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ANALYSIS OF STUDENTS' SCIENTIFIC LITERACY SKILL IN TERMS OF GENDER USING SCIENCE TEACHING MATERIALS DISCOVERY MODEL ASSISTED BY PhET SIMULATION

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ABSTRACT

This study aimed to analyze scientific literacy skills in terms of gender using discovery model science teaching materials assisted by PhET simulation. This study is a one-group pretest and posttest design and an experimental. This research was conducted at MTs Hidayatullah Mataram in class IXA students in three meetings for 80 minutes each. The material used is static electricity which consists of five sub materials, namely static electricity, atoms, electric charge, Coulomb's law, and electroscope. The collection method of the scientific literacy test is in the form of multiple-choice with the indicators of being to explain scientific phenomena, scientific discoveries, and statements, and use scientific data and evidence. Prior to use, a feasibility test was carried out. The results of the item analysis show that people have a good level of adjustment, reliability, and difficulty level. The research found that: (1) female and male students had different scientific literacy skills, where the scientific literacy skill of female students was higher (80) than male students (77.95); (2) there were three sub-materials dominated by female students, namely the sub-materials of electrical charge, Coulomb's Law, and electroscope; (3) there are two sub-materials of static electricity which are dominated by male students, namely the sub-materials of static electricity and atoms; (4) in the average percentage of the indicator of explaining phenomena scientifically and interpreting data and evidence scientifically, female students are higher than male students; and (5) the average percentage of evaluating and designing scientific statements is higher for male students than female students. Suggestions for teachers are to pay attention to the roles of female and male students in the learning process so that the abilities of female and male students are not much different.

Keywords: discovery learning models; gender; science teaching materials; scientific literacy

INTRODUCTION

21st century skills are a critical topic to be discussed in the world of education (Chalkiadaki, 2018) because it is closely related to the development of science and technology (Handajani et al., 2018). Digital learners and free thinkers are characteristics of 21st century learners. The main objective of these 21st century skills is to prepare students to solve complex problems related to competitive and technology-intensive daily life (Anagün, 2018; Çevik & Şentürk, 2019). Van Laar et al. (2019) stated that education expectations, which are more centered on innovative and critical approaches to problem-solving and decision-making, follow the development of 21st century abilities. It is anticipated that 21st-century education will develop human resources who possess various 21st century competencies, including scientific literacy (Menggo et al., 2019; Rios et al., 2022).

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In 1958, De Paul Hard Hurd, McCurry, and the Rockefeller Brothers Pund presented scientific literacy (Khaeroningtyas et al., 2016). Paul De Hard Hurd first proposed scientific literacy as an objective for science education (Naganuma, 2017; Valladares, 2021). Scientific literacy is the capacity for students to utilize their knowledge of science to formulate hypotheses, draw inferences, and come to judgments about their problems in light of the data that has been gathered (Widiyanti et al., 2015; Mm et al., 2020; Effendi et al., 2021). Scientific literacy relates to students' creative thinking skills (Bahtiar & Ibrahim, 2022). Students with scientific literacy skills can understand the concepts, principles, and theories that form the basis of scientific thinking (économiques, 2019; Ke et al., 2021). The emphasis on scientific literacy in learning aims to develop students' competence in constructing scientific knowledge using the scientific method (Liu et al., 2022).

Based on the Program for International Student Assessment (PISA) report, in 2018, Indonesia ranked 396. This shows that the results obtained by Indonesian students are far below the OECD average and experienced a significant decline, from 403 to 396 (Schleicher, 2018). The results of the PISA report are presented in Figure 1 below.

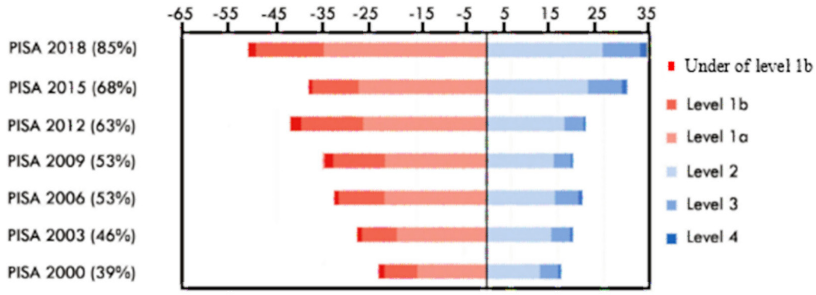

Figure 1. Indonesian Students' Scientific Literacy Results

Figure 1 shows that for the field of science, competency level 1a refers to students' ability to use general materials and procedural knowledge to recognize or distinguish explanations of simple scientific phenomena. In OECD countries, 15.7% of students have a competency level of 1a, and only 5.5% score below. In Indonesia, 35% of students are still in the competency group level 1a and 17% at lower levels. One factor contributing to Indonesian students' low levels of scientific literacy is their inability to read and interpret information presented to them in the form of tables, graphs, charts, and other introductions (Pujawan et al., 2022); students understand science as a theory so that it is still difficult to apply scientific concepts and scientific facts (Lestari et al., 2019; Rahayu et al., 2022); the level of students' understanding of the nature of science which includes is still low (Wei & Lin, 2022).

The results of the 2022 Indonesian Madrasah Competency Assessment (AKMI) as a measuring tool for diagnosing students' strengths and weaknesses in scientific literacy, which consists of five stages, show that the results are as follows: (1) need intervention (66%), (2) basic (25%), (3) competent (1%), and (4) skilled and (5) need to be creative, each of which has not reached 1% (Zainiyati & Suyitno, 2022; Widhiarso & Ridho, 2022). Meanwhile, there are 19 provinces whose scientific literacy index is still below the national average, one of which is madrasah students in West Nusa Tenggara. The low value of scientific literacy obtained by Indonesia at PISA 2018 and AKMI 2022 was also due to problems in teaching science in Indonesia (Putri et al., 2021). To raise the standard of Indonesian education, scientific literacy needs to get significant consideration and be addressed as soon as possible (Jeong et al., 2021).

Using appropriate teaching materials in science teaching is one strategy that helps students to develop their scientific literacy. Science learning provides opportunities for students to gain hands-on experience to increase their strength to accept, store, and apply the concepts learned (Lamb et al., 2018; Kızılaslan et al., 2019). In essence, scientific processes, attitudes, and products serve as the foundation for science (Yaşar, 2017; Ozdem-Yilmaz & Bilican, 2020). Student involvement in science learning is shown in several science activities, such as observing, analyzing data, discussing, and presenting the results of observations (Margunayasa et al., 2019; Hussein et al., 2019). These conditions must be followed by learning that can meet the demands of the 21st century (Inkinen et al., 2020). One of the learning models that follows the demands of the 21st century is the discovery learning model (Bahtiar et al., 2022).

The discovery learning model is one of the learning models that can facilitate students in the concept discovery process (Gunawan et al., 2021; Ilahi et al., 2022). The discovery learning model emphasizes the discovery of concepts and or principles that are not yet owned by students (Ritonga, 2021). Through the discovery learning model, students are familiar with the scientific method and have the ability to think critically and analytically (Serevina & Luthfi, 2021). The main goal of the discovery learning model is to increase students' understanding of knowledge construction through scaffolding, symbolic representation, and discovery (Ozdem-Yilmaz & Bilican, 2020). Research on the application of the discovery learning model conducted by Purwaningsih et al. (2020), Widoretno & Dwiastuti (2019), and Ristanto et al. (2022) showed that the discovery learning model could improve students' problem solving and critical thinking skills. The application of the discovery learning model in science learning must be accompanied by learning media that support the investigations (van Joolingen et al., 2005).

Learning media that facilitate students' learning process is very important (Muhammad, 2020; Winarni et al., 2020). One of the learning media that can be used is the PhET simulation. The College of Colorado Boulder's simulation experts developed the website-based simulation known as PhET Simulation to help students learn through simulated learning (Najib et al., 2022; Ben Ouahi et al., 2022). This PhET simulation was created in Java or Flash to enable direct website use with a specific web browser (Eichler, 2022; Qu et al., 2022). PhET Simulation in learning encourages students' interests to make direct observations (Rahmawati et al., 2022; Watson et al., 2020; Herrington et al., 2022).

Research conducted by Habibi et al. (2020), Eveline et al. (2019), Oktaviana et al. (2020), and Kamila & Rahmawati (2021) on the application of PhET Simulation media in science learning has a positive impact on improving the ability of students to critical thinking skills, mastery of concepts, problem-solving, and representation skills.

Therefore, this study aims to analyze students' scientific literacy skills regarding gender after using discovery learning model teaching materials assisted by PhET simulation. There were four main reasons for conducting this study. First, when it comes to analyzing data presented in tables, diagrams, graphs, and other formats, students find it difficult. Second, the combination of variables in this study, especially in science learning, has never been done. Third, research on students' scientific literacy skills regarding gender only presents research data descriptively. Fourth, gender research needs to be done so that teachers understand the different roles between males and females. Through gender recognition, teachers can teach students according to their respective roles.

METHODS

This research is experimental. Quasi-experimental research is experimental research that can be applied to only one group, which is the experimental class, without any comparison group or control group (Sugiyono, 2020). This study used a one-group pretest-posttest design as its method of investigation. This research design is presented in the form of the following Table 1.

Table 1. Desain One Group Pretest-Posttest

Pretest	Treatment	Post-test
O_1	X	O_2

The population used in this study were all students of class IXA MTs Hidayatullah Mataram. The research sample is part of the population. The sampling technique used was purposive sampling. This means that the sample was taken for specific considerations. The consideration in question is because the characteristics of the sample follow the study's objectives, the students' abilities are the same, and the criteria used are classes with male and female students, so the research sample is 30 students in class IX-A.

This research was conducted from October 2021 to April 2022 at MTs Hidayatullah Mataram. The timing of this research is right in the even semester of the 2021/2022 academic year. This research was conducted in three stages. The first stage is the research preparation stage. At this stage, several things were carried out, such as preparing research designs, studying literature, observing the school environment where the research was carried out, namely at MTs Hidayatullah Mataram, developing discovery-based learning tools assisted by PhET simulations, preparing PhET simulations, and making instrument content outlines and answers to instrument questions of students' scientific literacy.

The second stage is the implementation stage. At this stage, several things were done, namely validating the instrument for scientific literacy questions to students who have studied static electricity, conducting a pretest to the selected class as the research sample, and conducting learning using discovery learning tools assisted by PhET simulation, which has been developed for five meetings, and then conducting a posttest.

The third stage is the final stage of the research. At this stage, there are several things to do, including analyzing research data obtained during the study, presenting and discussing research results, and making conclusions. This research was conducted in stages, as presented in Table 2.

Table 2. Research Procedure

No.	Stages	Activity
1.	Stages of Research Preparation	Research design
		Study of literature
		Observing the school environment
		Develop science teaching materials for the Discovery Learning model
		Preparing PhET Simulation media
		Making scientific literacy questions
2.	Stages of Research Implementation	Validate the instrument on Science Literacy
		Carry out pretest
		Carry out learning using science teaching materials. The PhET Simulation-assisted Discovery learning model
		Carry out posttest
3.	Final Stages of Research	Perform data processing and analysis
		Make a discussion of the research results
		Making research conclusions

The research tool is a measurement device for the observed natural and social processes. From this understanding, it can be understood that an instrument is a tool used by researchers in using data collection methods systematically and more efficiently. The instrument that the researcher used in this study was a multiple-choice scientific literacy test with 15 questions. The following Table 3 is a content outline of scientific literacy questions.

Table 3. Content Outline of Science Literacy Questions

No.	Sub Material	Scientific Literacy Indicaor	No. Item
1.	Static Electricity	Explaining phenomena scientifically	Q1
		Evaluating and designing scientific statements	Q2
		Interpret data and evidence scientifically	Q3
2.	Atom	Explaining phenomena scientifically	Q4
		Evaluating and designing scientific statements	Q5
		Interpret data and evidence scientifically	Q6
3.	Electrical charge	Explaining phenomena scientifically	Q7
		Evaluating and designing scientific statements	Q8
		Interpret data and evidence scientifically	Q9
4.	Coulomb's Law	Explaining phenomena scientifically	Q10
		Evaluating and designing scientific statements	Q11
		Interpret data and evidence scientifically	Q12
5.	Electroscope	Explaining phenomena scientifically	Q13
		Evaluating and designing scientific statements	Q14
		Interpret data and evidence scientifically	Q15

Data analysis is one of the final stages of the research process. Data analysis in this study consisted of instrument analysis and analysis of scientific literacy skills. Analysis of the data in this study used the Rash model. Rash modeling is used to analyze the instrument and students' scientific literacy skills (Alagumalai et al., 2005) with the following equation.

$$P_{ni}\left(x_{ni}=\frac{1}{\beta_n},\delta_i\right)=\frac{e^{(\beta n-\delta_i)}}{1+e^{(\beta n-\delta_i)}}$$
%.

RESULTS AND DISCUSSION

This study aims to analyze students' scientific literacy skills using the PhET simulation-assisted discovery learning model after using science teaching materials. The topic of static electricity was the focus of this study. The following is a description of the research and discussion's findings. Scientific literacy questions were analyzed before the implementation of learning was carried out. An instrument analysis was conducted to assess the questions' validity, reliability, and difficulty. The following Figure 2 shows the outcomes of the instrument analysis for the items' level of appropriateness. Boone et al. (2013) and Bond et al. (2015) claim that the point measure correlation, outfit z-standard, and the value of outfit means-square are the metrics utilized to gauge an item's level of fit. If the items in the three criteria are not met, they are certainly not good enough, so they need to be improved.

ENTRY NUMBER	TOTAL SCORE	TOTAL COUNT	MEASURE	MODEL S.E.	INFIT MNSQ	INFIT ZSTD	OUTFIT MNSQ	OUTFIT ZSTD	PTMEASUR-AL CORR.	PTMEASUR-AL EXP.	EXACT MATCH OBS%	EXACT MATCH EXP%	Item
12	17	30	.15	.43	1.32	1.56	1.20	.75	A .33	.51	53.3	73.4	Q12
9	14	30	.69	.43	1.29	1.47	1.31	1.10	B .33	.51	60.0	72.7	Q9
4	11	30	1.25	.44	1.21	1.04	1.21	.69	C .37	.50	66.7	73.8	Q4
14	18	30	-.04	.43	1.12	.66	1.04	.23	D .44	.51	70.0	74.1	Q14
7	21	30	-.63	.46	1.06	.34	1.07	.29	E .43	.48	80.0	76.5	Q7
13	8	30	1.86	.47	1.01	.12	.85	-.18	F .46	.46	83.3	78.0	Q13
5	18	30	-.04	.43	.86	-.65	.99	.07	G .57	.51	83.3	74.1	Q5
8	25	30	-1.58	.54	.98	.03	.56	-.49	H .45	.39	76.7	83.7	Q8
3	17	30	.15	.43	.96	-.16	.90	-.24	g .55	.51	73.3	73.4	Q3
10	16	30	.33	.43	.95	-.18	.92	-.19	f .55	.52	70.0	73.1	Q10
15	7	30	2.09	.49	.94	-.17	.65	-.56	e .51	.44	80.0	79.5	Q15
1	19	30	-.23	.44	.92	-.34	.76	-.67	d .57	.50	73.3	74.7	Q1
6	24	30	-1.31	.51	.83	-.58	.53	-.72	c .55	.42	86.7	81.2	Q6
11	20	30	-.42	.45	.83	-.79	.80	-.43	b .59	.49	83.3	75.5	Q11
2	27	30	-2.27	.65	.74	-.55	.33	-.53	a .50	.31	90.0	89.9	Q2
MEAN	17.5	30.0	.00	.47	1.00	.1	.87	-.1			75.3	76.9	
P.SD	5.6	.0	1.15	.06	.17	.7	.27	.5			9.8	4.7	

Figure 2. Output Item Fit

In the output Figure 2 above, it can be seen that the questions Q2, Q12, Q9, and Q4 only do not meet one criterion, so there are no items that need to be changed or replaced. The following Figures 3 show the reliability analysis findings.

SUMMARY OF 30 MEASURED Person

	TOTAL SCORE	COUNT	MEASURE	MODEL S.E.	INFIT MNSQ	INFIT ZSTD	OUTFIT MNSQ	OUTFIT ZSTD
MEAN	8.7	15.0	.51	.67	1.01	.11	.87	-.04
SEM	.6	.0	.24	.02	.04	.15	.06	.11
P.SD	3.3	.0	1.30	.11	.24	.82	.30	.58
S.SD	3.3	.0	1.32	.11	.24	.84	.30	.59
MAX.	14.0	15.0	3.16	1.07	1.53	1.98	1.55	1.34
MIN.	3.0	15.0	-1.72	.58	.63	-1.45	.25	-1.15

REAL RMSE .71 TRUE SD 1.09 SEPARATION 1.53 Person RELIABILITY .70
MODEL RMSE .68 TRUE SD 1.11 SEPARATION 1.64 Person RELIABILITY .73
S.E. OF Person MEAN = .24

Person RAW SCORE-TO-MEASURE CORRELATION = .99
CRONBACH ALPHA (KR-20) Person RAW SCORE "TEST" RELIABILITY = .76 SEM = 1.61

Figure 3. Output Reliability

Figure 3 above demonstrates that the value of acquired item reliability is 0.82, whereas the value of achieved person reliability is 0.70. This indicates that the consistency of students' answers in solving scientific literacy questions according to their difficulty level is sufficient. However, the quality of the items used as data collection instruments for students' scientific literacy on static electricity is in good quality. Figure 4 below shows the findings of examining the questions' degree of difficulty.

ENTRY NUMBER	TOTAL SCORE	TOTAL COUNT	MEASURE	MODEL S.E.	INFIT MNSQ	INFIT ZSTD	OUTFIT MNSQ	OUTFIT ZSTD	PTMEASUR-AL CORR.	PTMEASUR-AL EXP.	EXACT MATCH OBS%	EXACT MATCH EXP%	Item
15	7	30	2.09	.49	.94	-.17	.65	-.56	.51	.44	80.0	79.5	Q15
13	8	30	1.86	.47	1.01	.12	.85	-.18	.46	.46	83.3	78.0	Q13
4	11	30	1.25	.44	1.21	1.04	1.21	.69	.37	.50	66.7	73.8	Q4
9	14	30	.69	.43	1.29	1.47	1.31	1.10	.33	.51	60.0	72.7	Q9
10	16	30	.33	.43	.95	-.18	.92	-.19	.55	.52	70.0	73.1	Q10
3	17	30	.15	.43	.96	-.16	.90	-.24	.55	.51	73.3	73.4	Q3
12	17	30	.15	.43	1.32	1.56	1.20	.75	.33	.51	53.3	73.4	Q12
5	18	30	-.04	.43	.86	-.65	.99	.07	.57	.51	83.3	74.1	Q5
14	18	30	-.04	.43	1.12	.66	1.04	.23	.44	.51	70.0	74.1	Q14
1	19	30	-.23	.44	.92	-.34	.76	-.67	.57	.50	73.3	74.7	Q1
11	20	30	-.42	.45	.83	-.79	.80	-.43	.59	.49	83.3	75.5	Q11
7	21	30	-.63	.46	1.06	.34	1.07	.29	.43	.48	80.0	76.5	Q7
6	24	30	-1.31	.51	.83	-.58	.53	-.72	.55	.42	86.7	81.2	Q6
8	25	30	-1.58	.54	.98	.03	.56	-.49	.45	.39	76.7	83.7	Q8
2	27	30	-2.27	.65	.74	-.55	.33	-.53	.50	.31	90.0	89.9	Q2
MEAN	17.5	30.0	.00	.47	1.00	.1	.87	-.1			75.3	76.9	
P.SD	5.6	.0	1.15	.06	.17	.7	.27	.5			9.8	4.7	

Figure 4. Output Item Difficulty Level

Characteristics of scientific literacy questions were analyzed based on item response theory with help from the Winstep program and the Rasch model. Based on the Rasch (1PL) model, the characteristic of the items that can be seen is the level of difficulty of the items. The criteria for the level of difficulty of the items are divided into five categories: very easy, easy, medium, difficult, and very difficult. Based on Figure 4 above, it is known that the level of difficulty of the questions varies. This can be seen from the various Measure values in Figure 4. The questions from the easiest to the most difficult are Q2, Q8, Q6, Q7, Q11, Q1, Q14, Q5, Q12, Q3, Q10, Q9, Q4, Q13, and Q15. The difficulty level of the items in the very easy criteria is 5 items (33.33%). Analysis of scientific literacy questions can also be seen from the following test information function graph.

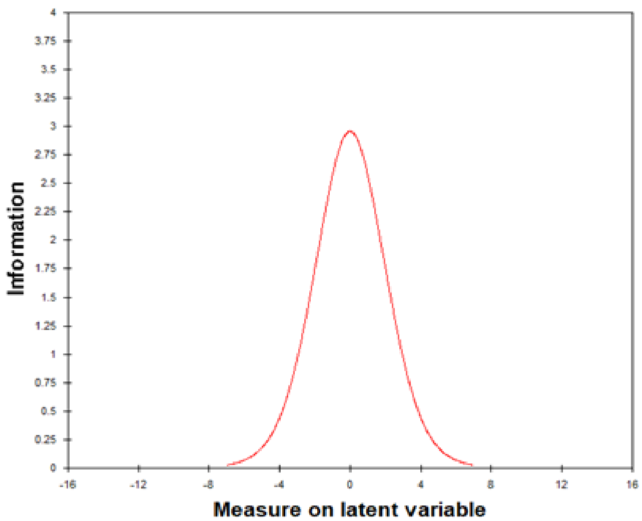

Figure 5. Test Information Function

Figure 5 above shows the measurement information obtained from the scientific literacy question instrument on static electricity material. The x-axis shows the level of students' ability to do the given test, while the y-axis shows the value of the information function. Based on the figure, the information obtained by the measurement is very high at the medium ability level. So that the development of the instrument for scientific literacy questions for students with static electricity is suitable if it is used for students with moderate abilities.

After testing the instrument and getting the results suitable for use in research, the next stage is the research implementation stage. At the implementation stage of this research, the researcher first conducted a pretest on the students who were selected as research samples. The pretest was conducted to determine the students' initial abilities related to scientific literacy. The results of the students' pretest analysis are presented in the following Figure 6.

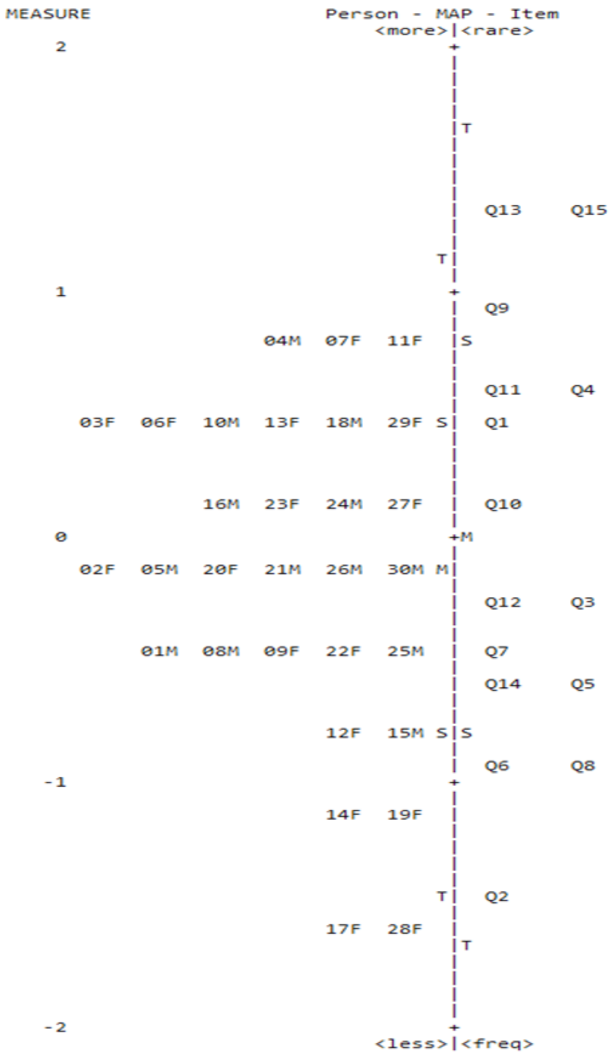

Figure 6. Person-Item Map Pretest

Based on the data obtained through Wright's map in Figure 6 above, we can observe the distribution of students' abilities in answering each scientific literacy question. The distribution of students' abilities was analyzed based on the logit measure value. The average logit value is always set at 0.0, which is the standard for the difficulty level of the questions and the standard for student abilities. Students 04M, 07F, and 011F have the highest literacy ability level with a logit measure value of +0.79. However, they were unable to answer questions Q9, Q13, and Q15 which had the highest logit value. Students below 0.00 logit are included in the category of students with abilities below the average standard level of problem difficulty. Based on the Wright map image above, it can be seen that as many as 17 students have below-average scientific literacy skills. In addition, there are also two students, namely 17F and 28F, who are in the outlier's category (below the T scale of questions) or students who have low abilities from the lowest difficulty of the questions (Q2). The low ability of scientific literacy in students is because students have not received complete static electricity material. Savitri et al. (2021) and Alatas & Fauziah (2020) stated that the low pretest results of students' scientific literacy skills were due to the previously not student-centered learning process.

The scalogram in Figure 7 below, representing the distribution of the students' pretest answers, can also be used to gauge a student's proficiency in scientific literacy.

```
Person  |Item
        |    1  11  1 11
        |268547320141935
        |---------------
     4  +111111110101000   04M
     7  +111111010011001   07F
    11  +111111111001000   11F
     3  +111101110110000   03F
     6  +111101101000101   06F
    10  +111001000111110   10M
    13  +111101110110000   13F
    18  +111101110110000   18M
    29  +110111110110000   29F
    16  +110111100010001   16M
    23  +111110000001110   23F
    24  +111101101010000   24M
    27  +001010011001111   27F
     2  +111001011000100   02F
     5  +000111110000011   05M
    20  +110110100101000   20F
    21  +111110101000000   21M
    26  +111110101000000   26M
    30  +111110001000001   30M
     1  +101110011000000   01M
     8  +100001101010100   08M
     9  +000010011101010   09F
    22  +100011101100000   22F
    25  +000010011101010   25M
    12  +110000010010100   12F
    15  +001001000101100   15M
    14  +110010010000000   14F
    19  +111000010000000   19F
    17  +001001100000000   17F
    28  +001110000000000   28F
        |---------------
        |    1  11  1 11
        |268547320141935
```

Figure 7. Guttman Scalogram of Responses

Distribution of students' pretest answers shown in Figure 7 above shows that the 9F and 25M students, in addition to not being careful (cannot do the easiest questions, item Q2; can work on difficult questions (Q13). This indicates a lucky guess. In addition, the picture above also shows that students are 03F, 13F, and 18M; 14F and 19F; and 21M and 26M have the same answer distribution pattern. This indicates the occurrence of mutual cheating. In addition to numbers, information on students' scientific literacy skills is also presented in Figure 8.

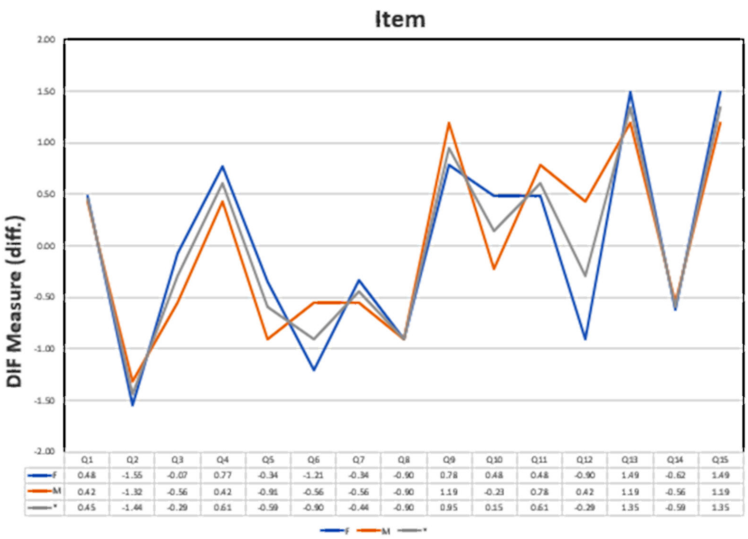

Figure 8. Person DIF Plot Pretest

Figure 8 shows that there are no appreciable disparities in the levels of scientific literacy between male and female pupils. The logit measure value obtained by male and female students is almost the same. The picture shows a curve close to the upper limit as in questions Q13 and Q15, indicating that the questions can be solved by both male and female students.

Based on the description above, it is known that students still have limited scientific literacy skills. Students' initial scientific literacy is still low, and both female and male students still find it challenging to answer difficult questions. This can be seen from most students' abilities spread below 0.0 logit. In addition, the pattern of answers given by students is almost the same. This indicates that students cooperated more at the time of the test in solving the given scientific literacy questions. This is done by students because they are not used to solving scientific literacy questions even though they are in the form of multiple choice.

After the pretest, students were taught to use discovery model teaching materials assisted by PhET simulation. This learning is carried out in three meetings, where each meeting lasts for 80 minutes of the teaching and learning process. During the learning process, it was seen that students were enthusiastic in learning. Students seemed interested in the PhET media used. In addition, students are also serious in completing the experiments given in the form of student worksheets. After the teaching and learning process using discovery model teaching materials assisted by PhET simulation, the researchers conducted a final test to measure the students' final abilities. Figure 9 below displays the findings from the evaluation of students' posttest.

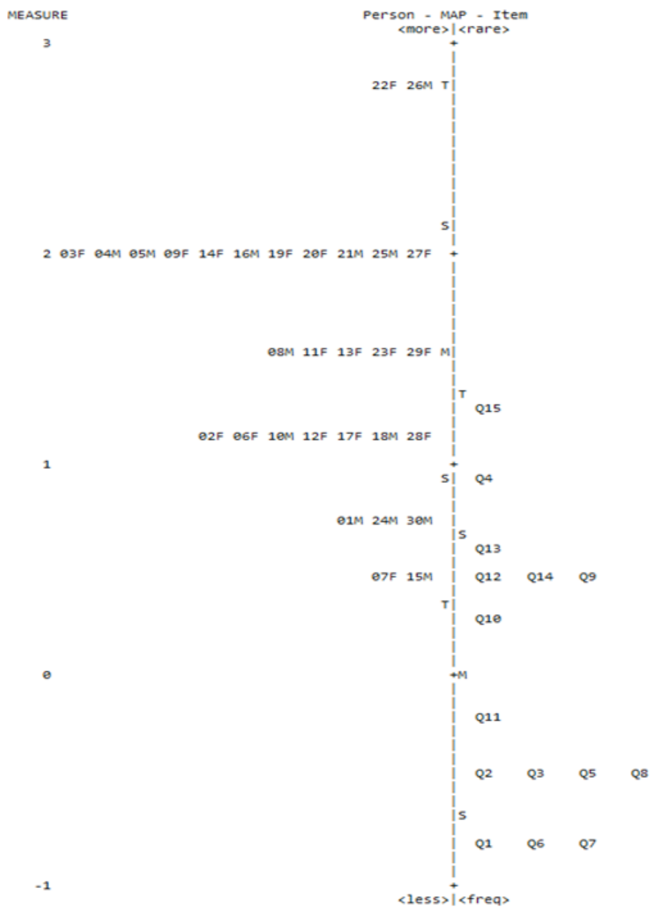

Figure 9. Person-Item Map Posttest

Based on Figure 9 above, it is known that students may grasp the provided scientific literacy questions under these circumstances. This can be seen from all student abilities spread over 0.0 logit. Students 22F and 26M have the highest levels of scientific literacy, whereas students 07F and 15M have average levels of scientific literacy. The skills of scientific literacy are also demonstrated in Figure 10.

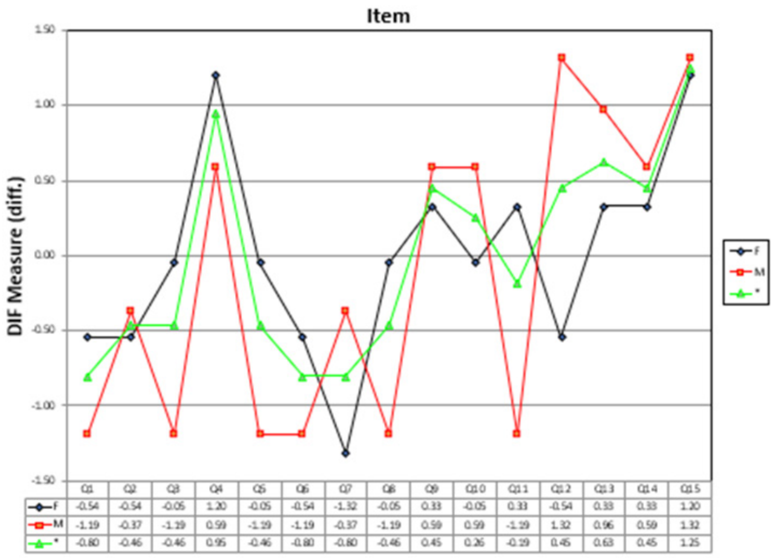

Figure 10. Person DIF Plot Posttest

We can assess the students' performance on each question's items based on the graph in Figure 10. The questions about static electricity, atoms, and electric charge (Q1, Q6, and Q7) are the ones that are the simplest for both male and female students to answer. These questions were easier for female students to answer than boys. Both groups of students have scientific literacy skills above 0.0 logit or higher than the average problem difficulty level. The question that has the largest logit is item Q15 about electroscopes. However, most of the female and male students could answer this question. Differences in the scientific literacy skill of male and female students also occur in other questions. On questions Q1, Q3, Q4, Q5, Q6, Q8, and Q11, female students' aptitude is higher than male students.

Analysis was also conducted to determine students' scientific literacy skills based on the static electricity sub-material. The following bar figure displays the average level of scientific literacy skills attained by students of both genders.

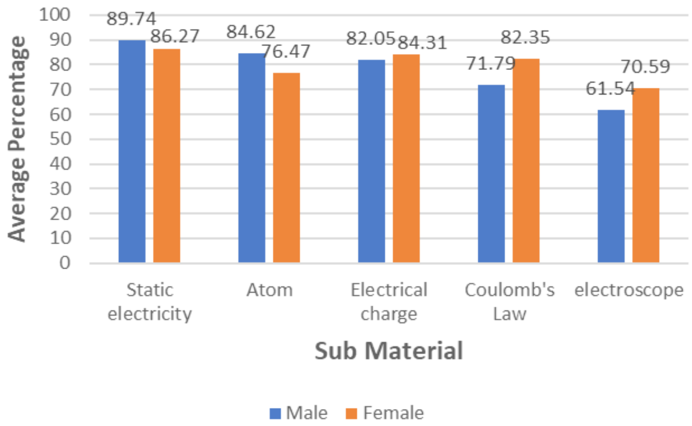

Figure 11. Comparison of Students' Literacy Skills Based on Sub Material

Figure 11 shows how the aptitude of male and female students for each static electricity sub-material varies. However, the difference is not too big. In the static electricity sub-material and atomic sub-material, male students are higher than female students. This is because in the learning process using discovery model teaching materials assisted by PhET simulation, male students are more active and enthusiastic than female students. In addition, male students were more likely to try new things in PhET simulations than female students, who were more focused on what was instructed on student worksheets. The illustration of the PhET simulation used in static electricity can be seen in Figure 12a.

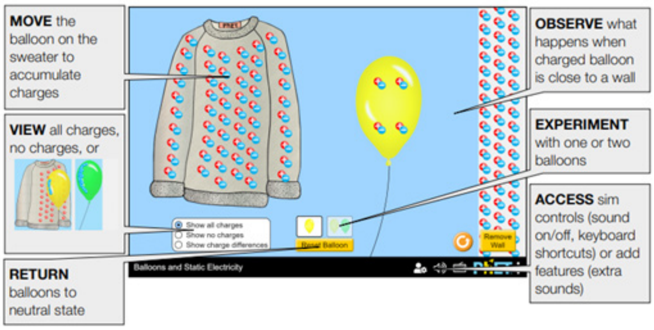

Figure 12a. PhET Simulation of Static and Atomic Electricity Sub-Material

Figure 12a shows a PhET simulation related to static electricity. Balloons and Static Electricity is one of the simulations containing much static electricity content related to positive and negative charges (Ajredini et al., 2017). The Balloons and Static Electricity simulation permits students to adaptably investigate static electricity (Lewis, 2018). Concepts include the exchange of charge, acceptance, fascination, repugnance, and establishing. In addition, the illustration of the PhET simulation used is atomic sub-materials. The illustration can be seen in the following Figure 12b.

Figure 12b. PhET Simulation of Static and Atomic Electricity Sub-Material

Figure 12b shows a PhET simulation related to static electricity and atoms. The figure explains the concept of two neutral objects rubbing against each other there will be displacements based on the object's electron affinity. In the sub-material of electric charge, Coulomb's Law, and electroscope, the average percentage of female students was higher than that of male students. This is because female students are able to operate with the maximum PhET simulation given. In Charges and Fields, students explore electrostatics as they arrange positive and negative charge space and observe the resulting electric field, voltage, and equipotential lines. An illustration of PhET Simulation of Sub material Electric Charge and Coulomb's Law can be seen in Figure 13 below.

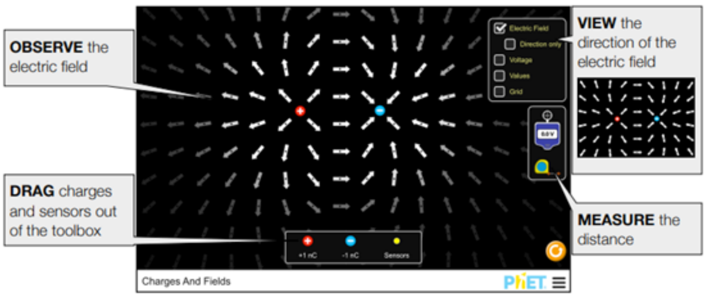

Figure 13. PhET Simulation of Sub-Material Electric Charge and Coulomb's Law

In addition to examining students' scientific literacy skills based on the sub-materials, a study of their skills based on the indicators was also done. Figure 14 is associated with it.

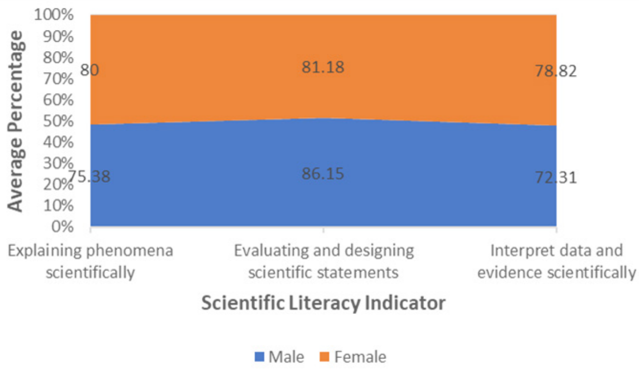

Figure 14. Comparison of Students' Science Literacy Skills Based on Indicators

Based on Figure 14, it is known that female students have a greater level of scientific literacy than male students have in terms of indicators of scientifically understanding phenomena and scientifically evaluating facts and evidence. This shows that female students understand better to apply scientific knowledge in situations given in the form of questions. Female students are also better at describing or interpreting phenomena scientifically. In addition, female students are also better at identifying the assumptions, evidence, and reasons behind the conclusions drawn.

However, on the indicators of evaluating and designing scientific statements, the ability of male students is higher than that of female students. This indicates that male students understand better about describing and evaluating the methods used in solving problems and can propose a method of investigation. The findings of this study are consistent with studies done by Susongko et al. (2021), which suggested that in science learning, female students need to be given further training in the ability to evaluate and design scientific statements, while male students need further training in explaining phenomena scientifically and interpret data and evidence scientifically. In general, students' scientific literacy skills after using discovery model teaching materials assisted by PhET simulation are presented in the following Figure 15.

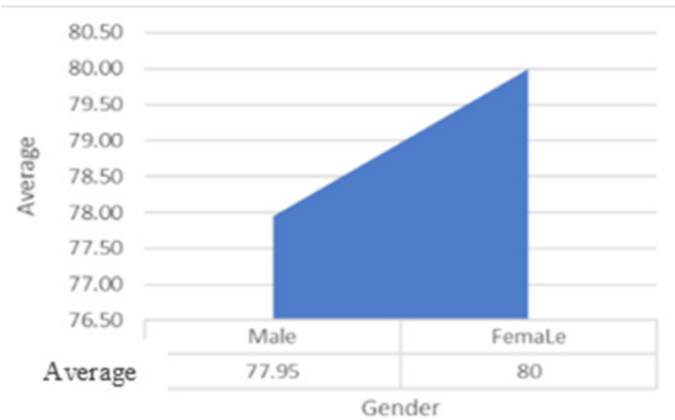

Figure 15. Comparison of Students' Literacy Skills Based on Gender

In general, Figure 15 demonstrates that female students have a better scientific literacy level than male students. Female students score on average at 80.00%, and male students score at 77.95% for scientific literacy. Based on the findings that have been stated, the authors recommend adding student-centered collaborative learning activities. Students can be grouped heterogeneously with the aim that male students can be helped by female students who tend to master certain parts of the concept more easily. On the other hand, some parts of the concept are easier for males to understand. Concepts that are easily understood by male students are static electricity sub-material and atomic sub-material. The high average percentage obtained by male students is because male students are more active in trying new things in this sub-material PhET simulation. This is in line with research conducted by Mukti et al. (2019) and Pramuda et al. (2019) that concluded that the scientific literacy skill of female students was higher than that of male students. Female students have high scientific literacy skills because female students are easier to work with and involve themselves in activities in the classroom (Queiruga-Dios et al., 2020). Female students are also more interested in learning than boys (Stoet & Geary, 2018). Another study also found that female students were less likely to be bullied than boys, which made female students more enthusiastic about learning (Haegele et al., 2018).

Female and male students' high scientific literacy skill is due to the use of discovery model teaching materials. Discovery teaching materials are one of the teaching materials that can create a student-centered learning atmosphere (Rosen et al., 2021; Rizki et al., 2021). The development of discovery model science teaching materials aims for students to find out for themselves what is being researched based on the worksheets provided (Ellizar et al., 2018; Munthe et al., 2019). Apart from the discovery model, Satria and Herumurti (2021) stated that the media also plays an essential role in the learning process. Learning media that can be used, such as PhET simulation, can replace experimental activities directly. The PhET simulation makes it easier for students to understand the concepts being studied (Price et al., 2019; Salame & Makki, 2021). Mahtari et al. (2020) also stated that the developed PhET simulation media could help students understand science concepts visually using dynamic graphics. The results of the study are helpful for teachers to determine the level of scientific literacy skills of males and females. Teachers can also consider the role of both male and female students in science learning. In addition, teachers can use this as a reference in implementing learning that involves the active role of students.

CONCLUSION

Based on the description above, it can be concluded that students' scientific literacy skills before and after using discovery model science teaching materials assisted by PhET simulation in the process of learning static electricity material in class IXA students of MTs Hidayatullah Mataram are different. The average posttest score is higher than the pretest. The average scientific literacy skill of female students at the posttest was 80, higher than male students who obtained an average of 77.95. However, in some sub-materials of static electricity, the literacy ability of male students is higher than that of female students. Regarding scientific literacy indicators, female students' two scientific literacy indicators are higher than male ones. The impact of this research in the world of education is to provide new knowledge, insight, and information about learning models and learning media, especially PhET simulations that can be used in science learning. This study's results can also be a reference and information for teachers in paying attention to diversity in the division of male and female groups. Some of the limitations of this research are that this research only analyzes the data on instrument questions and students' scientific literacy skills. Further analysis related to the increase and effect of discovery model science teaching materials assisted by PhET simulation is possible. In addition, researchers also still use a small sample, so it is possible to increase the number of samples in further research. In addition, teachers should pay attention to the roles of female and male students in the learning process so that the abilities of female and male students are not much different.

REFERENCES

Ajredini, F., Izairi, N., & Zajkov, O. (2017). Real Experiments versus Phet Simulations for Better High-School Students' Understanding of Electrostatic Charging. *European Journal of Physics Education*, *5*(1), 59.

Alagumalai, S., Curtis, D. D., & Hungi, N. (2005). *Applied Rasch measurement: A book of exemplars*. Springer.

Alatas, F., & Fauziah, L. (2020). Model problem based learning untuk meningkatkan kemampuan literasi sains pada konsep pemanasan global. *JIPVA (Jurnal Pendidikan IPA Veteran)*, *4*(2), 102–113.

Anagün, S. S. (2018). Teachers' Perceptions about the Relationship between 21st Century Skills and Managing Constructivist Learning Environments. *International Journal of Instruction*, *11*(4), 825–840.

Bahtiar, B., & Ibrahim, I. (2022, January). The Science Literacy Profile Based on Students' Creative Thinking Skill in the Time of Covid-19 Pandemic Using Blended Learning. In *International Conference on Madrasah Reform 2021 (ICMR 2021)* (pp. 102-110). Atlantis Press.

Bahtiar, B., Ibrahim, I., & Maimun, M. (2022). Profile of Student Problem Solving Skills Using Discovery Learning Model with Cognitive Conflict Approach. *Jurnal Penelitian Pendidikan IPA*, *8*(3), 1340–1349.

Ben Ouahi, M., Lamri, D., Hassouni, T., & Alibrahmi, E. (2022). Science Teachers' Views on the Use and Effectiveness of Interactive Simulations in Science Teaching and Learning. *International Journal of Instruction*, *Vol.15, No.1*, 277–292.

Bond, T. G., Yan, Z., Stone, G., & Beltyukova, S. (2015). Making measures, setting standards, and Rasch regression. In *Applying the Rasch model: Fundamental measurement in the human sciences* (pp. 187–225). Routledge.

Boone, W. J., Staver, J. R., & Yale, M. S. (2013). *Rasch analysis in the human sciences*. Springer.

Çevik, M., & Şentürk, C. (2019). *Multidimensional 21st century skills scale: Validity and reliability study*. *14*, 11–28.

Chalkiadaki, A. (2018). A Systematic Literature Review of 21st Century Skills and Competencies in Primary Education. *International Journal of Instruction*, *11*.

économiques, O. de coopération et de développement. (2019). *PISA 2018 assessment and analytical framework*. OECD publishing.

Effendi, D. N., Anggraini, W., Jatmiko, A., Rahmayanti, H., Ichsan, I. Z., & Rahman, M. M. (2021, February). Bibliometric analysis of scientific literacy using VOS viewer: Analysis of science education. In *Journal of Physics: Conference Series* (Vol. 1796, No. 1, p. 012096). IOP Publishing.

Eichler, J. F. (2022). Future of the Flipped Classroom in Chemistry Education: Recognizing the Value of Independent Preclass Learning and Promoting Deeper Understanding of Chemical Ways of Thinking During In-Person Instruction. *Journal of Chemical Education*, *99*(3), 1503–1508.

Ellizar, E., Hardeli, H., Beltris, S., & Suharni, R. (2018, April). Development of scientific approach based on discovery learning module. In *IOP Conference Series: Materials Science and Engineering* (Vol. 335, No. 1, p. 012101). IOP Publishing.

Eveline, E., Wilujeng, I., & Kuswanto, H. (2019, June). The Effect of Scaffolding Approach Assisted by PhET Simulation on Students' Conceptual Understanding and Students' Learning Independence in Physics. In *Journal of Physics: Conference Series* (Vol. 1233, No. 1, p. 012036). IOP Publishing.

Gunawan, G., Kosim, K., Ibrahim, I., Susilawati, S., & Syukur, A. (2021, February). The effectiveness of physics learning tools based on discovery model with cognitive conflict approach toward student's conceptual mastery. In *Journal of Physics: Conference Series* (Vol. 1747, No. 1, p. 012035). IOP Publishing.

Habibi, H., Jumadi, J., & Mundilarto, M. (2020). Phet Simulation as Means to Trigger the Creative Thinking Skills of Physics Concepts. *Int. J. Emerg. Technol. Learn.*, *15*(6), 166–172.

Haegele, J. A., Yessick, A., & Zhu, X. (2018). Females with Visual Impairments in Physical Education: Exploring the Intersection between Disability and Gender Identities. *Research Quarterly for Exercise and Sport*, *89*(3), 298–308.

Handajani, S., & Pratiwi, H. (2018, April). The 21st century skills with model eliciting activities on linear program. In *Journal of Physics: Conference Series* (Vol. 1008, No. 1, p. 012059). IOP Publishing.

Herrington, D. G., Hilborn, S. M., Sielaff, E. N., & Sweeder, R. D. (2022). ChemSims: Using simulations and screencasts to help students develop particle-level understanding of equilibrium in an online environment before and during COVID. *Chemistry Education Research and Practice*.

Hussein, M. H., Ow, S. H., Cheong, L. S., Thong, M.-K., & Ale Ebrahim, N. (2019). Effects of Digital Game-Based Learning on Elementary Science Learning: A Systematic Review. *IEEE Access*, *7*, 62465–62478.

Ilahi, M. R., Bahtiar, B., & Zaini, M. (2022). The Development of Discovery Learning Based Student'Worksheet on Topic Quantity, Measurements and Vectors. *Jurnal Pendidikan Fisika Dan Teknologi*, *8*(1), 107–115.

Inkinen, J., Klager, C., Juuti, K., Schneider, B., Salmela-Aro, K., Krajcik, J., & Lavonen, J. (2020). High school students' situational engagement associated with scientific practices in designed science learning situations. *Science Education*, *104*(4), 667–692.

Jeong, S., Sherman, B., & Tippins, D. J. (2021). The Anthropocene as we know it: Posthumanism, science education and scientific literacy as a path to sustainability. *Cultural Studies of Science Education*, *16*(3), 805–820.

Kamila, A. U., & Rahmawati, R. G. (2021). Development of Worksheet Based on STEM-PBL with PhET Simulation to Improve Student's Problem Solving during the Covid-19 Pandemic. *6th International Seminar on Science Education (ISSE 2020)*, 557–562.

Ke, L., Sadler, T. D., Zangori, L., & Friedrichsen, P. J. (2021). Developing and Using Multiple Models to Promote Scientific Literacy in the Context of Socio-Scientific Issues. *Science & Education*, *30*(3), 589–607.

Kızılaslan, A., Zorluoglu, S. L., & Sözbilir, M. (2019). A hands-on classroom activity to teach science concepts for students with visual impairment. *Science Activities*, *56*(4), 130–138.

Khaeroningtyas, N., Permanasari, A., & Hamidah, I. (2016). STEM Learning in Material of Temperature and Its Change to Improve Scientific Literacy of Junior High School. *Jurnal Pendidikan IPA Indonesia*, *5*(1), 94–100.

Lamb, R., Antonenko, P., Etopio, E., & Seccia, A. (2018). Comparison of virtual reality and hands on activities in science education via functional near infrared spectroscopy. *Computers & Education*, *124*, 14–26.

Lestari, H., Banila, L., & Siskandar, R. (2019). Improving Student's Science Literacy Competencies

Based on Learning Independence with STEM Learning. *Biodidaktika: Jurnal Biologi dan Pembelajarannya*, *14*(2), Article 2.

Lewis, C. (2018). Interactive Simulation II: Balloons and Static Electricity. In *Representation, Inclusion, and Innovation* (pp. 27–31). Springer.

Liu, C. C., Wen, C. T., Chang, H. Y., Chang, M. H., Lai, P. H., Fan Chiang, S. H., ... & Hwang, F. K. (2022). Augmenting the effect of virtual labs with" teacher demonstration" and" student critique" instructional designs to scaffold the development of scientific literacy. *Instructional Science*, *50*(2), 303-333.

Mahtari, S., Wati, M., Hartini, S., Misbah, M., & Dewantara, D. (2020). The effectiveness of the student worksheet with PhET simulation used scaffolding question prompt. In *Journal of Physics: Conference Series* (Vol. 1422, No. 1, p. 012010). IOP Publishing.

Margunayasa, I. G., Dantes, N., Marhaeni, A. A. I. N., & Suastra, I. W. (2019). The Effect of Guided Inquiry Learning and Cognitive Style on Science Learning Achievement. *International Journal of Instruction*, *12*(1), 737–750.

Menggo, S., Suastra, I. M., Budiarsa, M., & Padmadewi, N. N. (2019). Needs Analysis of Academic-English Speaking Material in Promoting 21st Century Skills. *International Journal of Instruction*, *12*(2), 739–754.

Mm, R. Y., Irwandani, Asniati, M., Anwar, C., & Subandi. (2020). Development of Google Form Based on Scientific Literacy Principles for Junior High School Students in Heat Material. *Journal of Physics: Conference Series*, *1467*(1), 012055.

Muhammad, M. (2020). Promoting Students' Autonomy through Online Learning Media in EFL Class. *International Journal of Higher Education*, *9*(4), 320.

Mukti, W. R., Yuliskurniawati, I. D., Noviyanti, N. I., Mahanal, S., & Zubaidah, S. (2019, June). A Survey of High School Students' Scientific Literacy Skills in Different Gender. In *Journal of Physics: Conference Series* (Vol. 1241, No. 1, p. 012043). IOP Publishing.

Munthe, E. A., Silaban, S., & Muchtar, Z. (2019). *Discovery Learning Based E-Module on Protein Material Development*. 710–713.

Naganuma, S. (2017). An assessment of civic scientific literacy in Japan: Development of a more authentic assessment task and scoring rubric. *International Journal of Science Education, Part B*, *7*(4), 301–322.

Najib, M. N. M., Md-Ali, R., & Yaacob, A. (2022). Effects of Phet Interactive Simulation Activities on Secondary School Students' Physics Achievement. *South Asian Journal of Social Science and Humanities*, *3*(2), 73–78.

Oktaviana, D., Mahardika, I. K., & Budiarso, A. S. (2020). The effectiveness of guided inquiry learning assisted by PhET simulation to improve the capability of representation image of science student in junior high school. *ScienceEdu: Jurnal Pendidikan IPA*, *3*(1), 43–47.

Ozdem-Yilmaz, Y., & Bilican, K. (2020). Discovery Learning—Jerome Bruner. In *Science Education in Theory and Practice* (pp. 177–190). Springer.

Pramuda, A., Mundilarto, M., Kuswanto, H., & Hadiati, S. (2019). Effect of Real-time Physics Organizer Based Smartphone and Indigenous Technology to Students' Scientific Literacy Viewed from Gender Differences. *International Journal of Instruction*, *12*, 253–270.

Price, A., Perkins, K., Holmes, N., & Wieman, C. (2019). *How and why do high school teachers use PhET interactive simulations?*

Pujawan, I. G. N., Rediani, N. N., Antara, I. G. W. S., Putri, N. N. C. A., & Bayu, G. W. (2022). Revised Bloom Taxonomy-Oriented Learning Activities to Develop Scientific Literacy and Creative Thinking Skills. *Jurnal Pendidikan IPA Indonesia*, *11*(1), 47–60.

Purwaningsih, E., Sari, S. P., Sari, A. M., & Suryadi, A. (2020). The Effect of STEM-PjBL and Discovery Learning on Improving Students' Problem-Solving Skills of Impulse and Momentum Topic. *Jurnal Pendidikan IPA Indonesia*, *9*(4), 465–476.

Putri, L. A., Permanasari, A., Winarno, N., & Ahmad, N. J. (2021). Enhancing Students' Scientific Literacy using Virtual Lab Activity with Inquiry-Based Learning. *Journal of Science Learning*, *4*(2), 173–184.

Qu, A., Nicolas, M., Leung, E. M., Jones, S. M., Katyal, P., Punia, K., Maxfield, M., & Montclare, J. K. (2022). Exploring the Viability and Role of Virtual Laboratories in Chemistry Education Using Two Original Modules. *Journal of Chemical Education*, *99*(4), 1596–1603.

Queiruga-Dios, M. Á., López-Iñesta, E., Diez-Ojeda, M., Sáiz-Manzanares, M. C., & Vázquez Dorrío, J. B. (2020). Citizen science for scientific literacy and the attainment of sustainable development goals in formal education. *Sustainability*, *12*(10), 4283.

Rahayu, I. D., Permanasari, A., & Heliawati, L. (2022). The Effectiveness of Socioscientific Issue-Based Petroleum Materials Integrated with The Elsmawar Website on Students' Scientific Literacy. *Journal of Innovation in Educational and Cultural Research*, *3*(2), 279–286.

Rahmawati, Y., Zulhipri, Z., Hartanto, O., Falani, I., & Iriyadi, D. (2022). Students' conceptual understanding in chemistry learning using PhET interactive simulations. *Journal of Technology and Science Education*, *12*(2), 303–326.

Rios, J., Ling, G., Pugh, R., Becker, D., & Bacall, A. (2020). Identifying Critical 21st-Century Skills for Workplace Success: A Content Analysis of Job Advertisements. *Educational Researcher*, *49*(1), 0013189X1989060.

Ristanto, R., Sabrina, A., & Komala, R. (2022). Critical Thinking Skills of Environmental Changes: A Biological Instruction Using Guided Discovery Learning-Argument Mapping (GDL-AM). *Participatory Educational Research*, *9*(1), 173–191.

Ritonga, S. (2021). The Implementation of STEM-Based Discovery Learning Model in Motion Systems Concept to Improve Learning Outcomes. *Asian Journal of Science Education*, *3*(2), 120–125.

Rizki, A., Khaldun, I., & Pada, A. U. T. (2021). Development of Discovery Learning Student Worksheets to Improve Students' Critical Thinking Skills in Chemical Balance Materials. *Jurnal Penelitian Pendidikan IPA*, *7*(4), 707–711.

Rosen, A., Iyer, S., Ray, D., Yao, Z., Aspuru-Guzik, A., Gagliardi, L., Notestein, J., & Snurr, R. (2021). Machine learning the quantum-chemical properties of metal–organic frameworks for accelerated materials discovery. *Matter*, *4*(1), 1–20.

Salame, I. I., & Makki, J. (2021). Examining the Use of PhET Simulations on Students' Attitudes and Learning in General Chemistry II. *Interdisciplinary Journal of Environmental and Science Education*, *17*(4), 1–9.

Satria, V. H., & Herumurti, D. (2021). Role-Playing Game as Learning Media To Support Online Learning. *Journal of Education Technology*, *5*(4), 579–587.

Savitri, E. N., Amalia, A. V., Prabowo, S. A., Rahmadani, O. E. P., & Kholidah, A. (2021). The Effectiveness of Real Science Mask with QR Code on Students' Problem-Solving Skills and Scientific Literacy. *Jurnal Pendidikan IPA Indonesia*, *10*(2), 209–219.

Schleicher, A. (2018). Insights and interpretations. *Pisa 2018*, *10*.

Serevina, V., & Luthfi, K. (2021, April). Development of discovery learning-based on online learning tools on momentum and impulse. In *Journal of Physics: Conference Series* (Vol. 1876, No. 1, p. 012076). IOP Publishing.

Sugiyono. (2020). *Metode Penelitian Kuantitatif Dan Kualitatif Dan R&D*. Alfabeta.

Susongko, P., Arfiani, Y., & Kusuma, M. (2021). Determination of Gender Differential Item Functioning in Tegal Students' Scientific Literacy Skills with Integrated Science (SLiSIS) Test Using Rasch Model. *Jurnal Pendidikan IPA Indonesia*, *10*(2), 270–281.

Stoet, G., & Geary, D. C. (2018). The Gender-Equality Paradox in Science, Technology, Engineering, and Mathematics Education. *Psychological Science*, *29*(4), 581–593.

Valladares, L. (2021). Scientific Literacy and Social Transformation: Critical Perspectives about Science Participation and Emancipation. *Science & Education*, *30*(3), 557–587.

Van Joolingen, W. R., de Jong, T., Lazonder, A. W., Savelsbergh, E. R., & Manlove, S. (2005). Co-Lab: Research and development of an online learning environment for collaborative scientific discovery learning. *Computers in Human Behavior*, *21*(4), 671–688.

Van Laar, E., Deursen, A. J. A. M., Van Dijk, J. A. G. M., & Haan, J. (2019). Determinants of 21st-century digital skills: A large-scale survey among working professionals. *Computers in Human Behavior*, *100*(1), 93–104.

Watson, S. W., Dubrovskiy, A. V., & Peters, M. L. (2020). Increasing chemistry students' knowledge, confidence, and conceptual understanding of pH using a collaborative computer pH simulation. *Chemistry Education Research and Practice*, *21*(2), 528–535.

Wei, B., & Lin, J. (2022). Manifestation of Three Visions of Scientific Literacy in a Senior High School Chemistry Curriculum: A Content Analysis Study. *Journal of Chemical Education*, *99*(5), 1906–1912.

Widhiarso, W., & Ridho, A. (2022). Validation of Setting and Design of Multi-Stage Testing (MST) to Portray Students' Achievement on Reading Literacy in AKMI 2021. *International Conference on Madrasah Reform 2021 (ICMR 2021)*, 6–10.

Widiyanti, F., Indriyanti, D. R., & Ngabekti, S. (2015). The Effectiveness of The Application of Scientific Literacy-Based Natural Science Teaching Set Toward The Students' Learning Activities and Outcomes On The Topic of The Interaction of Living Organism And Environment. *Jurnal Pendidikan IPA Indonesia*, *4*(1), 20–24.

Widoretno, S., & Dwiastuti, S. (2019). Improving Students' Thinking Skill Based on Class Interaction in Discovery Instructional: A Case of Lesson Study. *Jurnal Pendidikan IPA Indonesia*, *8*(3), 347–353.

Winarni, E. W., Hambali, D., & Purwandari, E. P. (2020). Analysis of Language and Scientific Literacy Skills for 4th Grade Elementary School Students through Discovery Learning and ICT Media. *International Journal of Instruction*, *13*(2), 213–222.

Yaşar, M. D. (2017). Brain Based Learning in Science Education in Turkey: Descriptive content and Meta analysis of dissertations. *Journal of Education and Practice*, *8*(9), 161–168.

Zainiyati, H. S., & Suyitno, I. (2022). Implementation of Technical Guidance on the Results of Indonesian Madrasah Competency Assessment 2021. *International Conference on Madrasah Reform 2021 (ICMR 2021)*, 11–17.