JPII 12 (1) (2023) 80-95

Jurnal Pendidikan IPA Indonesia

http://journal.unnes.ac.id/index.php/jpii

STREM PBL WITH E-AUTHENTIC ASSESSMENT: ITS IMPACT TO STUDENTS' SCIENTIFIC CREATIVITY ON STATIC FLUID

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DOI: 10.15294/jpii.v12i1.40214

Accepted: November 18th, 2022. Approved: March 30th, 2023. Published: March 31st, 2023

ABSTRACT

This study aims to explore the scientific creativity of high school students on the static fluid in STREM PBL with an e-authentic assessment. This study used a mixed method with an embedded experimental design. This study involved 30 11th-grade senior high school students in Sidoarjo, Indonesia. Data collection techniques were carried out through pretest-posttest, interview, and observation. Pretest and posttest instruments consist of three scientific creativity essay questions with a reliability of 0.610. The results of the Wilcoxon test of p = .000, with the posttest being higher than the pretest, indicate a significant difference between students' scientific creativity before and after learning. The effect size value of 0.87 indicates that STREM PBL with an e-authentic assessment moderately affects students' scientific creativity. All indicators of scientific creativity have increased. The order of increasing the average scientific creativity score for each indicator is fluency (high) > elaboration (moderate) > originality (moderate) > flexibility (moderate). Meanwhile, the order of the average level of scientific creativity at the posttest is fluency (very creative) > elaboration (quite creative) = flexibility (quite creative) > originality (less creative). Students' scientific creativity increases because this learning makes students solve problems, carry out projects (design and create a product), carry out inquiry activities (experiment and investigation), collaborate with groups, and evaluate projects through self and peer assessment. Learning activities that can increase the level of fluency indicators are mentioning as many ideas as possible for experimental designs and product designs. Learning activities that can increase the level of flexibility indicators are integrating religion content into STEM (it is also better if integrating art content) and providing several problems and products from various fields. Learning activities that increase originality indicators give each individual or group a different project topic. Learning activities that can increase elaboration indicators are strengthening mastery of concepts and evaluating the work of oneself and others through self-assessment and peer assessment.

Keywords: e-authentic assessment; PBL; scientific creativity; static fluid; STREM

INTRODUCTION

Creativity is one of the 21st-century skills which students need to have. The complexity of today's problems requires one to find creative solutions (Mumford et al., 2012). The amount of knowledge may not necessarily be able to solve every problem and fulfill all needs. Knowledge must be creatively processed to produce something that can solve problems and fulfill needs (Park et al., 2006). In addition, the innovations carried out by many industries today require students to develop their creativity to support their future careers. Through creativity, students are expected to be able to generate new ideas in solving problems or making products using the knowledge they have.

Creativity in the domain of science is called scientific creativity. Scientific creativity is used to solve problems creatively or produce innovative products. Scientific creativity is the same as general creativity in divergent thinking but

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emphasizes problem-finding, problem-solving, supposition, hypothesis generation, experimentation, product creation, product design, and product improvement (Siew et al., 2014; Raj & Saxena, 2016). Scientific creativity requires scientific process skills (Pinasa & Srisook, 2019). When students study scientific phenomena, students also need scientific creativity (Samsudin et al., 2018). According to Blašková (2014), scientific creativity includes learning skills, innovation, and responsibility as part of life and career skills in the 21st century. Scientific creativity is considered one of the most important fields that contribute to the progress of human civilization (Hu et al., 2010). It shows that students need to be prepared as part of modern society, which later requires scientific creativity to solve life's problems.

Several research results also show that students' scientific creativity needs to be developed. The results of Cevher et al. (2014) showed that the average total score of students' scientific creativity was moderate, but the originality and elaboration scores were insufficient to generate creative ideas. Astutik et al. (2020) said that students' scientific creativity needs to be developed, especially in problem-solving and production techniques, 90% of students have difficulties in problem-solving, and 78% of students have difficulties in production techniques. In terms of experiments, students have not been able to design experiments creatively (Akcay, 2013) or conduct experiments independently but are still guided by worksheets similar to recipes (Sulistyanto & Rusilowati, 2009).

The low scientific creativity is caused by the lack of opportunities for students to use their knowledge and skills in solving problems creatively or creating innovative products. Preliminary studies at several high schools in Sidoarjo (East Java, Indonesia) show that the learning process in schools rarely encourages students to develop their scientific creativity. Students focus more on learning than applying knowledge to solve problems or create products. The knowledge learned is also directly on the final concept. Students are rarely involved in the process of discovering and proving concepts. Opportunities to convey ideas are also rarely given. Most tasks and questions do not require higher-order thinking skills and are less applicable to everyday life. Previous studies also observed the same conditions (Saido et al., 2015; Rahmawati et al., 2019; Sumarni et al., 2019; Wijayati et al., 2019; Sumarni & Kadarwati, 2020). Students' scientific creativity can be developed by implementing learning activities. Learning activities that make it possible for students to develop their creativity are formulating, integrating, and improving ideas to solve creative problems or create innovative products. Therefore, it is necessary to develop students' scientific creativity.

One of the efforts to develop students' scientific creativity is through the STEM approach. Genek & Küçük (2020) stated that the STEM program's implementation positively impacted students' scientific creativity. STEM activities increase students' scientific creativity (Knezek et al., 2013; Pertiwi et al., 2017; Yulianti et al., 2020). STEM integrated with PjBL also positively affected all dimensions of students' scientific creativity traits (Lou et al., 2017; Siew & Ambo, 2018). Recently, the STEM approach has been integrated with art and religion. The integration of STEM with art (STEAM) has been widely studied, while STEM with religion (STREM) is still rare. Integrating religious values is also needed to build student character. Religious values can also be integrated into the material as knowledge to stimulate students' curiosity and high-order thinking skills. Therefore, it is necessary to conduct STREM research to stimulate students further to develop their scientific creativity. The learning model that aligns with the principles of the STREM approach is Problem-Based Learning (PBL). This learning model enables good learning practices in teaching STEM content (Mutakinati et al., 2018). STREM and PBL are problem-centered learning. At the beginning of learning, students are given problems and asked to provide solutions in the form of products in groups, and the teacher acts as a facilitator.

This kind of learning is suitable for developing students' scientific creativity but takes more time. The solution to making learning time more effective is to include an e-authentic assessment in STREM PBL learning. Authentic assessment simplifies the assessment of student performance (Rustaman et al., 2017). This authentic assessment is web-based (e-authentic assessment), so students can quickly receive feedback for better learning outcomes. The assessment process carried out via the web makes the learning process more effective and efficient, considering the large number of students (Kusairi et al., 2017). This type of assessment allows for educational transformation and can increase students' ability to learn independently (Kearney, 2013). An e-authentic assessment puts student skills in the very good category and student knowledge in the medium category (Ambiyar et al., 2020). Therefore, it is necessary to research the scientific creativity of high school students on static fluid material in

STREM PBL with an e-authentic assessment to answer the following research questions: (1) How is the effect of STREM PBL with an e-authentic assessment on the scientific creativity of high school students in static fluid?; (2) How is high school students' scientific creativity level on the static fluid in STREM PBL with an e-authentic assessment?

METHODS

This research used mixed methods with an embedded experimental design. The stages of the research are shown in Figure 1. The research began with collecting qualitative data through interviews with several students about students' scientific creativity in a static fluid material. Furthermore, all students were given a pretest using essay questions to measure students scientific creativity. The intervention in the form of STREM PBL with an e-authentic assessment was carried out during four meetings. Students are orientated to the problem at the first meeting and strengthened conceptual understanding. At the second meeting, students investigated the literature and designed the product. At the third meeting, students evaluated and created the product design. At the fourth meeting, students tested and evaluated the product. During the learning process, observations are made of the learning process. After the intervention, all students were given a posttest with the same questions as the pretest. After that, interviews were conducted with several students to dig deeper regarding students' scientific creativity in static fluid material after being given STREM PBL with an e-authentic assessment.

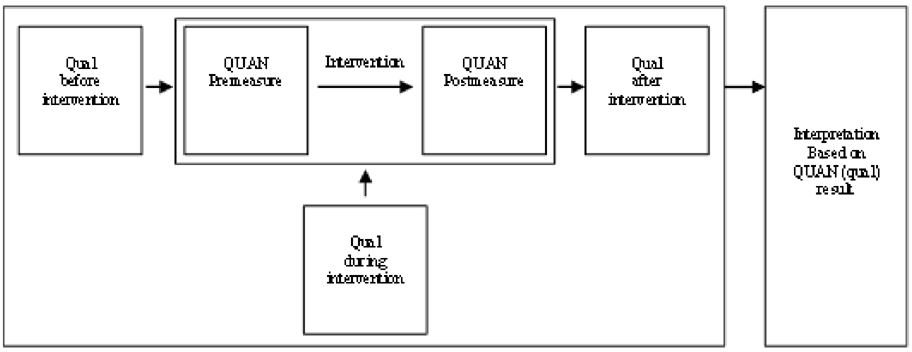


Figure 1. Embebded Experimental Model
Creswell & Clark (2017)

The research subjects comprised 30 students in the 11th grade of Senior High School in Sidoarjo, Indonesia. Data collection techniques were carried out through pretest-posttest, interviews, and observations. The pretest and posttest instruments consist of three scientific creativity essay questions on static fluid material. The expert validated the three questions and declared them valid, both in terms of content and constructs. The instrument has also been tested empirically. The results of the empirical test show that the three questions are valid with an instrument reliability of 0.610. The rubric for assessing scientific creativity refers to Table 1. The interview technique in this study is a semi-structured interview. The interview was conducted before and after the intervention. Interview questions regarding product innovation that applies the static fluid concept. Observations were also made during the learning activities. Observation focus on student activities. The results of the observations are written in field notes.

Table 1. Assessment Criteria of Scientific Creativity

Indicator	Criteria	Score
Fluency	No answer	0
	Answer 1 correct answer	1
	Answer 2 correct answers	2
	Answer 3 correct answers	3
	Answer 4 correct answers	4

Flexibility	No answer	0
	Answer 1 correct answer	1
	Answer 2 correct answers	2
	Answer 3 correct answers	3
	Answer 4 correct answers	4
Originality	No answer	0
	Answer frequency >15% (>5)	1
	Answer frequency between 11% - 15% (4-5)	2
	Answer frequency between 5% - 10% (2-3)	3
	Answer frequency <5% (1)	4
Elaboration	No answer	0
	Picture is not detailed	1
	Picture is detailed	2
	Picture is detailed and equipped with a description of each part	3
	Picture is detailed and equipped with a description of each part and work principle	4

Data from student responses to the pretest and posttest were analyzed quantitatively and qualitatively. Quantitative data were analyzed statistically through the Wilcoxon test and effect size. The result of the effect size calculation is interpreted using categories, as shown in Table 2.

Table 2. Category of Effect Size

Range	Category
0-0,20	Weak effect
0,21-0,50	Modest effect
0,51-1,00	Moderate effect
>1,00	Strong effect

Cohen et al. (2017)

The increase in scientific creativity of each student is also analyzed using the following N-gain equation and categories.

$$N - gain = \frac{posttest\ score - pretest\ score}{maximum\ score - prestest\ score} \times 100$$

Table 3. Category of N-gain

Range	Category
<0,30	Low
0,30≤g<0,70	Medium
0,70≤g≤1,00	High

Hake (1999)

Qualitative data were analyzed to support quantitative data. Analyzing qualitative data is data reduction, coding, data presentation, and concluding. Coding for scientific creativity uses the terms in Table 4.

Table 4. Coding for Scientific Creativity

Indicator	Category	Level	Criteria
Fluency	Not creative	0	No answer
	Less creative	1	Answer 1 correct answer
	Quite creative	2	Answer 2 correct answers
	Creative	3	Answer 3 correct answers
	Very creative	4	Answer 4 correct answers
Flexibility	Not creative	0	No answer
	Less creative	1	Answer 1 correct answer
	Quite creative	2	Answer 2 correct answers
	Creative	3	Answer 3 correct answers
	Very creative	4	Answer 4 correct answers
Originality	Not creative	0	No answer
	Less creative	1	Answer frequency >15% (>5)
	Quite creative	2	Answer frequency between 11% - 15% (4-5)
	Creative	3	Answer frequency between 5% - 10% (2-3)
	Very creative	4	Answer frequency <5% (1)
Elaboration	Not creative	0	No answer
	Less creative	1	Picture is not detailed
	Quite creative	2	Picture is detailed
	Creative	3	Picture is detailed and equipped with a description of each part
	Very creative	4	Picture is detailed and equipped with a description of each part and work principle

RESULTS AND DISCUSSION

STREM PBL with an e-authentic assessment is carried out offline and online. Online activities focusing on assessment and feedback are carried out as the solution to making learning time more effective. This is because STREM PBL is suitable for developing creativity but requires a long time, so it needs to be integrated with an e-authentic assessment. This learning began with giving a problem in the form of a flood. The focus of the problem chosen is material loss and damage to buildings, especially mosques. Students began to be involved in the problem-solving process by demonstrating the ship's phenomena and discussing the Al-Qur'an's values related to the concept of floating objects. After that, project tasks are formulated to solve the problem by designing and making miniature floating mosques in groups.

Before designing, students carried out investigations related to the concept and construction of miniatures. In investigative activities, students conducted experiments on the factors that affect the buoyant force's magnitude and the object's position in the fluid. Students were asked to design their experiment, such as determining as many experimental variables as possible and then making an experiment design. This experiment design activity aims to train students' scientific creativity on indicators of fluency and flexibility. In this section, students can mention many variables, although not all are conceptually correct. However, this activity must be done to train students to think flexibly. Unique answers were also found, which also trained students' originality. After collecting data, analyzing experimental results, and discussing them, students will understand the correct concept. After that, students were invited to discuss more profound concepts to strengthen students' conceptual understanding and practice elaboration indicators. The concepts obtained were also integrated with the previous values of the Al-Qur'an. Apart from strengthening elaboration, this activity also aims to train flexibility and students to think about other scopes or categories.

After investigating the concept, students investigated references related to the miniature construction and then designed a floating mosque miniature. This design activity is to increase elaboration as well as student originality. The results of each group's design showed that students could design in detail, which shows that student elaboration is good. However, in terms of originality, the construction of mosques for each group is almost the same. They are like the design of mosques in general. The designs are assessed by peer assessment and self-assessment. The goal is to motivate students more and make students produce better products. After completing the design and assessment activities, each group realized their designs into the miniatures. Miniature that has been tested. The miniatures were also assessed during the trials by self-assessment and peer assessment. After that, each group was allowed to revise their miniatures. Finally, students are invited to reflect on the process of making and producing the product. This self-assessment and peer assessment activity can improve student work and train student elaboration. Before the assessment was carried out, the miniatures of some groups could not float properly and accommodate the maximum load. After the assessment and revision, the miniatures of all groups can float properly and accommodate the maximum load.

Descriptive statistics of the pretest and posttest of students' scientific creativity in STREM PBL with an e-authentic assessment are presented in table 5.

Table 5. Descriptive Statistics of Pretest and Posttest

	Minimum	Maximum	Mean	Std. Deviation
Pretest	0	63	4.79	14.09
Posttest	19	100	62.29	21.31

Table 5 shows that the average posttest score (M=62.29; SD=21.31) is higher than the average pretest score (M=4.79; SD=14.09). The difference between pretest and posttest scores was tested statistically with the Wilcoxon test. This non-parametric test was carried out because the posttest data (p=.167) was normally distributed, while the pretest (p=.000) was not normally distributed. The result of the Wilcoxon test showed that the average posttest score was significantly higher than the average pretest score Z (30)=-4.791,p=.000,d=.87. According to Cohen et al. (2017), effect size (d=.87) is included in the medium category. N-gain of each student's scientific creativity after being given STREM PBL with e-authentic assessment is also calculated. Three students (10%) experienced an increase in the low category, 17 students (57%) experienced an increase in the medium category, and ten students (33 %) experienced an increase in the high category.

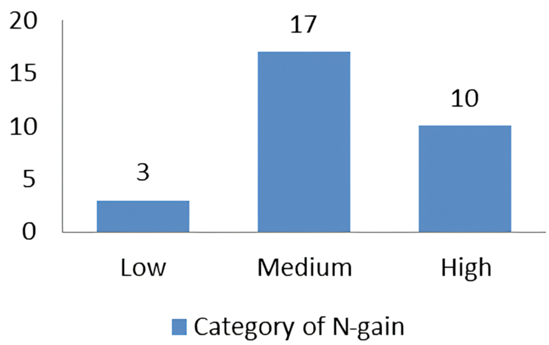
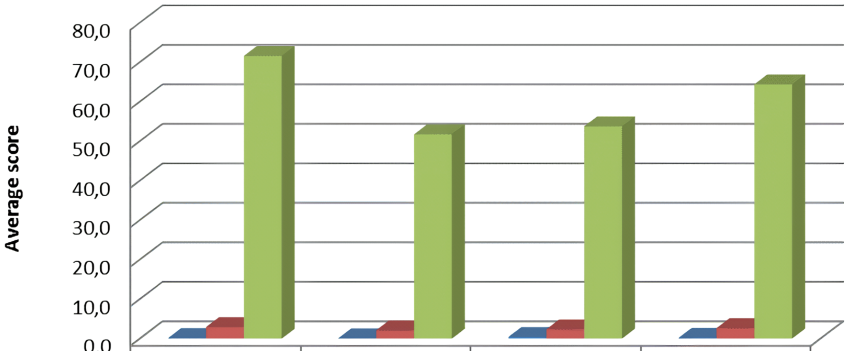


Figure 2. Graph of N-gain Category

The total score and the score for each indicator of scientific creativity have also increased. All indicators of scientific creativity have increased. Fluency (71.6%) increased to the high category, while flexibility (51.7%), originality (53.7%), and elaboration (64.3%) increased to the medium category.



	Fluency	Flexibility	Originality	Elaboration
Pretest	0,1	0,1	0,4	0,2
Posttest	2,9	2,1	2,3	2,6
N-gain (%)	71,6	51,7	53,7	64,3

Figure 3. Graph of the Average Score of Pretest, Posttest, and N-gain (%) for Each Indicator of Students' Scientific Creativity

The result of statistical tests shows that STREM PBL with an e-authentic assessment has a moderate effect on students' scientific creativity. This result is suitable with the research of (Widyasmah et al., 2020), which state that STEM PBL on Pascal's Law improves creative thinking skills in the moderate category. PBL activities and modules positively impact training students' scientific creativity in learning natural sciences (Siew et al., 2015; Nuswowati et al., 2017; Sumarni & Kadarwati, 2020). The results of this study also support the research of Setiawan et al. (2020), Hebebci & Usta (2022), Lou et al. (2017), and Siew & Ambo (2018), which states that STEM learning has a positive impact and can increase students' scientific creativity. Not only did the average total score increase, but the average score for all indicators also increased. These findings support the discovery of Sirajudin et al. (2021) for scientific creativity in electrical materials. According to Kuo et al. (2019) and Susilowati et al. (2020), STEM learning and creativity are interrelated and influenced because STEM learning can help increase creativity, which is the key to the success of STEM learning.

Each step in STREM PBL with an e-authentic assessment increases students' scientific creativity. This learning begins with giving authentic problems, and students are asked to solve these problems. The authentic problem given is the impact of flood losses, one of which is making the mosque unusable during a flood. Learning that involves problem-solving activities is the basis for increasing students' scientific creativity (Hu et al., 2013; Mayasari et al., 2016). Problem-solving activities greatly affect students' scientific creativity (Bi et al., 2020). Kind & Osborne (2017); Lou et al. (2011) also mentions that problem-solving activities are one way to enhance creativity. Through the problem of flood losses, students were given project assignments to make designs and miniatures of floating mosques. Giving projects can hone students' scientific creativity (Erdogan et al., 2013; Knezek et al., 2013; Gülhan & Şahin, 2016; Kustiana et al., 2020). Design activities are a means to develop creativity (Gibson, 2003). Product design and manufacture is a catalysts to encourage scientific creativity (Siew & Ambo, 2018). One of the supporting factors for increasing student creativity is student enthusiasm for designing activities. According to Cavaş & Kesercioğlu (2012); Lou et al. (2012), scientific creativity increases when problem-solving is emphasized in design and development through hands-on and minds-on. Siew & Ambo (2018) also state that scientific creativity increases when activities and thoughts are emphasized in project design and development. Students are given more project assignments to develop their creativity.

Before designing and making miniature floating mosques, students are directed to learn the concept of static fluid through inquiry activities. The scientific knowledge gained can later be used to evaluate ideas in designing and making miniature floating mosques. Inquiry activities are also helpful for developing students' creativity (Liu & Lin, 2014). Students are directed to conduct experiments related to hydrostatic pressure and Archimedes' Law. Based on the objectives of the given experiment, students are asked to determine their experimental design. Designing experiments is alternative learning that can increase students' creativity (practical work). Yang et al. (2016) stated that the activity of designing experimental procedures can increase scientific creativity. Activities to formulate problems, hypotheses, variables, and other process skill activities can increase scientific creativity (Zainuddin et al., 2020).

Students work on project assignments together with their groups. Working in groups is one way to practice creativity (Dousay & Weible, 2019). Discussion activities can increase creativity (Rohim & Susanto, 2012). Siew et al. (2015) stated that communication and information sharing is social process variables associated with increasing scientific creativity. Perry & Karpova's (2017) results also state that group learning increases students' creativity more than individually. Collaborative learning is proven to have a moderate effect on students' scientific creativity (Bi et al., 2020).

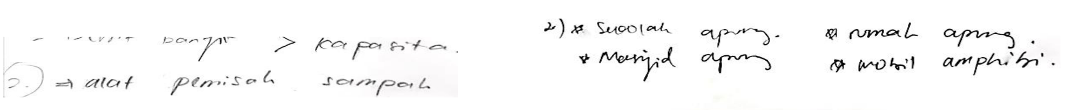
Designs and miniatures are assessed by self-assessment and peer assessment. Students are asked to test and assess their group's and other groups' work. Both types of assessment aim to make students more independent and motivated to produce better work. The activity of testing and reflecting on this project requires students to develop their creativity (Hu et al., 2013; Putri et al., 2020). The assessment activities during this process encourage students to choose the best solution to enhance their creativity (Bennett, 2011). Perseverance in producing good products also guides students to be more creative (Owen et al., 2019).

STREM PBL with an e-authentic assessment has been shown to increase the average score of each indicator of scientific creativity. Next, it will be analyzed how creative the students are after being given STREM PBL with an e-authentic assessment. To determine the level of scientific creativity of students, students' responses to scientific creativity questions are categorized into five levels of scientific creativity, namely Level 0 (not creative), level 1 (less creative), level 2 (quite creative), level 3 (creative), and level 4 (very creative). In this study, the fluency indicator was measured by asking students to mention the product innovations which applied Archimedes' Law to solve the flood problem. Table 6 shows the number of students at each level in the fluency indicator during the pretest and posttest.

Table 6. Cross Tabulation of Pretest*Posttest on Fluency

		Posttest					Total
		Level 0	Level 1	Level 2	Level 3	Level 4	
Pretest	Level 0	0	3	9	3	12	27
	Level 1	0	0	1	0	1	2
	Level 2	0	0	0	1	0	1
	Level 3	0	0	0	0	0	0
	Level 4	0	0	0	0	0	0
Total		0	3	10	4	13	30

During the pretest, there were only three students who gave answers, while 27 other students did not give answers. Two of the three students mentioned boats and garbage separators in rivers. While one of the three students mentioned floating houses and flood detection alarms. During the posttest, no more students are at level 0. All students could answer even if only one answered. There were three students at level 1, 10 at level 2, four at level 3, and 13 at level 4. The number of answers each student gives during the posttest is always more than the pretest. The answers given during the posttest were also more varied. Figure 4 shows one of the students' answers during the pretest and posttest. In the pretest, students gave one answer, but in the posttest, students could give four answers.



Pretest　　　　Posttest

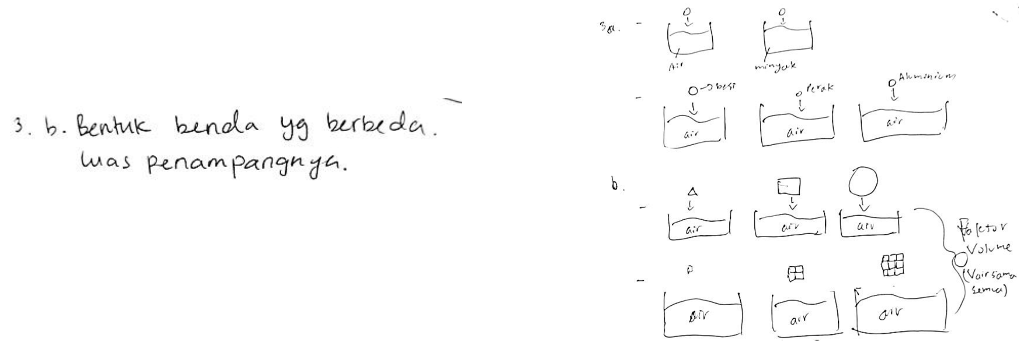
Figure 4. The Answer to Pretest and Posttest on Fluency

Flexibility was measured by asking students to mention the factors affecting the objects' position in the fluid. Table 7 shows the number of students at each level in the flexibility indicator during the pretest and posttest.

Table 7. Cross Tabulation of Pretest*Posttest on Flexibility

		Posttest					**Total**
		Level 0	**Level 1**	**Level 2**	**Level 3**	**Level 4**	
Pretest	Level 0	1	8	13	3	4	29
	Level 1	0	0	0	0	0	0
	Level 2	0	0	0	0	1	1
	Level 3	0	0	0	0	0	0
	Level 4	0	0	0	0	0	0
Total		1	8	13	3	5	30

During the pretest, there was only one student who could answer, while 29 students did not answer. A student mentions two factors that affect the position of an object in a fluid. These factors are the shape of different objects and the cross-sectional area of the object. During the posttest, only one student remained at level 0. The student could not answer. While the other 28 students were spread at different levels and 13 at level 2. The answers given by the students varied. The following is one of the student's answers in the pretest and posttest. Through the experimental design drawings, the student answered the type of fluid, the type of object, the object's shape, and the object's volume.



Pretest Posttest

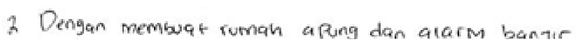
Figure 5. The Answer to Pretest and Posttest on Flexibility

This study measured originality by asking students to mention the product innovations that applied Archimedes' Law to solve the flood problem. Students are asked to mention the most innovative products possible. Table 8 shows the number of students at each level in the originality indicator during the pretest and posttest.

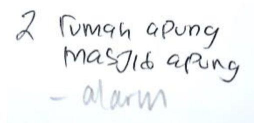
Table 8. Cross Tabulation of Pretest*Posttest on Originality

		Posttest					**Total**
		Level 0	**Level 1**	**Level 2**	**Level 3**	**Level 4**	
Pretest	Level 0	0	11	4	7	5	27
	Level 1	0	0	0	0	0	0
	Level 2	0	0	0	0	0	0
	Level 3	0	0	0	0	0	0
	Level 4	0	0	1	0	2	3
Total		0	11	5	7	7	30

Only three students could answer in the pretest, while the other 27 did not. Three students mentioned garbage filters in the river, floating houses, and flood detection alarms. In the posttest, no more students are at level 0. All students can provide answers even though the answers given are not new ideas (more than one person also mentioned the answer). All students in the pretest were at level 0, in the posttest was spread at levels 1, 2, 3, and 4. 11 students at level 1, four students at level 2, seven students at level 3, and five students at level 5. Two of three students at level 4 in the pretest remained at level 4 in the posttest, while one other dropped to level 2. One student gave the same answer as the answer in the pretest during the posttest, namely the flood detection alarm and floating house. In the pretest, only these students mentioned flood detection alarms and floating houses, but in the posttest, the frequency of responses to flooding detection alarms and floating houses was high, so the originality was low. To be declared as a creative person, at all times must be able to provide new ideas because ideas that are considered new today may not necessarily be considered new ideas in the future. Figure 6 shows the student's answer.



Pretest



Posttest

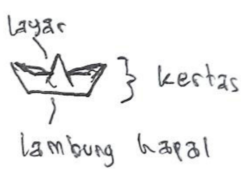
Figure 6. The Answer of Pretest and Posttest on Originality

Elaboration is measured by asking students to describe the design of a product that applied Archimedes' Law to solve the flood problem. Table 9 shows the number of students at each level in the elaboration indicator during the pretest and posttest.

Table 9. Cross Tabulation of Pretest*Posttest on Elaboration

		Posttest					Total
		Level 0	Level 1	Level 2	Level 3	Level 4	
Pretest	Level 0	2	2	13	1	10	28
	Level 1	0	0	0	0	1	1
	Level 2	0	0	0	0	0	0
	Level 3	0	0	0	0	0	0
	Level 4	0	0	0	0	1	1
Total		2	2	13	1	12	30

In the pretest, three students could mention a product to solve the flood problem. Of the three students, one student could not describe the product, one could describe it but lacked detail so that it was at level 1, and another could describe the product in detail so that it was at level 4. In the posttest, students initially at level 4 remained at level 4, and students initially at level 1 remained at level 1. While students who were initially at level 0 became level up, except for two students who remained at level 0. The following was one of the students' answers when the pretest was at Level 1 and when the posttest was at Level 4 with a different product.

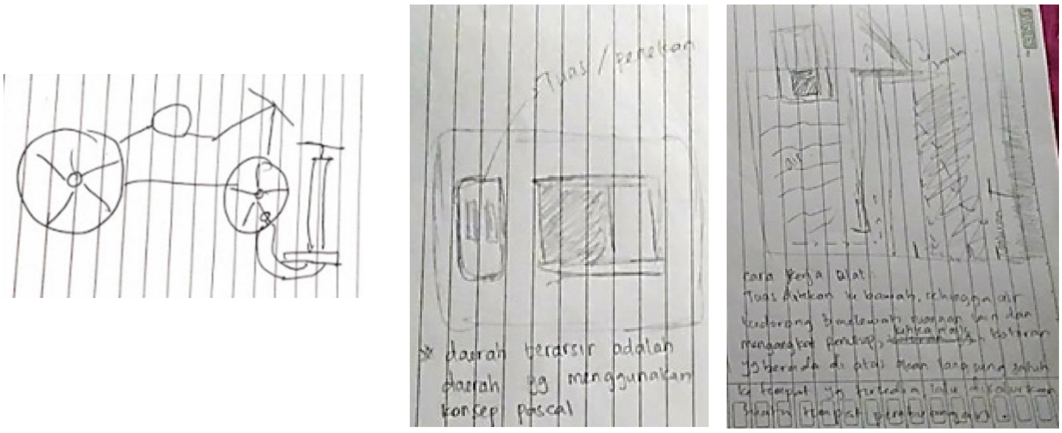


Pretest

Posttest

Figure 7. The Answer of Pretest and Posttest on Elaboration

Before and after being given STREM PBL with an e-authentic assessment, several students were interviewed. Interview questions about Pascal's Law. Students are asked to mention as many product innovations which apply Pascal's Law as possible and then explain the working principle. The following is the interview result of one of the students before and after STREM PBL with an e-authentic assessment.



Before After

Figure 8. Interview Results Before and After STREM PBL with an E-authentic Assessment

Before the intervention, the student mentioned hydraulic pumps as product innovations that applied Pascal's Law. Student only mentions one answer, so they are at level 1 for fluency and flexibility. Judging from the originality indicator, many students also mention hydraulic pumps, so the student is at level 1 for originality. Based on the answers given, the student has not been able to provide new and different ideas. The answer given is an application that is often mentioned in textbooks. The student answered hydraulic pump because she remembered the application from the book and from the explanation given by the teacher when discussing Pascal's Law. Judging from the elaboration indicator, the student is at level 2. The student can describe the answer, but the picture is still general. Students do not provide information on the parts of the product. When asked to explain the product's working principle in more detail, the student could not explain it in detail.

After the intervention, the student mentioned the automatic cat cage cleaner. The student only mentions one answer, so it remains at level 1 for fluency and flexibility indicators. Meanwhile, for the originality indicator, the student is at level 4 because only her who was mentioned that idea. The idea of an automatic cat cage cleaner is also new and unique. This idea has not been discussed in any book or study resource. The student mentioned this idea because of her love and concern for animals, especially cats. Judging from the elaboration indicator, the student can describe the answer in detail. The student was able to describe each part of the product and explain the working principle of the product in detail and systematically. It means the student is at level 4 for the elaboration indicator.

All indicators of scientific creativity increased after STREM PBL with an e-authentic assessment. The most considerable increase occurred in the fluency indicator with the high category (71,6%). The average scientific creativity level of students (13 students) on the fluency indicator during the posttest is also the highest among all indicators, which is at Level 4 (very creative). These results are similar to those of Azizah et al. (2020); Altan & Tan (2021); Mayasari et al. (2016); Pinasa & Srisook (2019) that the highest indicator achieved by students is fluency. However, it is in contrast to Siew et al. (2015), whose posttest fluency score decreased from the pretest score. Problem-centered learning, project assignment assignments, inquiry activities, and group discussion activities are supporting factors for improving fluency indicators. Awang & Ramly's (2008) research results show that problem-centered learning through applying PBL can increase fluency scores. Giving project assignments that lead students to plan, design, and reflect on learning outcomes in various post-project cases requires students to think fluently (Putri et al., 2020). This is also following the research of Isabekov & Sadyrova (2018); Srikoon et al. (2018), who found that when students were given a problem and asked to produce a product, they could train students to generate many ideas. The number of ideas referred to is part of the fluency indicator. When experimenting, students are asked to think of as many factors that can influence it as a variable. Activities train students to think fluently. Another factor that increases the fluency score is the activity of designing the experiment. One of them is when doing experiments related to Archimedes' Law. Students must think about factors that affect the magnitude of the buoyant force and the position of objects in a liquid. Brainstorming activities to consider as many possibilities as possible and solutions can also increase fluency scores (Siew et al., 2015). Pinasa et al. (2018) also state the same thing, that sharing the application of knowledge and design to products can increase fluency scores.

The flexibility indicator has increased to the moderate category (51.7%). The students' average level of scientific creativity (13 students) on the flexibility indicator at the posttest is at Level 2 (quite creative). These results follow the research results by Kencana et al. (2020). When studying in groups, the ideas conveyed vary. When there is a difference of opinion, it must be decided which idea to use or how to think flexibly to take a middle ground between these ideas. Activities like this can increase students' creativity on flexibility indicators (Siew et al., 2015; Shively et al., 2018). Knowledge sharing and product design activities also increase flexibility (Pinasa et al., 2018). However, it is also difficult for students to develop solutions after finding several solutions. It affects flexibility (Altan & Tan, 2021).

Originality increased by 53.7% in the moderate category. However, the average scientific creativity level (11 students) on the originality indicator at the posttest was Level 1 (less creative). The results of this study are suitable with the results of research by Rustaman et al. (2018); Widyasmah et al. (2020), that originality is in the medium category. Problem-based learning and project assignments also increase originality (Awang & Ramly, 2008; Putri et al., 2020). When designing the miniature form of the floating mosque, students were also asked to make designs different from the existing ones. This activity trains students to think about new things. These results follow what Siew et al. (2015); Isabekov & Sadyrova (2018) found in their research that such activities can stimulate students to find new ideas. This is what helps make students' originality increase in this study. Activities that focus on questions on design and products also contribute to increasing originality (Pinasa et al., 2018). Even though the average originality score increased, the average student was still at level 1 (less creative) during the posttest. This is the lowest level acquisition of all indicators. This finding is the same as the findings of previous research, which also found that the originality score was the lowest among other indicators of scientific creativity (Mayasari et al., 2016; Syukri et al., 2017). One of the causes of originality being the lowest is the familiarity between students and small classrooms which can influence students' new ideas (Jindal-Snape et al., 2013).

Elaboration increased 64.3% in the moderate category. The average level of scientific creativity (13 students) on the elaboration indicator during the posttest is at Level 2 (quite creative). These results follow the research of Kencana et al. (2020), Kuo et al. (2019), and Widyasmah et al. (2020), which also shows that elaboration is in the medium category. Before making a product in the form of a miniature floating mosque, students are directed to design the miniature first. Design activities are also a means to develop creativity (Gibson, 2003). When designing, students must make designs as detailed as possible and need to consider many things, including related concepts. Activities like this can develop students' elaboration. As explained by (Altan & Tan, 2021) in their research, students with sufficient knowledge to decipher solutions can affect elaboration scores. Students also realize that groups must choose the best solution among the solutions given, so each group must describe the complete solution to present it. The activity of clarifying and focusing questions on design and product makes students' thinking more explicit about the elaboration indicator (Pinasa et al., 2018).

The order of increasing the average scientific creativity score for each indicator is fluency (high) > elaboration (moderate) > originality (moderate) > flexibility (moderate). Meanwhile, the average sequence of scientific creativity levels at the posttest was fluency (level 4 very creative) > elaboration (level 2 quite creative) = flexibility (level 2 quite creative) > originality (level 1 less creative). The fluency indicator shows the best results. The average score increased, and the average student reached a very creative level at the posttest. Fluency is the easiest indicator to achieve and can be used as an initial step to becoming more creative. In this study, fluency was always trained in every STREM PBL with an e-authentic assessment. Students are always instructed to state as many ideas as possible, starting from variable ideas and experimental designs to discover the concept of static fluid until product design ideas. This kind of training should always be done because most of the first ideas students mention are not the most creative. However, when students were asked to continue to mention their ideas, some of the ideas mentioned were the most creative ideas. If it is not an entirely new idea, at least it is a combination of a modified idea of an old idea.

The elaboration indicator also shows consistent results. In this study, fluency is always in the first best position, followed by elaboration, both in increasing the average score and the average level of scientific creativity at the posttest. At the posttest, the average elaboration level was still quite creative. However, the average score has experienced a moderate increase. This increase results from giving systematic concept questions in making product designs. The questions given require students to enrich their ideas and insights. The elaboration score, which is quite good, is not surprising because students' conceptual understanding in the population is also good, indicated by the score of learning outcomes in the realm of good conceptual understanding. Familiarity with detailed analysis of each static fluid concept and integration of each STREM content also give effect. The scientific content of the static fluid concept is related to the aspect of religion in this study in the form of Qur'an values and references to the concept of floating buildings. Science and religion content is then applied to make technology products through engineering processes and mathematical calculations. E-authentic assessment in the form of self and peer assessment of the designs and products of the group and other groups also trains student elaboration. When students are asked to evaluate the designs and products of other groups, they will also think of other ideas and add insight that can enrich their ideas. Actually, students' elaboration level has not been maximized in this study, which has been reflected since students made product design drawings. If, when making product design drawings, students are trained to make more details, maybe the level of elaboration of students will also increase.

Furthermore, regarding the flexibility indicator, even though the increase in the average score is the lowest, at the posttest, the average student is at a quite creative level, higher than the originality indicator. It turned out that it was not easy for students to give ideas in different categories. Students who provide many ideas do not necessarily provide many categories of ideas. Conversely, some students give a few ideas, but all of these ideas are in different categories. It is also difficult for students to develop solutions with different categories after finding the right solution, even though this research has added R (Religion) content in STEM learning. Further research can add elements of art (STREAM) so that students are more familiar with various categories. In addition, the problems, product types, and main concepts applied have also been determined and are the same for all groups. The problem given was in the form of a flood disaster, then all groups were asked to make a miniature mosque product that applied the concept of floating style. In order to achieve the maximum level of flexibility, problems, types of products, and the main concepts applied can be varied or given more than one. If making more than one product is burdensome and time-consuming, it can only be designed.

The lowest level occurs on the originality indicator. Even though it experienced a moderate increase, the average student was less creative in the posttest. The proximity between students and small rooms also seems to affect the originality of students. What is more, the pretest and posttest questions are the same problem. When students know the answers other students believe to be correct, they tend to choose that answer rather than give other answers that are not necessarily true. Especially if they do not have an idea yet, then the possibility of imitating the answer is even greater. The topic of the pretest-posttest questions that measure originality is the same as the topic of the student project, which is about buoyancy. This further reduces the possibility of students generating new ideas. Therefore, further research is suggested to be a more conditional test. The pretest and posttest questions can be made differently but with the same difficulty level, and the topic is also different from the project's main topic. In addition, the problems or products, or concepts applied can be more varied. It is conditioned that each student or group provides different product ideas to get used to thinking differently and not depending on other students.

CONCLUSION

Students' scientific creativity in static fluid material has increased after STREM PBL with an e-authentic assessment. This learning is significant, with increased scientific creativity in the moderate category. All indicators of scientific creativity have increased. The order of increasing the average scientific creativity score for each indicator is fluency (high) > elaboration (moderate) > originality (moderate) > flexibility (moderate). Meanwhile, the order of the average level of scientific creativity at the posttest is fluency (very creative) > elaboration (quite creative) = flexibility (quite creative) > originality (less creative). Students' scientific creativity increases because this learning makes students solve problems, carry out projects (design and manufacture products), conduct inquiry activities (trials and investigations), collaborate with groups, and evaluate work through self and peer assessment. Learning activities that can increase the level of fluency indicators are mentioning as many ideas as possible for experimental designs and product designs. Learning activities that can increase the level of flexibility indicators are integrating religion content into STEM (it is also better if integrating art content) and providing several problems and products from various fields. Learning activities that increase originality indicators give each individual or group a different project topic. Learning activities that can increase elaboration indicators are strengthening mastery of concepts and evaluating the work of oneself and others through self-assessment and peer assessment.

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