



ANALYSIS OF STUDENTS' CRITICAL THINKING SKILLS IN TERMS OF GENDER USING SCIENCE TEACHING MATERIALS BASED ON THE 5E LEARNING CYCLE INTEGRATED WITH LOCAL WISDOM

A. Ramdani^{*1,4}, A. W. Jufri², Gunawan³, M. Fahrurrozi⁴, M. Yustiqvar⁵

^{1,2}Department of Biology Education, University of Mataram, Indonesia

³Department of Physics Education, University of Mataram, Indonesia

^{4,5}Master of Science Education, Postgraduate University of Mataram, Indonesia

DOI: 10.15294/jpii.v10i2.29956

Accepted: April 22nd 2021. Approved: June 29th 2021. Published: June 30th 2021

ABSTRACT

Critical thinking is an important thing in building learners' knowledge. Students who have these skills will be able to solve problems effectively. This study examines the effect of science teaching materials based on the 5E learning cycle integrated with local wisdom in terms of gender on students' critical thinking skills. This quasi-experimental research with a pre-test-post-test control group design was carried out at Madrasah Tsanawiyah. Purposive sampling was used to select the research sample, including an experiment and a control group of equal ability between male and female students. The data were analyzed using a t-test and N-gain test to determine the improvement of critical thinking skills in both groups. The results showed that this teaching material affected students' critical thinking skills by the results of the t-test. The difference in the improvement of students' critical thinking skills is significant based on the result of N-gain and categorized as high. Students become more critical in solving problems after study using 5E integrated by local wisdom. The result shows an impact of this teaching material on first to fourth indicators of critical thinking skills. The fifth indicator is not affected by this teaching material because of students' weakness in elaborate the solution. There were also significant differences in the improvement of male and female students' critical thinking skills. One of them is that male students have a quicker response and higher self-confidence than female students in solving the problems. Based on this result, we conclude that applying science teaching material with 5E integrated by local wisdom positively affects students' critical thinking skills.

© 2021 Science Education Study Program FMIPA UNNES Semarang

Keywords: 5E learning cycle; critical thinking skill; science teaching material; local wisdom; gender

INTRODUCTION

Teachers have been encouraged to deliver 21st-century learning, including educating pupils to be critical thinkers and problem solvers and creative, innovative, communicative, and collaborative (ZivkoviL, 2016; Saleh, 2019). It is not simple to meet international standards for teacher responsibilities as we approach the twenty-first century. Teachers are required to be capable and knowledgeable. Teachers are expected to be able to teach a variety of subjects. (Glaze, 2018; Rochmawati, et al., 2019).

Students need to have critical thinking skills because they are needed to face the challenges of the 21st century (Vieira & Tenreiro-Vieira, 2016; Wulandari et al., 2017; Purnami et al., 2021). Students who have critical thinking skills will solve problems more effectively (Saputra et al., 2019; Wahidin & Romli, 2020). Critical thinking skills must be trained in students. As one of the school level components at the school level, teachers are responsible for equipping school graduates with critical thinking skills (Liu et al., 2014; Anazifa & Djukri, 2017).

Students' critical thinking skills in Indonesia are low (Saputri & Rinanto, 2018; Zubaidah et al., 2018). Saputra et al. (2019) revealed that stu-

*Correspondence Address

E-mail: aramdani07@unram.ac.id

dents' critical thinking is still low, seen from the symptoms of problems that dominate the results of observations during the science learning process in the classroom. Symptoms of the problems referred to include: (1) it is difficult for them to work on high-level questions (C4-C6); (2) many of them find it difficult to connect concepts and problems; (3) some of them had difficulty expressing their opinions during the discussion. Besides that, Basri (2019) and Hadisaputra et al. (2020) revealed that some students are passive when working on group assignments, students have not been proactive in raising problems in learning, only a few students are involved in answering the problems raised. As a result, students have not been able to provide solutions to the problems found. That condition can be used as an indicator that students' critical analysis skills are still low. Some students are still familiar with using rote and memory learning methods. It causes students to quickly forget the information they have received (Hadisaputra et al., 2020). The students' low critical thinking skills are closely related to the weaknesses of the science learning process. Teachers have not designed learning tools by combining learning approaches and models to help students be active in the learning process (Hadisaputra et al., 2020; Ramdani et al., 2020a).

Based on the field studies conducted at Public and Private Madrasah Tsanawiyah, one problem is the availability of teaching materials that have not facilitated and trained students to learn independently. Furthermore, based on observations at school, teachers still use the Electronic Student Book (BSE), textbooks, reference books, student worksheets, and modules, which also have limitations. Based on the result conducted by Irsyada (2016); Dani (2019) that the use of language in BSE is too complicated, complex, lacks content, less communicative pictures, the question level is relatively low. As a result, students struggle to grasp the concept. Furthermore, as a science learning resource, the book does not integrate environmental components into the material content. Another consequence is that the teacher cannot comprehend the learning process, which includes local wisdom and thus cannot integrate science learning with the culture of the surrounding area. Students tend to wait for the teacher to learn concepts, not to train students' activeness and independence (Deswita & Hufri, 2018). Therefore, teaching materials such as student textbooks must be made as varied as possible, containing specific steps to make students active

during learning activities. The teacher's design of teaching materials and the science learning model play a vital role in improving students' critical thinking skills.

Besides, various innovations in education must be carried out correctly to foster an academic culture so that high quality can be obtained (Dewi et al., 2021; Gunawan et al., 2021). One alternative that must be done is selecting appropriate teaching materials to help students be active in the learning process and improve learning outcomes. The goal is that students get direct experience from the learning process (Ramdani et al., 2020a). The science teaching materials intended are based on the 5E learning cycle integrated with local wisdom. This teaching material is developed following the stages of the 5E learning model integrated with local wisdom. Based on several studies about 5E, which found that this model can improve students' critical thinking skills (Irhamna et al., 2017; Superni, 2018), it came out that the students only familiar with basic problems. Local wisdom is an urge to be integrated with this model to ensure that they can relate the solution close to their environment.

The learning experience of each student is different. Several things related to education and learning experiences currently in the spotlight of the world are about gender equality. Learning outcomes between male and female students have differences. The thinking process between men and women is different (Izzati et al., 2019). This statement is supported by Gunawan et al. (2020a), which states that the thought processes and thinking abilities between men and women are different. Currently, most women have been given the same opportunity to get an education as men. However, how female students achieve their goals in the learning process sometimes happens without realizing it. The issue of differences in the learning process of male and female students in several regions in Indonesia (Izzati et al., 2019) will provide a deep understanding of the differences in the development of students based on different genders.

Apart from low students' critical thinking skills, the availability of teaching materials that are still minimal, and learning outcomes for male and female students, there are other problems, namely local wisdom. In the current era of globalization, the State of Indonesia is faced with problems that have shifted local cultural values that should be maintained and preserved by the younger generation, especially students, as agents

of change (Andayani et al., 2020). The problem must be resolved, and one way is through education and learning. By combining scientific science knowledge in schools with genuine science knowledge in the community (Gondwe & Longnecker, 2015; Dewi et al., 2017), students will care more about the surrounding environment. The application of learning like this can increase students' understanding of scientific science concepts, and learning becomes more meaningful (Sudarmin & Samini, 2015).

In daily life, we constantly interact in the local environment and culture. However, the potential of the local culture has not been optimally utilized by teachers in the learning process. Even the values adopted by local communities full of local wisdom are neglected in learning, including science learning (Andayani et al., 2020). On the other hand, globalization has shifted local cultural values. The reality of this shift in cultural values has resulted in neglected local cultural values. It is still rare for science learning to reveal the cultural realities around students. The material content taught has not been much integrated with culture (Sudarmin et al., 2017; Ramdani et al., 2020b).

Based on these problems, it is necessary to innovate science learning by incorporating local wisdom in the city of Mataram into teaching materials. *Cimol* and *gendang beleq* like dance forms are forms of local wisdom typical of the city of Mataram. There are many dances typical of the city of Mataram with various movements on the dancer's body. From this dance phenomenon, it can be studied in science material, especially the human movement system. Movement by movement of the dancer is one example that can be related to the material of the human movement system, namely bones, muscles, and joints in humans. Apart from that, other local wisdom related to the motion system in animals and plants is the typical animals and plants of Mataram City, for example, *nyale* animals and examples for plants, namely the *kepundung* plant.

Concerning these problems, it is necessary to make improvements and renewal of learning tools such as developing the quality of science teaching materials relevant to the conditions of students and the environment in which they are learning. In connection with this problem, this study aims to determine the effect of science teaching materials on the motion system material based on the integrated 5E learning cycle local wisdom in terms of gender on students' critical thinking skills.

METHODS

According to Cash et al. (2016), this is a quasi-experimental research with a pretest-posttest control group design. The population in this study was one hundred seventh-grade students at Madrasah Tsanawiyah. The research sample was taken using the purposive sampling technique based on the level of student academic ability. The pretest is carried out to select a sample of women who have the same abilities as men. Not all female students were sampled because it was adjusted to the number of male students.

The sample size is 80 students, with 40 males and 40 female students. Students at Madrasah Tsanawiyah have the characteristic of being unconcerned about their surroundings. According to Hadi and Subhani (2017), insufficient knowledge of the importance of environmental sustainability is the cause of reduced and even loss of one's concern for the surrounding environment. Furthermore, Hadi and Subhani (2017) stated that this phenomenon causes environmental problems that continue to occur and are prolonged. Of course, this is inseparable from the old human perspective on nature which considers nature and its contents only to satisfy human needs or interests without caring about its ecological sustainability.

The experimental class and control class each consisted of 2 classes. Students in experimental classes 1 and 2 consisted of 40 people, while students in control classes 1 and 2 also consisted of 40 people. The experimental class and control class consisted of 20 male and female students. The experimental class learned using science teaching materials based on the 5E learning cycle integrated with local wisdom, while the control class learned using conventional teaching materials. Conventional teaching materials are in the form of textbooks and student worksheets that have been provided at school. The lesson is divided into five learning sessions, each lasting 90 minutes.

The data was collected through tests. The critical thinking skills test arranged in the form of an essay consists of 10 questions. The instrument preparation stage includes compiling test specifications, writing test questions, reviewing and correcting test questions, compiling assessment guidelines, and determining completeness criteria. The implementation stage consists of conducting a test, analyzing the answers to the questions, and describing the test results. The critical thinking skills test instrument is made based on indicators

of critical thinking, referring to the indicators developed by Ennis (2011). Critical thinking indicators consist of: (1) providing simple explanations; (2) building basic skills; (3) concluding; (4) provide a further explanation; and (5) formulating a strategy. Previously, the instrument was tested to determine the validity, reliability, and difficulty level of the questions using the Rasch Model application. The instrument was tested for validity, reliability, and level of difficulty using the Rasch Model (Sumintono & Widhiarso, 2014) with the help of Ministep. This modeling makes the statistical results more accurate in the analysis of the results carried out.

Enhancement of students' critical thinking skills was determined from normalized gain scores (Cheng et al., 2004) to avoid misinterpretation of the improvement for each student. This study

also examines the effect of treatment in the experimental and control classes based on the influence test using the t-test (Independent Sample t-test) (De Winter, 2013), preceded by the prerequisite test for normality and homogeneity. All statistical tests were carried out at a 5% significance level.

RESULTS AND DISCUSSION

This study was conducted to find the effect of science teaching material based on 5E integrated with local wisdom toward critical thinking skills. All instruments used in the experiment were first tested for validity before being used in the experiment. The validation process is carried out using the Rasch Model (Sumintono & Widhiarso, 2014). The results of the validation are shown in Table 1.

Table 1. Results of Instruments Validity Test by Rasch Model

Question Number	Outfit		Pt. Measure Correlation	Criteria
	MNSQ	ZSTD		
1	1,52	1,9	0,57	Valid
2	0,43	-2,2	0,67	Valid
4	0,75	-1,1	0,52	Valid
3	0,61	-1,9	0,47	Valid
5	0,77	-1,1	0,72	Valid
6	0,74	-1,5	0,70	Valid
7	0,81	-1,0	0,65	Valid
8	1,31	1,7	0,40	Valid
9	1,49	2,3	0,38	Valid
10	1,39	1,8	0,13	Valid

After validation, the instrument's reliability was tested using Rasch Model K-R 20 (Cronbach Alpha) (Sumintono & Widhiarso, 2014). This instrument was tested on 18 students who already

study the matter. The reliability value of the items obtained was 0.81 with good criteria. The analysis results are presented in Table 2.

Table 2. Result of Instrument Reliability Test by Rasch Model

	Total Score	Count	Measure	Model S.E	Infit		Outfit	
					MNSQ	ZSTD	MNSQ	ZSTD
Mean	12.1	8.0	.01	.51	.97	-.1	1.01	.0
P.SD	4.8	.0	1.15	.04	.50	1.1	.56	1.1
S.SD	5.0	.0	1.18	.04	.52	1.1	.57	1.1
Max.	19.0	8.0	1.70	.60	1.95	1.8	2.26	1.9
Min.	4.0	8.0	-2.03	.47	.28	-2.1	.30	-2.0
Real RMSE.55 True SD			1.01 SEPAR	1.82	Person Reliability		.77	
Model RMSE.51 True SD			1.03 SEPAR	2.03	Person Reliability		.81	
S.E of Person Mean = .28								

Person RAW SCORE = TO - MEASURE CORRELATION = 1.00

CRONBACH ALPHA (KR-20) PERSON RAW SCORE "TEST" RELIABILITY = .81 SEM = 2.13

After the validation and reliability test, the instrument was being tested for their difficulty level. The test was conducted using the Rasch Mo-

del (Sumintono & Widhiarso, 2014). The result is shown in Table 3.

Table 3. The Rasch Model’s Analysis of Instrument Difficulty Level

Entry Number	Total Score	Total Count	Measure	Infit		Outfit		PTMeasural		Exact Match		Item
				MNSQ	ZSTD	MNSQ	ZSTD	CORR	EXP.	OBS%	EXP%	
9	31	50	2.59	1.05	.3	1.07	.4	.25	.33	58.0	55.8	PG 9
8	60	50	1.30	.57	-2.5	.57	-2.4	.49	.40	62.0	53.0	PG 8
10	87	50	.44	1.12	.8	1.11	.7	.42	.42	46.0	38.9	PG 10
6	89	50	.38	.82	-1.2	.80	-1.2	.64	.42	38.0	38.1	PG 6
7	97	50	.14	.72	-2.0	.70	-2.0	.48	.41	44.0	37.8	PG 7
5	103	50	-.04	1.23	1.4	1.24	1.4	.28	.40	30.0	36.2	PG 5
4	120	50	-.61	1.02	.2	1.00	.1	.38	.35	42.0	45.9	PG 4
2	132	50	-1.16	1.44	1.6	1.26	.9	.16	.28	62.0	67.7	PG 2
3	133	50	-1.21	1.33	1.3	1.18	.6	.31	.28	66.0	68.6	PG 3
1	141	50	-1.83	1.09	.4	.98	.1	.25	.21	86.0	84.5	PG 1
MEAN	99.3	50.0	.00	1.04	.0	.99	-.1			53.4	52.7	
PSD	33.0	.0	1.24	.26	1.4	.22	1.2			15.6	15.6	

The results obtained by question number nine are in a higher difficulty level compared to other questions. The logit value of this question is 2.59 in the difficult category. Besides that, the value of question number one is in the lowest difficulty level with a logit value of -1.83. The higher the value on the logit scale, the more complex the problem is. It can also be seen based on the total score that the simpler the questions are, the higher the total score on the questions.

After the instrument valid and reliable, the instrument was used to determine the effect of natural science teaching material based on 5E integrated with local wisdom toward students’ critical thinking skills. The analysis of data was conducted using the N-gain test and t-test. Based on the result of the N-gain test, students’ critical thinking skills were improved significantly in the experimental class. The result is shown in Table 4.

Table 4. N-gain Score for Students’ Critical Thinking Skill

Class	Average		N-Gain Average Score (%)	Criteria
	Pretest	Post-test		
Experiment	56,25	96,87	82	High
Control	59,37	87,50	68	Medium
	Average		75	High

Based on Table 4, the experimental class gets 82 % of the N-gain score, which is categorized as high criteria. Meanwhile, the control class gets a medium score of N-gain. This result shows that the natural science teaching material based on 5E integrated with local wisdom improves students’ critical thinking skills effectively.

The critical thinking skills test is arranged in the form of an essay. The pretest and posttest results of students’ critical thinking skills in the experimental and control class are presented in Table 5.

Table 5. Pretest and Posttest Critical Thinking Skills Data

Class	N	The Highest Score		Lowest Value		Average		SD	
		Pre Test	Post test	Pre test	Post test	Pre Test	Post Test	Pre test	Post Test
Experiment	40	56.25	96.87	40.62	75.00	46.87	86.71	3.78	1.03
Control	40	59.37	87.50	40.62	62.50	46.40	73.51	3.93	0.95

Based on Table 5, it was identified that the pretest average value of critical thinking skills in the experimental class was the same as the control class. This result shows that students' initial skills in the experimental and control classes are relatively the same. The average posttest score of the experimental class is higher than the control class. Students in the experimental class are more active in the learning process than students in the control class. The data analyzed in the hypothesis test were the pretest and posttest scores of students' critical thinking skills in experiment and control classes. The results of the t-test were presented in Table 6.

Table 6. Summary of t-test Data for Students' Critical Thinking Skills

Assessment Aspects	<i>t</i>	<i>Sig.</i>
Teaching materials	0.52	0.00

Based on Table 6, the significant value of the t-test is 0.00, which less than the significance level (0.05). This finding implies that using natural science teaching materials based on the 5E learning cycle integrated with local wisdom affects students' critical thinking skills. Data analysis was carried out based on gender after assessing the impact of teaching materials in experimental and control classes. The analysis results are presented in Table 7.

Table 7. Data on Critical Thinking Skills Based on Gender

Test	Criteria	Men	Women
Amount		40	40
Pretest	Average	48.90	44.84
	Homogeneity		0.33
Posttest	Hypothesis testing		0.60
	Average	89.22	84.22
	Homogeneity		0.72
	Hypothesis testing		0.001

Based on Table 7, it can be seen that the posttest mean score of male students, both the experimental and control classes, got higher scores than female students. The result means that male students have higher critical thinking skills than female students. After analyzing the data on students' critical thinking skills in terms of gender, data analysis was carried out for each indicator of critical thinking skills presented in Figure 1.

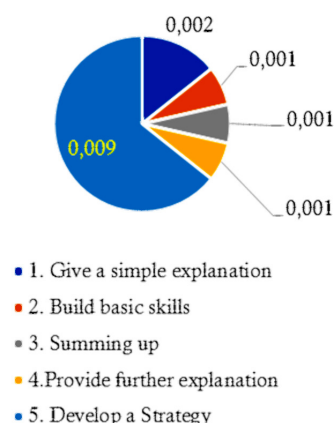


Figure 1. Critical Thinking Skills Indicator

The data in Figure 1 shows that the fifth indicator of critical thinking skills, namely developing strategies, does not affect, while the first to fourth critical thinking indicators show an effect of using science teaching materials based on the 5E learning cycle integrated with local wisdom. Students' skills in developing strategies are considered lacking, or it can be said that students are not familiar with strategy development activities in the learning process.

The use of teaching materials in learning can increase student motivation (Chin et al., 2015). Lai et al. (2018) also emphasized that teaching materials have a significant influence and role in teaching and learning activities. This result shows that motivation can come from teaching materials. The factors influencing student motivation towards teaching materials are interest in the subject matter, level of difficulty, relevance to existing knowledge, and perceived usefulness (Chen, 2019; Safaruddin et al., 2020). Therefore, science teaching materials are helpful and positively affect students' critical thinking skills (Permatasari et al., 2019).

Safaruddin et al. (2020) concluded that the more teachers use visual and audio material during learning, the better students will concentrate on the lesson. Furthermore, Yustiqvar et al. (2019) said that images as visual material attract students' interest and attention. Natural science teaching materials based on the 5E learning cycle integrated with local wisdom present learning materials more attractive and informative. This material is intended to facilitate and increase student interest in learning. The teaching materials developed have been facilitated with indicators of critical thinking skills so that students' thinking abilities can be trained.

Learning science in schools will be easier to understand if teachers pay attention to the culture of students (Khusniati, 2017; Sudarmin et al., 2017; Ramdani et al., 2020b). Teachers' understanding of wisdom learning can make science learning occur meaningfully so that teachers need understanding and combine actual knowledge in society with scientific knowledge in schools (Sudarmin et al., 2017; Dewi et al., 2021). Integrating culture into learning is an essential effort because school learning is suitable for the 21st century, namely science learning with a multicultural approach (Gunstone, 2014).

Because of this condition, the teacher's role is crucial, especially in developing science teaching materials integrated with local wisdom to improve students' higher-order thinking skills. Teaching materials delivered by a teacher should instill students' character education through the culture and local wisdom around students who are integrated with the concepts they are going to learn so that students can think scientifically about the phenomena encountered every day. One way to integrate local wisdom-based learning is through making teaching materials based on ethnoscience (Nurkhalisa & Ummayah, 2015).

Local wisdom referred to in this study is *rudat*, *cimol*, *gendang beleq*, *nyale*, and *kepundung*, which are associated with the material system of motion in living things. Local wisdom is applied in science learning by incorporating a culture that is specific to the city of Mataram. Natural science teaching materials integrated with local wisdom are expected to help students find information and translate from generation to generation the knowledge of motion systems in living things. Rahayu and Sudarmin (2015) stated that teaching materials based on local wisdom are an assimilation of scientific knowledge and original knowledge.

Through this teaching material, students can easily understand the material discussed and see examples of applying motion systems in everyday life based on the *rudat*, *gendang beleq*, and *cimol* events presented through pictures and information in teaching materials. In addition, pictures and information about the process of the motion system in *nyale* and *kepundung* plants in Mataram city are presented to motivate students to study teaching materials which will have implications for increased achievement so that learning objectives are achieved.

Teaching materials can help create a good quality of learning (Hartini et al., 2018). Teaching materials in the learning process requires students to learn independently (Yuliawati et

al., 2013) to be actively involved in the learning process. These activities ultimately affect student achievement (Izzati et al., 2013), thus learning quality will be better (Setyowati et al., 2013). In addition, the integration of local wisdom in the learning process supports good science learning (Kumala & Setiawan, 2019; Sofyan et al., 2019). This statement follows research results by Uge et al. (2019) that science teaching materials based on local wisdom can increase the effectiveness of learning and student achievement (Nurcahyani et al., 2021). Ethnic-based science learning guides students in finding and building their knowledge (Hairida, 2017; Hartini et al., 2018). Furthermore, learning based on local wisdom produces more meaningful learning because the objects observed are in the environment (Susilawati et al., 2016).

Learning with science teaching materials based on the 5 E learning cycle integrated with local wisdom is a learning resource to help teachers connect the material being taught with students' real-world situations and its application in their daily lives. Natural science teaching materials based on the 5E learning cycle and local wisdom aim to develop students' caring character for the environment, particularly in environmental problems, and shape behavior to participate in environmental care. It will have a positive impact on students' critical thinking skills.

Higher-order thinking skills of students at the junior high school level can be developed through science teaching materials (Yuliati, 2013). Integrated science teaching materials arranged with an inductive approach, where students learn science by observing the phenomena of everyday life, it turns out that it can arouse students' curiosity to study science more deeply. Through several alternative experimental activities provided in teaching materials, students learn science in an integrated manner. By studying the case being studied, students simultaneously examine the case through studies in physics, chemistry, and biology.

These results provide differences in the thinking abilities of students who use integrated science teaching materials compared to students who use science teaching materials where the teaching materials are separated (Yuliati, 2013). The statement also supports that the analysis of the concepts studied is carried out comprehensively and relevant, which will train students to think at a higher level (Gunawan et al., 2021). Also, science teaching materials presented with accurate and contextual problems will facilitate the implementation of science learning (Selvia-

niresa & Prabawanto, 2017). Besides, Kumalasari et al. (2019) stated that integrated science teaching materials ethnoscience effectively fosters students' critical thinking skills.

These results can be achieved because learning materials based on the 5E learning cycle integrated with local wisdom involve students actively in the learning process. Students are invited to carry out demonstration activities, discussions, or other activities in this learning model to open students' insights and foster a sense of student curiosity. Student activities during the learning process with learning materials based on the 5E learning cycle integrated with local wisdom show that students participate actively during the learning process.

The difference in the value of critical thinking skills between the experimental and control classes is caused by students' activities in the experimental class using science teaching materials based on the 5E learning cycle integrated with local wisdom. Cahyarini et al. (2016) revealed that based on statistical analysis, there were significant differences in students' critical thinking between students taught using conventional methods and students taught using the 5E model. Furthermore, Khasanah et al. (2017) stated differences in student learning outcomes using teaching materials based on critical thinking skills in learning with teaching materials at school. Teaching materials based on critical thinking skills are more effective than teaching materials in schools.

Each word "E" from the 5E learning model is part of a process to help students experience a learning sequence in connecting previous knowledge with new concepts. This model consists of engagement, exploration, explanation, elaboration, and evaluation (Jack, 2017). The learning cycle model has several advantages. Maskur et al. (2019) revealed that one of the advantages of this model is its ability to encourage students to be active and think optimally to gain knowledge. The 5E learning model activity has a positive effect on student involvement in learning: a) contributes significantly to student learning and interest in learning; b) helps students to develop their scientific process skills; c) is easily applied in science classes (Widodo et al., 2020). Student activeness in this study is driven by integrating 5E learning cycle teaching materials with local wisdom, such as activities involving students exploring, explaining, describing, and evaluating daily problems presented in teaching materials.

This explanation is under the results of previous research by Temel et al. (2012), which explains that the learning cycle model significantly increases higher-order thinking skills and lo-

wer-level thinking skills. Hadisaputra et al. (2020) also show that critical thinking skills can be developed through contextual learning. The statement is in line with research by Herman and Dahlan (2017), which states that there are differences in the critical thinking skills of science between students who take learning with the 5E learning cycle model and students who take learning with conventional models. The 5E learning model positively affects student learning outcomes (Nasir et al., 2015; Sari et al., 2019).

Based on the results of the t-test per indicator of critical thinking skills, it is known that the first to fourth indicators are influenced by the use of science teaching materials based on the 5E learning cycle integrated with local wisdom. This statement is evidenced by the significance value of the four indicators, which is smaller than the error rate. In comparison, the fifth indicator gets a significant value greater than the error rate, which means that there is no effect on using science teaching materials based on the 5E learning cycle integrated with local wisdom. The reason is that students in the experimental and control classes have difficulty developing strategies where many students are accustomed to learning by only receiving information from the teacher. When faced with developing problem-solving strategies, most students experience difficulties. The role of the teacher still rarely trains students to formulate strategies. Therefore the ability of students to develop strategies is still lacking.

Luzyawati (2017) stated that one of the factors that affect critical thinking skills is the interaction between teachers and students. The fifth indicator of critical thinking skills does not affect because when students are given the task to develop new strategies, they only rely on the strategies available in teaching materials without developing new strategies. Feyzioğlu and Ergin (2012) and Daşdemir (2016) stated that one of the weaknesses of the 5E learning model is that students who are accustomed to learning by only receiving information from the teacher have difficulty if required to think for themselves.

Each student can only develop the strategy as stated in the teaching material, but if they are faced with a problem that requires them to develop new strategies, some students still have difficulties. Test results also support the results of these observations. Students' answers have not responded correctly to the assumptions or information provided and have not developed new strategies to solve problems. The statement is evidenced by the test results where they used inappropriate strategies.

Learning in the control class using conventional teaching materials tends to be teacher-centered, meaning that the teacher's role is the most dominant in the learning process. In learning using conventional teaching materials, the teacher presents information step by step, while students only pay attention and accept what the teacher says. The teacher tells students what they should learn or read, which results in students' minds not developing correctly. Learning outcomes like this result in students only remembering the subject matter delivered by the teacher, but students do not understand the use of the concept is being studied. According to Mardianto (2014), the weaknesses of the conventional model are the following: (a) the material that students can master is limited to what the teacher has mastered; (b) learning that is not accompanied by demonstrations can result in errors in student understanding; (c) teachers who are not able to speak well are often considered boring by the students; (d) through conventional learning it is complicated to know whether all students have understood; (e) the lecture model cannot provide an opportunity to discuss problem-solving so that the knowledge absorption process is less sharp.

Learning with conventional models and materials involves much one-way communication, making it difficult for teachers to get feedback on student understanding. Teachers dictate information, and students only pay attention and take notes, so students are not used to expressing ideas and solving real-life problems. The statement is the following research conducted by Suratno (2011), which states that thinking skills cannot emerge without treatment and only focus on methods dominated by lecture methods. Nisa et al. (2018) stated that thinking skills do not appear by themselves in learning.

This study also provides a general description of differences in critical thinking skills between male and female students, where the results obtained indicate that the male students' scores are higher than female students. The result is in line with Gunawan et al. (2020a; 2020b), which states that male students' thinking abilities get higher scores than female students. The interest of male students when learning to use teaching materials in this study is increasing. Meanwhile, female students' interest in learning is lower than male students. One study showed that female students were more influenced by the teachers they chose as their role models and showed high levels of intrinsic motivation (Christophersen et al., 2015).

Before learning begins, the teacher explains how to learn using science teaching materials based on the 5E learning cycle integrated with local wisdom. When learning takes place, female students often ask how to solve the problems contained in the teaching material for fear of answering the wrong answer. However, male students quickly solve the problems contained in the teaching materials directly. Also, observations during learning show that male students complete a series of lessons with teaching materials faster than female students. The result is in line with Gunawan et al. (2020a) research, which stated those female students have a low interest in learning. The reason is that they are not accustomed to learning using developed media, in contrast to male students who are more enthusiastic and have a high spirit and motivation to learn to use media.

An interesting finding from this study is those female students are less able to solve problems that require an explanation of concepts. Based on these data, female students have lower mastery of concepts than male students. Therefore, they cannot solve problems that require analysis. This finding is different from other research, which states that conceptual mastery does not affect students in solving problems (Broman & Parchmann, 2014). On conceptual problems, female students lack self-confidence, in contrast to male students. Male students tend to review the solutions to the problems they provide in teaching materials. It happens because they have confidence in the solutions given (Gulacar et al., 2013). The study results also look attractive from the factors that cause these differences because most students' parents' culture comes from the school environment still views that women do not need higher education so that it affects their enthusiasm for learning. The evidence that some female students drop out of school due to a lack of learning enthusiasm or get married early supported the fact. Girls should marry between the ages of 18 and 20, according to local custom. Furthermore, education is only a formality for the people there, so many children are uneducated and run a gold medal business.

CONCLUSION

Using science teaching materials based on the 5E learning cycle integrated with local wisdom positively affects students' critical thinking skills. The conclusion is shown by the N-gain score of the experimental class, which is higher than

the control class. The t-test showed a difference in critical thinking skills from both classes. There were also significant differences in the improvement of male and female students' critical thinking skills. In both classes, male students have better critical thinking skills than female students. Furthermore, male students in the experimental class performed better than those in the control class.

REFERENCES

- Anazifa, R. D., & Djukri, D. (2017). Project-Based Learning and Problem-Based Learning: Are They Effective to Improve Student's Thinking Skills?. *Jurnal Pendidikan IPA Indonesia*, 6(2), 346-355.
- Andayani, Y., Purwoko, A. A., Jamaluddin, J., Makhrus, M., & Harjono, A. (2020). Identifikasi Pemahaman Guru Tentang Pengembangan Perangkat Pembelajaran IPA SMP dengan Pendekatan Etnosain. *Jurnal PEPADU*, 1(2), 229-234.
- Basri, H. (2019). Investigating Critical Thinking Skill of Junior High School in Solving Mathematical Problem. *International Journal of Instruction*, 12(3), 745-758.
- Broman, K., & Parchmann, I. (2014). Students' application of chemical concepts when solving chemistry problems in different contexts. *Chemistry Education Research and Practice*, 15(4), 516-529.
- Cahyarini, A., Rahayu, S., & Yahmin, Y. (2016). The Effect of 5e Learning Cycle Instructional Model Using Socioscientific Issues (Ssi) Learning Context on Students' Critical Thinking. *Jurnal Pendidikan IPA Indonesia*, 5(2), 222-229.
- Cash, P., Stanković, T., & Štorga, M. (2016). Experimental design research. *Cham: Springer International Publishing*.
- Chen, Y. C. (2019). Effect of mobile augmented reality on learning performance, motivation, and math anxiety in a math course. *Journal of Educational Computing Research*, 57(7), 1695-1722.
- Cheng, K. K., Thacker, B. A., Cardenas, R. L., Crouch, C., Cheng, K. K., Thacker, A., & Cardenas, R. L. (2004). Using an Online Homework System Enhances Students' Learning of Physics Concepts in An Introductory Physics Course. *American Journal of Physics*, 72(11), 1447- 1455.
- Chin, K. Y., Lee, K. F., & Chen, Y. L. (2015). Impact on student motivation by using a QR-based U-learning material production system to create authentic learning experiences. *IEEE Transactions on Learning Technologies*, 8(4), 367-382.
- Christophersen, K.-A., Elstad, E., Solhaug, T., & Turmo, A. (2015). Gender Variations in Norwegian Pre-Service Teachers' Motivational Orientations. *Problems on education in the 21st century*, 63, 17-28.
- Dani, I. (2019, April). Needs analysis in teacher book development Integrated Natural Science type connected character charged with the theme of the sense of hearing and the sonar system of living things. In *Journal of Physics: Conference Series* (Vol. 1185, No. 1, p. 012089). IOP Publishing.
- Daşdemir, İ. (2016). The effect of the 5e instructional model enriched with cooperative learning and animations on seventh-grade students' academic achievement and scientific attitudes. *International Electronic Journal of Elementary Education*, 9(1), 21.
- De Winter, J. C. (2013). Using the student's t-test with extremely small sample sizes. *Practical Assessment, Research, and Evaluation*, 18(1), 10.
- Deswita, D., & Hufri, H. (2018). Validasi Bahan Ajar Fisika Berbasis Inkuiri pada Materi Hukum Newton Tentang Gerak dan Gravitasi untuk Meningkatkan Literasi Sains. *Pillar of Physics Education*, 11(3), 153-160.
- Dewi, I. N., Dwi, U. S., Effendi, I., Ramdani, A., & Rohyani, I. S. (2021). The Effectiveness of Biology Learning-Local Genius Program of Mount Rinjani Area to Improve the Generic Skills. *International Journal of Instruction*, 14(1), 265-282.
- Dewi, I. N., Poedjiastoeti, S., & Prahani, B. K. (2017). ELSII learning model based local wisdom to improve students' problem solving skills and scientific communication. *International Journal of Education and Research*, 5(1), 107-118.
- Ennis, R. H. (2011). The nature of critical thinking: An outline of critical thinking dispositions and abilities. *University of Illinois*, 2(4).
- Feyzioglu, E. Y., & Ergin, Ö. (2012). The effect of 5E learning model instruction on seventh grade students' metacognitive process. *Turkish Journal of Science Education*, 9(3), 78-86.
- Glaze, A. L. (2018). Teaching and learning science in the 21st century: Challenging critical assumptions in post-secondary science. *Education Sciences*, 8(1), 12.
- Gondwe, M., & Longnecker, N. (2015). Scientific and cultural knowledge in intercultural science education: Student perceptions of common ground. *Research in Science Education*, 45(1), 117-147.
- Gulacar, O., Bowman, C. R., & Feakes, D. A. (2013). Observational Investigation of Student Problem Solving: The Role and Importance of Habits. *Science Education International*, 24(2), 344-360.
- Gunawan, G., Mashami, R., Herayanti, L. (2020a). Gender Description on Problem-Solving Skills in Chemistry Learning Using Interactive Multimedia. *Journal for the Education of Gifted Young Scientists*, 8(1), 571-589
- Gunawan, G., Jufri, A. W., Nisrina, N., Al-Idrus, A., Ramdani, A., & Harjono, A. (2021, February). Guided inquiry blended learning tools (GIBL) for school magnetic matter in junior high school to improve students' scientific literacy. In *Journal of Physics: Conference Series* (Vol. 1747, No. 1, p. 012034). IOP Publishing.

- Gunawan, G., Susilawati, SM, Herayanti, L., Lestari, PAS, & Fathoroni, F. (2020b). Gender Influence on Students Creativity in Physics Learning with Virtual Laboratory. In *Journal of Physics: Conference Series*, 1471(1), 012036.
- Gunstone, A. (2014). *Developing Sustainable Education in Regional Australia*. Melbourne: Monash University Publishing
- Hadi, H., & Subhani, A. (2017, October). Internalisasi karakter peduli lingkungan dan tanggap bencana pada siswa sekolah melalui program Geography Partner Schools. In *Prosiding Seminar Nasional Pendidik dan Pengembangan Pendidikan Indonesia* (pp. 176-188).
- Hadisaputra, S., Ihsan, MS, Gunawan, & Ramdani, A. (2020). The development of chemistry learning devices is based on a blended learning model to promote students' critical thinking skills. In *Journal of Physics: Conference Series* (Vol. 1521, p. 042083).
- Hairida, H. (2017). Using learning science, environment, technology and society (SETS) local wisdom and based colloids teaching material. *Journal of Education, Teaching and Learning*, 2(1), 84-89.
- Hartini, S., Firdausi, S., Misbah, M., & Sulaeman, N. F. (2018). The development of physics teaching materials based on local wisdom to train sarabakawa character. *Jurnal Pendidikan IPA Indonesia*, 7(2), 130-137.
- Herman, T., & Dahlan, J. A. (2017, January). The Enhancement of Students' Critical Thinking Skills in Mathematics through The 5E Learning Cycle with Metacognitive Technique. In *International Conference on Mathematics and Science Education*. Atlantis Press.
- Irhamna, I., Rosdianto, H., & Murdani, E. (2017). Penerapan Model Learning Cycle 5E untuk Meningkatkan Keterampilan Berpikir Kritis Siswa Pada Materi Fluida Statis Kelas VIII. *Jurnal Fisika Flux: Jurnal Ilmiah Fisika FMIPA Universitas Lambung Mangkurat*, 14(1), 61-64.
- Irsyada, R. (2016). Analisis Isi dan Kelayakan Penyajian Buku Sekolah Elektronik (BSE) Mata Pelajaran Penjasorkes Kelas 2 Sekolah Dasar. *Journal of Physical Education Health and Sport*, 3(2).
- Izzati, N., Hindarto, N., & Pamelasari, S. D. (2013). Pengembangan Modul Tematik dan Inovatif Berkarakter pada Tema Pencemaran Lingkungan untuk Siswa Kelas VII SMP. *Jurnal Pendidikan IPA Indonesia*, 2(2), 203-208.
- Izzati, U. A., Bachri, B. S., Sahid, M., & Indriani, D. E. (2019). Character education: Gender differences in moral knowing, moral feeling, and moral action in elementary schools in Indonesia. *Journal for the Education of Gifted Young Scientists*, 7(3), 547-556.
- Jack, G. U. (2017). The Effect of Learning Cycle Constructivist-Based Approach on Students' Academic Achievement and Attitude towards Chemistry in Secondary Schools in North-Eastern Part of Nigeria. *Educational Research and Reviews*, 12(7), 456-466.
- Khasanah, A. N., Widoretno, S., & Sajidan, S. (2017). Effectiveness of Critical Thinking Indicator-Based Module in Empowering Student's Learning Outcome in Respiratory System Study Material. *Jurnal Pendidikan IPA Indonesia*, 6(1), 120425.
- Khusniati, M. (2017). Local Wisdom-Based Science Learning Model through Reconstruction of Indigenous Science to Improve Student's Conservationist Character. *Journal of Turkish Science Education*, 14(3), 16-23.
- Kumala, F. N., & Setiawan, D. A. (2019, December). Local wisdom-based e-encyclopedia as a science learning medium in elementary school. In *Journal of Physics: Conference Series* (Vol. 1402, No. 6, p. 066061). IOP Publishing.
- Kumalasari, L., Sudarmin, S., & Sulistyorini, S. (2019). Development of Supplementary Science Teaching Materials with Ethnoscience Contained to Foster Students' Critical Thinking. *Journal of Primary Education*, 8(9), 326-333.
- Lai, H. M., Hsiao, Y. L., & Hsieh, P. J. (2018). The role of motivation, ability, and opportunity in university teachers' continuance use intention for flipped teaching. *Computers & Education*, 124, 37-50.
- Liu, O. L., Frankel, L., & Roohr, K. C. (2014). Assessing critical thinking in higher education: Current state and directions for next-generation assessment. *ETS Research Report Series*, 2014(1), 1-23.
- Luzyawati, L. (2017). Analisis kemampuan berpikir kritis siswa SMA materi alat indera melalui model pembelajaran inquiry pictorial riddle. *Edu Sains: Jurnal Pendidikan Sains dan Matematika*, 5(2), 9-21.
- Mardianto, M. (2014). Perbedaan Hasil Belajar Ekonomi Antara Model Prediction Guide Dengan Model Konvensional Yang Di Laksanakan Di Kelas X SMA N 2 Koto XI Tarusan. *Jurnal Mahasiswa Program Studi Pendidikan Ekonomi*, 2(2), 152-164.
- Maskur, R., Latifah, S., Pricilia, A., Walid, A., & Ravanis, K. (2019). The 7E learning cycle approach to understand thermal phenomena. *Jurnal Pendidikan IPA Indonesia*, 8(4), 464-474.
- Nasir, M., & Jufri, W. Muhlis (2015). Pengembangan Perangkat Pembelajaran Model 5E Untuk Meningkatkan Kemampuan Berpikir Kritis Siswa. *Journal penelitian pendidikan ipa*, 1(2).
- Nisa, E. K., Koestiari, T., Habibulloh, M., & Jatmiko, B. (2018, March). Effectiveness of guided inquiry learning model to improve students' critical thinking skills at senior high school. In *Journal of Physics: Conference Series* (Vol. 997, No. 1, p. 012049). IOP Publishing.
- Nurcahyani, D., Rahmayanti, H., Ichsan, I. Z., & Rahman, M. M. (2021, February). Ethnoscience learning on science literacy of physics

- material to support environment: A meta-analysis research. In *Journal of Physics: Conference Series* (Vol. 1796, No. 1, p. 012094). IOP Publishing.
- Nurkhalisa, S., & Ummayah, F. F. D. (2015). Etse-Module "The Benefits of Acidic Bases in Life" Ethnoscience Based Demak Society in the Utilisation of Lime. *International Journal of Science and Research (IJSR)*, 6(7), 1396-1400.
- Permatasari, I., Ramdani, A., & Syukur, A. (2019). Pengembangan Bahan Ajar IPA Berbasis Inkuiri Terintegrasi Sets (Science, Environment, Technology And Society) pada Materi Sistem Reproduksi Manusia. *Jurnal Pijar Mipa*, 14(2), 74-78.
- Purnami, W., Sarwanto, S., Suranto, S., Suyanti, R., & Mocerino, M. (2021). Investigation of Science Technology Ecocultural Society (STEcS) Model to Enhance Eco Critical Thinking Skills. *Journal of Innovation in Educational and Cultural Research*, 2(2), 77-85.
- Rahayu, W. E., & Sudarmin, S. (2015). Pengembangan modul IPA terpadu berbasis etnosains tema energi dalam kehidupan untuk menanamkan jiwa konservasi siswa. *Unnes Science Education Journal*, 4(2).
- Ramdani, A., Syukur, A., Gunawan, G., Permatasari, I., & Yustiqvar, M. (2020a). Increasing Students' Metacognition Awareness: Learning Studies Using Science Teaching Materials Based on SETS Integrated Inquiry. *International Journal of Advanced Science and Technology*, 29(5), 6708-6721.
- Ramdani, A., Utami, S. D., Efendi, I., Dewi, I. N., & Rohyani, I. S. (2020b, March). Local wisdom integrated biology learning program as an alternative to increase generic science skills. In *Journal of Physics: Conference Series* (Vol. 1521, No. 4, p. 042027). IOP Publishing.
- Rochmawati, A., Wiyanto, W., & Ridlo, S. (2019). Analysis of 21st Century Skills of Student on Implementation Project Based Learning and Problem Posing Models in Science Learning. *Journal of Primary Education*, 8(4), 58-67.
- Safaruddin, S., Ibrahim, N., Juhaeni, J., Harmilawati, H., & Qadrianti, L. (2020). The Effect of Project-Based Learning Assisted by Electronic Media on Learning Motivation and Science Process Skills. *Journal of Innovation in Educational and Cultural Research*, 1(1), 22-29.
- Saleh, S. E. (2019). Critical thinking as a 21st century skill: conceptions, implementation and challenges in the EFL classroom. *European Journal of Foreign Language Teaching*.
- Saputra, M. D., Joyoatmojo, S., Wardani, D. K., & Sangka, K. B. (2019). Developing Critical-Thinking Skills through the Collaboration of Jigsaw Model with Problem-Based Learning Model. *International Journal of Instruction*, 12(1), 1077-1094.
- Saputri, A. C., & Rinanto, Y. (2018, April). Critical thinking skills profile of senior high school students in Biology learning. In *Journal of Physics: Conference Series* (Vol. 1006, No. 1, p. 012002). IOP Publishing.
- Sari, M., Darussyamsu, R., Putri, I. L. E., & Syamsurizal, S. (2019). The Effect Of 5E Learning Cycle Models Containing Science Literacy on Students' Learning Competencies in Additives and Addictive Substances Material at Junior High School 18 Padang. *Atrium Pendidikan Biologi*, 4(1), 74-83.
- Selvaniresa, D., & Prabawanto, S. (2017, September). Contextual teaching and learning approach of mathematics in primary schools. In *Journal of Physics: Conference Series* (Vol. 895, No. 1, p. 012171). IOP Publishing.
- Setyowati, R., Parmin, P., & Widiatmoko, A. (2013). Pengembangan modul IPA berkarakter peduli lingkungan tema polusi sebagai bahan ajar siswa SMK N 11 Semarang. *Unnes Science Education Journal*, 2(2), 245-253.
- Sofyan, H., Anggereini, E., & Saadiah, J. (2019). Development of E-Modules Based on Local Wisdom in Central Learning Model at Kindergartens in Jambi City. *European Journal of Educational Research*, 8(4), 1137-1143.
- Sudarmin, Febu, R., Nuswowati, M., & Sumarni, W. (2017). Development of Ethnoscience Approach in The Module Theme Substance Additive s to Improve the Cognitive Learning Outcome and Student's Entrepreneurship. *Journal of Physics: Conference Series*, 824(1).
- Sudarmin, S., & Samini, S. (2015). Efektivitas penggunaan modul terintegrasi etnosains dalam pembelajaran berbasis masalah untuk meningkatkan literasi sains siswa. *Unnes Science Education Journal*, 4(3).
- Sumintono, B., & Widhiarso, W. (2014). *Aplikasi model Rasch untuk penelitian ilmu-ilmu sosial (edisi revisi)*. Trim Komunikata Publishing House.
- Superni, S. (2018). Pengaruh Model Siklus Belajar 5E (Engagement, Exploration, Explanation, Elaboration, Evaluation) terhadap Kemampuan Berpikir Kritis dan Penguasaan Konsep IPA. *International Journal of Elementary Education*, 2(2), 115-122.
- Suratno. (2011). Kemampuan Metakognisi dengan Metacognitive AwarenessInventory (MAI) pada Pembelajaran Biologi SMA dengan Strategi Jigsaw, Reciprocal Teaching (RT), dan Gabungan Jigsaw-RT. *Jurnal Pendidikan dan Pembelajaran (JPP)*, 18(1), 11-18.
- Susilawati, S., Fikriyah, F., & Saefudin, A. (2016). Science education based on Cirebon local culinary food. *Umrans-International Journal of Islamic and Civilizational Studies*, 3(3-1).
- Temel, S., Özgür, S. D., & Yılmaz, A. (2012). The effect of learning cycle model on preservice chemistry teachers' understanding of oxidation

- reduction topic and thinking skills. *Necatibey Faculty of Education Electronic Journal of Science and Mathematics Education*, 6(1), 287-305.
- Uge, S., Neolaka, A., & Yasin, M. (2019). Development of Social Studies Learning Model Based on Local Wisdom in Improving Students' Knowledge and Social Attitude. *International Journal of Instruction*, 12(3), 375-388.
- Vieira, R. M., & Tenreiro-Vieira, C. (2016). Fostering scientific literacy and critical thinking in elementary science education. *International Journal of Science and Mathematics Education*, 14(4), 659-680.
- Wahidin, D., & Romli, L. A. M. (2020). Students Critical Thinking Development in National Sciences and Mathematics Competition in Indonesia: A Descriptive Study. *Jurnal Pendidikan IPA Indonesia*, 9(1), 106-116.
- Widodo, W., Sudiby, E., Suryanti, S., Sari, D. A. P., Inzanah, I., & Setiawan, B. (2020). The effectiveness of gadget-based interactive multimedia in improving generation z's scientific literacy. *Jurnal Pendidikan IPA Indonesia*, 9(2), 248-256.
- Wulandari, T. S. H., Amin, M., Zubaidah, S., & IAM, M. H. (2017). Students' Critical Thinking Improvement through "PDEODE" and "STAD" Combination in the Nutrition and Health Lecture. *International Journal of Evaluation and Research in Education*, 6(2), 110-117.
- Yuliati, L. (2013). Efektivitas bahan ajar IPA terpadu terhadap kemampuan berpikir tingkat tinggi siswa SMP. *Jurnal Pendidikan Fisika Indonesia*, 9(1).
- Yuliawati, F., Rokhimawan, M. A., & Suprihatinigrum, J. (2013). Pengembangan modul pembelajaran sains berbasis integrasi islam-sains untuk peserta didik difabel netra mi/sd kelas 5 semester 2 materi pokok bumi dan alam semesta. *Jurnal Pendidikan IPA Indonesia*, 2(2), 169-177.
- Yustiqvar, M., Gunawan, G., & Hadisaputra, S. (2019, December). Green Chemistry Based Interactive Multimedia on Acid-Base Concept. In *Journal of Physics: Conference Series* (Vol. 1364, No. 1, p. 012006). IOP Publishing.
- Živković, S. (2016). A model of critical thinking as an important attribute for success in the 21st century. *Procedia-social and behavioral sciences*, 232, 102-108.
- Zubaidah, S., Corebima, A. D., & Mahanal, S. (2018). Revealing the Relationship between Reading Interest and Critical Thinking Skills through Remap GI and Remap Jigsaw. *International Journal of Instruction*, 11(2), 41-56.