation, this component emphasizes that you should not only receive information and interpret information passively, but you should also contribute, analyze and sharpen your critical thinking when dealing with information. 8.) electronic security, also known as e-safety. This includes knowledge of data security concerns and one's own privacy in cyberspace, protection from copyright and plagiarism violations, and protection of devices from potential virus attacks, among other things.

According to observation, both experimental and control classes' average scores for digital literacy were above 56.77, which is considered pretty good. On indications with levels at 3 (always meeting expectations), 4 (often exceeding expectations), and 5 (always meeting expectations/occasionally exceeding expectations). Due to their consistency in meeting and exceeding objectives and their familiarity with using computers to access media, students in both classes have powerful digital literacy abilities. This is consistent with Hague & Payton's assertion in Rini et al, (2018) that, in the context of education, solid digital literacy will contribute to a person's ability to learn a particular subject by fostering Creativity and curiosity. In the functional skill and beyond indicators, The ability to find and select information, and cultural social and understanding in the control class seems to have a higher value than the experimental class, this is based on the fact that the control class applies a discovery learning model in line with research by Hutajulu (2021) where the model involves students to develop knowledge and skills and according to Rahayu and Hardini (2019) this model can Improve the ability to search for information actively.

This study used questionnaires to gather information on how the experimental class's pupils responded to using the Interactive Demonstration learning paradigm for lessons on the immune system. Following the conclusion of the learning process, the experimental class's pupils were handed the response survey. The questionnaire has 22 statements, ten of which are good and ten of which are negative. This response questionnaire provided five alternative answers, namely SS (Strongly Agree), S (Agree), N (Neutral), and TS (Disagree) (Sugiyono, 2014). The questionnaire aims to learn: 1) students' responses to the learning design applied in the game; 2) Operational in the technical use of games; and 3) visual communication related to in-game features.

The Microsoft Excel program used the Likert scale to analyze survey data. According to Abidin and Purbawanto (2015), the interpretation of Likert scale categories is based on Arikunto's (2013) work. For example, if the score range is 84-100%, Very Positive, 68-84%, Positive, 52-68%, Ordinary, 36-52%, Negative, 0-36%, and Very Negative, the category is excellent.

Figure 5 below shows the results of the questionnaire processing of the replies from students regarding the use of the game-assisted Interactive Demonstration learning approach.

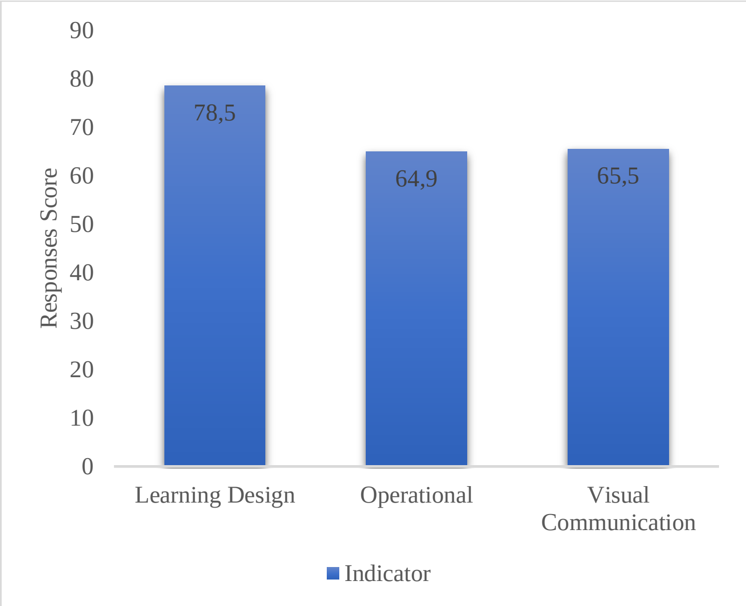

Figure 5. Graph of the average score of student responses to the game-assisted Interactive Demonstration model

According to Figure 5 above, the average score is in the range of 68–84%, with an average score of Indicator 1 of 78.5%, an average score of indicator 2 of 64.9%, and an average score of Indicator 3 of 65.5%. This means that the student's response is categorized positively in indicator 1, namely, learning design. Therefore, it can be concluded that students respond favourably to using the game-assisted *Interactive demonstration* learning model on the immune system (body's defense system) content.

In this project, experimental classes on the use of Interactive Demonstration are aided through games. The University High School in Parkville, in the northern part of Melbourne, Australia's capital city, is home to the *GTAC (Gene* Technology *Access Centre)*, which created the game. Since its founding in 2000, GTAC has developed and offered a variety of cellular and molecular biology teaching programs to students and teachers throughout Victoria. As a specialized science education center, GTAC offers on-site, off-site, and online programs that significantly advance knowledge in the life sciences, classroom instruction, and professional development.

In this frantic and incredibly addicting real-time strategy game, Pathogens Attack, you manage your immune cells as you battle invasions from pathogens like influenza viruses and streptococcus bacteria. The GTAC Immunology Game educates players on the many compartments and pathways to mounting an immune response. It was created in collaboration with immunology experts and software engineers. Your grasp of the components of adaptive immune responses will be tested when you complete the associated exercises in this online course. Rahmatania & Setiawan's (2021) research aligns with the notion that educational games unquestionably aid the educational process. According to *the Massachusetts Institute of Technology (MIT)*, players' logic and understanding of a topic are developed through gaming projects using good games. Figure 6 shows a game perspective.

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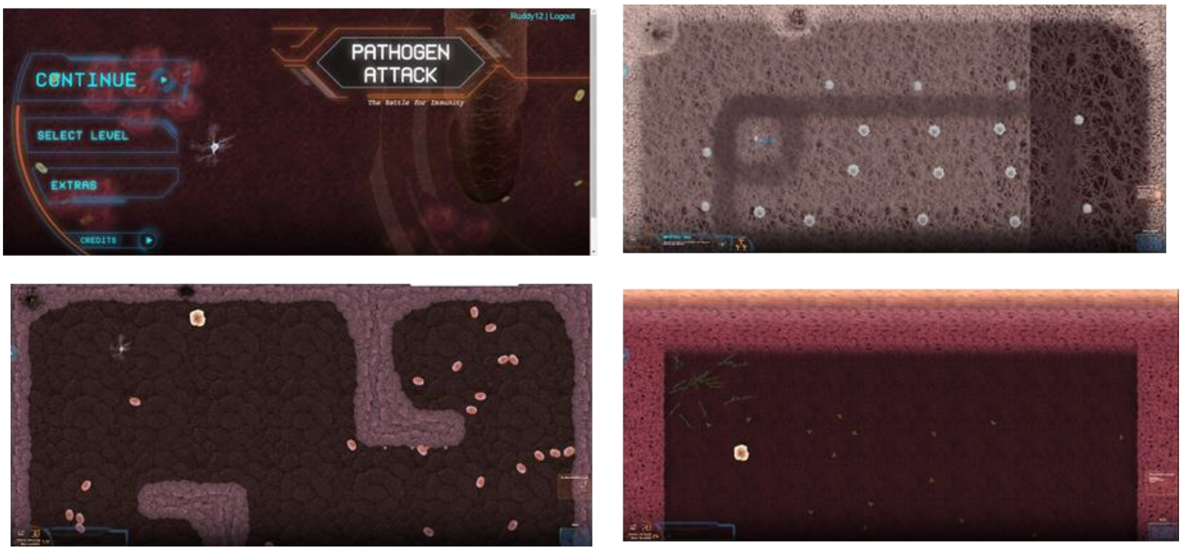

Figure 6. Game Pathogens Attack (GTAC)

4. CONCLUSION

The conclusion of the hypothesis test results obtained from the calculation of the the pretest value get a significance value of 0.443 which is not significantly different from the control class. The *post-test* value got a significance value of 0.000 based on the results of the research and data analysis the research conducted, demonstrating the impact of the game-assisted *Interactive Demonstration* learning model on the problem-solving ability of high school students on the subject matter of the body's defense system (Immune). Students in the experimental class scored 0.74 in the high category on the N-Gain test's pretest and post-test, compared to 0.21 in the low category in the control class. Every sign in the experimental class displays a high level of apparent problem-solving ability, except for the first and third indicators, which indicate a low level of evident problem-solving ability. In terms of expectations met, pupils in the experimental class had an average digital literacy above level 3. Scores in the Positive category for student comments on using a game-assisted Interactive Demonstration ranged from 68% to 84%. This shows that using the game-assisted Interactive Demonstration learning model affects high school student's ability to solve problems involving the body's immune system, according to the results of all the instruments employed.

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6. REFERENCES

Abidin, Z., & Purbawanto, S. (2015). Pemahaman Siswa Terhadap Pemanfaatan Media Pembelajaran Berbasis Livewire Pada Mata Pelajaran Teknik Listrik Kelas X Jurusan Audio Video Di Smk Negeri 4 Semarang. *Edu Elektrika Journal*, *4*(1), 38–49.

Anggia, D., Ramdan, B., Juhanda, A., & Artikel, I. (2022). *BIODIK: Jurnal Ilmiah Pendidikan Biologi Analisis Kemampuan Literasi Digital Siswa SMP Ditinjau dari Penggunaan Aplikasi Mobile Learning pada Konsep Sistem Peredaran Darah Manusia (Analysis of Digital Literacy Abilities of Junior High School Students in T*. *08*, 65–75. https://online-journal.unja.ac.id/biodik

Azizah, R., *Yuliati*, L., & Latifa, E. (2017). Kemampuan Pemecahan Masalah Melalui Pembelajaran Interactive Demonstration Siswa Kelas X SMA pada Materi Kalor. *Jurnal Pendidikan Fisika Dan Teknologi*, *2*(2), 55–60. https://doi.org/10.29303/jpft.v2i2.289

Curriculum, D. L. A. the. (2020). *Instrumen penelitian indeks literasi digital 1*. *1*, 1–5.

Febrianti, R. eka, Yuliati, L., & Yulianti, E. (2016). KEMAMPUAN PEMECAHAN MASALAH IPA PESERTA DIDIK KELAS VII SMP YANG BELAJAR DENGAN MODEL LEVELS OF INQUIRY-

INTERACTIVE DEMONSTRATION. *Prosiding Seminar Nasional Pembelajaran IPA Ke-1 Implementasi Kurikulum Nasional Dalam Abad Literasi Sains*, hlm.33-37.

Hanifah, E., Setiono, S., & Nuranti, G. (2021). Pengaruh Model Socio-Scientific Issue Terhadap Keterampilan Memecahkan Masalah Menggunakan Aplikasi Powtoon pada Materi Perubahan Lingkungan. *Biodik*, *7*(4), 18–28. https://doi.org/10.22437/bio.v7i4.13758

Hayuana, W., Suwono, H., & Setiowati, F. K. (2023). Effectiveness of PBL STEM to Improve Problem Solving Skills. *Bioedukasi*, *21*(2), 144. https://doi.org/10.19184/bioedu.v21i2.39740

Jainuri, M. (2014). Kemampuan Pemecahan Masalah Matematika. *Acamedia*, *1*(1), 1–8.

Jana, P., & Fahmawati, A. A. N. (2020). Model Discovery Learning Untuk Meningkatkan Kemampuan Pemecahan Masalah. *AKSIOMA: Jurnal Program Studi Pendidikan Matematika*, *9*(1), 213. https://doi.org/10.24127/ajpm.v9i1.2157

Juditha, C. (2013). *Literasi Media pada Anak di Daerah Perbatasan Indonesia dan Timor Leste Children Media Literacy in the Border of Indonesia and Timor Leste*. *15*(1), 47–62. http://www.lontar.ui.ac.id/

Junedi, B., Mahuda, I., & Kusuma, J. W. (2020). Optimalisasi keterampilan pembelajaran abad 21 dalam proses pembelajaran pada Guru MTs Massaratul Mut'allimin Banten. *Transformasi: Jurnal Pengabdian Masyarakat*, *16*(1), 63–72. https://doi.org/10.20414/transformasi.v16i1.1963

Koltay, T. (2011). The media and the literacies: Media literacy, information literacy, digital literacy. *Media, Culture and Society*, *33*(2), 211–221. https://doi.org/10.1177/0163443710393382

Kurniawan, A. B., & Hidayah, R. (2020). Kepraktisan Permainan Zuper Abase Berbasis Android Sebagai Media Pembelajaran Asam Basa. *UNESA Journal of Chemical Education*, *9*(3), 317–323. https://doi.org/10.26740/ujced.v9n3.p317-323

Kurniawan, B. R., & Taqwa, M. R. A. (2018). Pengembangan Instrumen Tes Kemampuan Pemecahan Masalah Fisika pada Materi Listrik Dinamis. *Jurnal Pendidikan: Teori, Penelitian, Dan Pengembangan*, *3*(11), 1451–1457.

Lase, D. (2020). Pendidikan Di Era Revolusi Industri 4.0. *Jurnal Teknologi Industri Dan Rekayasa (JTIR)*, *1*(1), 43–48. https://doi.org/10.53091/jtir.v1i1.17

Mardhiyah, R. H., Aldriani, S., Chitta, F., & Zulfikar, M. R. (2021). *Pentingnya Keterampilan Belajar di Abad 21 sebagai Tuntutan dalam Pengembangan Sumber Daya Manusia*. *12*(1), 187–193.

Masropah, S. M., Juhanda, A., & Ramdhan, B. (2022). Analisis Keterampilan Literasi Digital Siswa SMA melalui Penggunaan Google Lens pada Konsep Tumbuhan Berbasis Gender (Analysis of Digital Literacy Skills among High School Students through the Use of Google Lens. *Jurnal Ilmiah Pendidikan Biologi*, *08*, 115–124.

Nugraha, D. (2022). Literasi Digital dan Pembelajaran Sastra Berpaut Literasi Digital di Tingkat Sekolah Dasar. *Jurnal Basicedu*, *6*(6), 9230–9244. https://doi.org/10.31004/basicedu.v6i6.3318

Polya, G. (2010). How to Solve it. In *Stochastic Optimization in Continuous Time*. https://doi.org/10.1017/cbo9780511616747.007

Pratama, D. P., Darvina, Y., & Sari, S. Y. (2020). Peningkatan Pencapaian HOTS Siswa pada Materi Gerak Melingkar dan Gerak Parabola Menggunakan LKS Berorientasi Model Inkuiri Terbimbing di SMAN 2 Pariaman. *Pillar Of Physics Education*, *13*(2), 225–232.

Puspita, W. I., Sutopo, & Yuliati, L. (2017). Interactive Demonstration Untuk Meningkatkan Penguasaan Konsep Fisika pada Materi Fluida Siswa SMA Kelas XI. *Prosiding Seminar Pendidikan IPA*, *2*, 333–339.

Rahmatania, D. D., & Setiawan, Y. (2021). Pengembangan Media Poly Game pada Pembelajaran Matematika

Dalam Meningkatkan Kemampuan Pemecahan Masalah di Sekolah Dasar. *Jurnal Basicedu*, *5*(4), 2449–2460. https://jbasic.org/index.php/basicedu/article/view/1249

Restianty, A. (2018). Literasi Digital, Sebuah Tantangan Baru Dalam Literasi Media. *Gunahumas*, *1*(1), 72–87. https://doi.org/10.17509/ghm.v1i1.28380

Rini, R., Suryadinata, N., & Efendi, U. (2018). Digital Literacy Ability towards Curiosity Level and Student Self-Determination. *Pendidikan Progresif*, *8*(2), 53–67. https://doi.org/10.23960/jpp.v

Saputri, D. E., & Suyudi, A. (2020). Pembelajaran Interactive Demonstration dengan Diagram Gaya melalui Real dan Virtual Lab untuk Meningkatkan Pemahaman Konsep Dinamika Rotasi. *Jurnal Riset Pendidikan Fisika*, *5*(1), 18–23.

Sugiyono. (2014). *Metode Penelitian kuantitatif, kualitatif dan R & D*. Alfabeta, CV.

Susiana, N., Yuliati, L., Latifah, E., Malang, F. U. N., & Newton, H. (2018). *Pengaruh Interactive Demonstration* terhadap *Kemampuan Pemecahan Masalah Siswa Kelas X pada Materi Hukum Newton*. *2001*, 312–315.

Susilowati, R. D., & Wahyudi, W. (2020). Efektivitas Model Pembelajaran Inquiry dan Problem Based Learning Terhadap Kemampuan Pemecahan Masalah pada Mata Pelajaran Matematika Kelas IV SD. *Jurnal Edukasi Matematika Dan Sains*, *8*(1), 49. https://doi.org/10.25273/jems.v8i1.6084

Wianti, W. ayu. (2016). *PENINGKATAN LEVELS OF UNDERSTANDING, PERUBAHAN PROFIL MODELS OF UNDERSTANDING DAN PENINGKATAN KEMAMPUAN ANALISIS SISWA SMA MELALUI PENERAPAN INTERACTIVE LECTURE DEMONSTRATION BERORIENTASI KONSTRUKSI KONSEPSI* PADA *PEMBELAJARAN FISIKA*. 1–23.