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Using the Reaction Rate Learning Module with a STEM Approach to Student's Creative Thinking Ability

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ABSTRAK

Kreativitas menjadi salah satu daya saing pada abad 21.. Permasalahan yang dihadapi masih banyak siswa kurang memahami materi pada buku pegangan yang menyebabkan kemampuan berpikir kreatif rendah, salah satu alternatif dalam pembelajaran abad ini yaitu pendekatan STEM. Penelitian ini bertujuan untuk menentukan kemampuan berpikir kreatif siswa menggunakan modul pembelajaran laju reaksi dengan pendekatan STEM melalui google classroom. Jenis penelitian yang digunakan yaitu Pra eksperimen (pre experimental) dengan one grup pretest-posttest design. Data hasil kemampuan berpikir kreatif siswa diambil menggunakan tes berpikir kreatif yang diberikan sebelum dan sesudah pembelajaran. Hasil penelitian menunjukkan kemampuan berpikir kreatif siswa Setelah menerapkan modul pembelajaran laju reaksi dengan pendekatan STEM melalui google classroom kemampuan berpikir kreatif siswa pada aspek berpikir lancar dan orisinal berada pada kategori sangat tinggi sedangkan kategori berpikir luwes dan memerinci berada pada kategori tinggi dengan presentasi rata-rata dari keempat aspek berada pada kategori tinggi yakni 67,1% serta nilai rata-rata N-Gain sebesar 0,59 berada pada kategori sedang. Dapat disimpulkan adanya meningkatan kekampuan berpikir kreatif siswa.

ABSTRACT

Creativity is one of the competitiveness in the 21st century. The problems faced by many students are that they do not understand the material in the handbook which causes low creative thinking skills, one of the alternatives in learning this century is the STEM approach. This study aims to determine students' creative thinking skills using the reaction rate learning module with the STEM approach through Google Classroom. The type of research used was pre-experimental with one group pretest-posttest design. Data on the results of students' creative thinking abilities were taken using a creative thinking test given before and after learning. The results showed that students' creative thinking abilities After implementing the reaction rate learning module with the STEM approach through Google Classroom, students' creative thinking abilities in aspects of fluent and original thinking were in the very high category, while the flexible and detailed thinking category was in the high category with an average presentation of the four aspects are in the high category, namely 67.1% and the average N-Gain value of 0.59 is in the medium category. It can be concluded that there is an increase in students' creative thinking skills.

1. INTRODUCTION

Education is one of the pillars of a nation's progress, so it must be in line with the developments and demands of the times to become a successful and competitive person in the 21st century (Insyasiska, et al. 2015). One of the basic skills to face the 21st century is creative thinking, which is the ability someone needs to think creatively in solving a problem (Sirajudin, et al 2021). Creativity is one aspect that is expected through education as stated in the national education goals. Therefore, to achieve the expectations of these educational goals, the learning process should also be oriented toward the development of creativity. In line with this, one learning approach that is in line with the development of the 21st century is the STEM approach (Gustiani, et al 2019; Fadzilah, et al 2016).

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Creativity plays a very important role to be trained so that students are better prepared to deal with it. Creativity also shows how to express oneself through work, using mastered techniques, alternative problem-solving, an open attitude, and respect for work (Munandar, 2012). The STEM approach is a learning approach that combines two or more areas of knowledge contained in STEM, namely science, technology, engineering/engineering, and mathematics (Ismayani, 2016; Baker et al, 2017; Pimthong & Williams 2018). With the STEM approach, students are expected to be able to learn and innovate skills which include critical thinking, creativity, innovation, and the ability to communicate and collaborate (Winarni, et al 2016; Rahmawati et al. 2019; Diana et al 2021). STEM is considered a very important learning method to support future success. Therefore, it attracts teachers and students to learn it regardless of the challenges they face (Saptarani et al, 2019; Stolhamm et al 2012).

The success of learning besides depending on the method also depends heavily on the learning tools used. Books as teaching materials and learning resources are seen as an important factor in the success of learning (Tjiptiany, et al, 2016). The problems that arise from the results of interviews and observations at SMA Negeri 4 Sigi are that students still have difficulty understanding the material in the handbook so the value of student creativity is still low. In addition, there are no STEM modules that teachers use to support the learning process in class. Based on that reason, it encourages researchers to apply teaching materials that can make it easier for students to understand learning material. Teaching materials applied by researchers in this study are in the form of modules. The module is a teaching material that aims to make students learn independently without or with the guidance of educators so that the module contains at least the main components of teaching materials (Diana, Netriwati, & Suri, 2018; Sari, Farida, & Syazali, 2016).

The outbreak of the Covid-19 virus in Indonesia has had an impact on the world of education. Teaching and learning activities that are usually carried out face-to-face in class have shifted to teaching and learning at home through online/distance learning (Lutfi, et al 2021; Nadeak, et al, 2020). Online learning is the use of the internet in the learning process. In online learning, students have flexibility in study time and can study anywhere, anytime (Isman in Dewi, 2020). For this study, the researcher chose Google Classroom because it is a form of Learning Management System (LMS) application that is most widely used by students. After all, it is easy to use and students are more familiar (Bintarawati, 2020).

Technological developments that have not been utilized properly by students are also one of the causes of low student creativity. However, because students spend more time with their smartphones or laptops playing games and social media than using them to access subject matter, student learning outcomes are low. In addition, teachers also have not utilized technological facilities that have been developed and are currently available to assist the learning process. Even though technological developments should be utilized by teachers and students to support the learning process (Khumairah, et al. 2020). This research was conducted to determine students' creative thinking abilities through the use of the reaction rate learning module with the STEM approach through Google Classroom.

2. METHOD

This type of research is pre-experimental (pre-experimental) with one group pretest-posttest design (Figure 1). All sample groups were given the same treatment and the results were observed. The treatment is in the form of learning using modules with the STEM approach as the independent variable and the ability to think creatively as the dependent variable (Creswell, 2014).

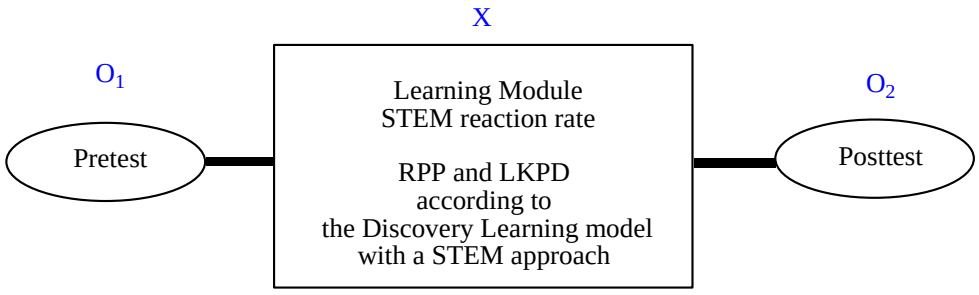


Figure 1. Research Design

The instruments used in this study consisted of preparing a Learning Implementation Plan (RPP), worksheets, creative thinking skills test instruments, creative thinking skills assessment rubrics and the N-gain test. All research instruments have been validated by several experts from Tadulako University. Valid instruments are then used for data collection. The rubric for assessing creative thinking skills for each indicator can be seen in Table 1.

Table 1. Creative Thinking Ability Category

Value Intervals (%)	Category
81% < NR ≤ 100%	Very High
61% < NR ≤ 80%	High
41% < NR ≤ 60%	Medium
21% <NR ≤ 40%	Low
0% < NR ≤ 20%	Very Low

(Riduwan, 2010)

Data were analyzed in the form of percentages according to the rubik's assessment of creative thinking skills. The data obtained was then analyzed descriptively quantitatively using rubrics and criteria as in Table 1 and Table 2. While the N-gain test was carried out to measure how effective the use of the STEM module was on students' creative thinking abilities between before and after learning by describing or describing the data collected. Gain calculation results are then interpreted using the classification in Table 3.

Table 2. Scoring Rubric for Creative Thinking Skills

Aspects of creative thinking	Rubric	Score
Fluent thinking ability	Students do not answer or answer ideas that are not relevant to the problem	0
	Students give ideas of relevant answers and wrong answers	1
	Students give ideas of relevant answers and correct answers	2
	Students give more than one idea but the answer is still wrong	3
	Students provide more than one relevant idea and the solution is correct and clear	4
Ability to think flexibly	Students do not provide answers	0
	Students give answers only one way but the answer is wrong	1
	Students give answers in one way, the calculation process and the results are correct	2
	Students give answers in more than one way (various) but the results are wrong because there is an error in the calculation process	3
	Students give answers in more than one way (various), calculation process and the result is correct	4
Original thinking ability	Students do not provide answers	0
	Students give answers in their own way but the answers are wrong	1
	Students give answers in their own way, the calculation process is directed but not finished	2
	Give answers in their own way but there is an error in the calculation process so the result is wrong	3
	Give answers in their own way, the calculation process and the results are correct	4
Ability to detail / elaborate	Students do not provide answers	0
	Students give answers, there are errors in the answers and are not accompanied by details	1
	Students give answers, there are errors in the answers but accompanied by less detailed details	2
	Students give answers, there are errors in the answers but accompanied by detailed details	3
	Students give correct and detailed answers	4

Table 3. Gains Classification

Normalized average gain	Classification
(g) ≥ 0,70	High
0,30 ≤ (g) < 0,70	Medium
(g) < 0,30	Low

(Alep, 2014)

3. RESULT AND DISCUSSION

Result

The results obtained in this study were in the form of data during the teaching and learning process in class XI IPA 1 SMA Negeri 4 Sigi using the reaction rate learning module with the STEM approach to students' creative thinking abilities through Google classroom. The application of this learning module uses a discovery learning model that is adapted to the learning model at the school where the researcher conducts research. The initial stages of making observations, determining the population and research sample, and preparing a Learning Implementation Plan (RPP) with a time allocation of 2 x 45 minutes for 4 meetings. At the first meeting, a face-to-face initial test (pretest) was carried out with an allotted time of 45 minutes or for one lesson hour, and another lesson hour was used for the process of learning activities, namely by using Google Classroom as a learning medium, the Google Classroom website was created first. and designed in such a way. Google Classroom was chosen because it is an LMS device that is easy to use, and can connect with various other Google features and access only uses Gmail. Before learning begins, the material is uploaded to Google Classroom. Then introduce the use of the Google Classroom-based website to students and direct students to log in to the application. In the second meeting, the learning process was based on the lesson plan according to the syntax of the discovery learning model that had been prepared for two hours of learning with the initial stage of directing students to access learning materials in Google Classroom and then watching videos by accessing them using the link in the STEM module, then doing learning in class and create groups to discuss and answer questions in the LKPD that have been uploaded on Google Classroom. At the third meeting, learning was based on the RPP that had been prepared for two hours of learning according to the second meeting. At the fourth meeting, the first 45 minutes were used for the process of learning activities, namely giving time for students to recall the material they had learned before giving the final test and the other 45 minutes doing the final test (post-test) face to face. The main material taught in this class is under the material in the STEM module, namely reaction rate material.

The learning instrument used in this study has been validated in advance by an expert validator. The goal is that the instruments used can be feasible to use. The instrument that was validated was the Reaction Rate Learning Module with the STEM approach which had been previously validated in research conducted by Puala, A (2020), and was declared valid and feasible to use. Other instruments that have been validated are the Learning Implementation Plan (RPP), Student Worksheets (LKPD), Teacher and Student Activity Observation Sheets, and creative thinking tests. The validated creative thinking test is in the form of 10 essay questions that contain the four aspects of creative thinking, namely fluency, flexibility, originality, and elaboration.

Analysis of aspects of fluent thinking in students as shown in Table 4 shows that the level of student's creative thinking aspects (fluency) after being given the pretest is in the medium category with a percentage of 35.7%. After being given treatment by applying the reaction rate learning module with the STEM approach through Google classroom, the students' posttest results were in the very high category with the highest presentation of 85.7%.

Table 4. Thinking Aspect Data Fluency

Category	Creative Thinking Result Data			
	Pretest	%	Post-test	%
Very High	0	0	24	85,7
High	6	21,4	1	3,6
Medium	10	35,7	0	0
Low	6	21,4	0	0
Very Low	6	21,4	3	10,7
Total	28	100	28	100

Analysis of aspects of flexible thinking in students is shown in Table 5 which shows that the level of student's creative thinking aspects (Flexibility) after being given a pretest is in the low category with the highest percentage of 46.4%. After being given the treatment of applying the reaction rate learning module with the STEM approach through Google Classroom, the results of the student posttest were in the high category with the highest presentation of 78.6%.

Table 5. Thinking Aspect Data Flexibility

Category	Creative Thinking Result Data			
	Pretest	%	Post-test	%
Very High	0	0	1	3,6
High	1	3,6	22	78.6
Medium	2	7,1	2	7,1
Low	13	46,4	0	0
Very Low	12	42,9	3	10,7
Total	28	100	28	100

Analysis of aspects of original thinking in students as shown in Table 6 which shows that the level of student's creative thinking in aspects of originality after being given a pretest is in the very low category with the highest percentage of 46.4%. After being given the treatment of applying the reaction rate learning module with the STEM approach through Google Classroom, the post-test results were in the very high category with the highest presentation of 46.4%.

Table 6. Thinking Aspect Data Originality

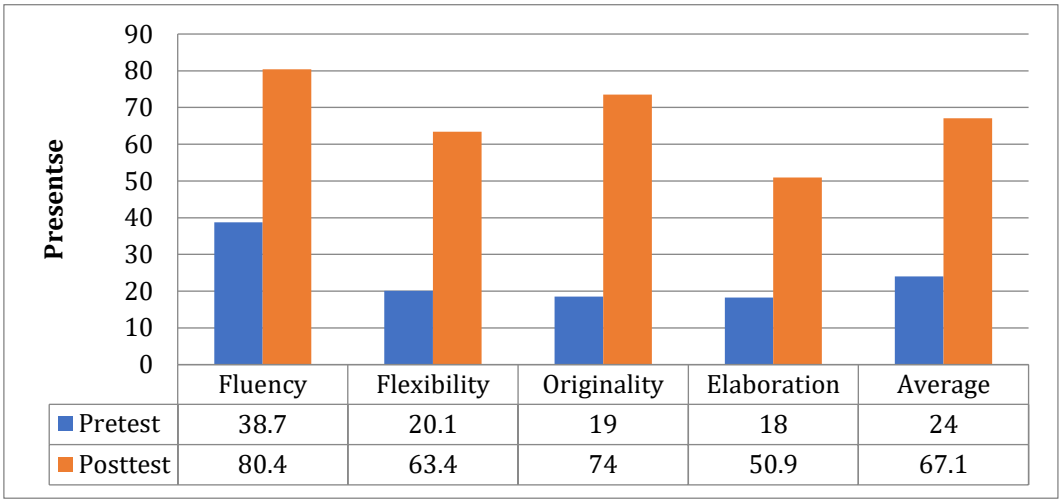
Category	Creative Thinking Result Data			
	Pretest	%	Post-test	%
Very High	0	0	13	46,4
High	0	0	11	39,3
Medium	4	14,3	1	3,6
Low	11	39,3	0	0
Very Low	13	46,4	3	10,7
Total	28	100	28	100

Analysis of aspects of thinking in detail in experimental class students as shown in Table 7 which shows that the level of student's creative thinking in the Elaboration aspect after being given the pretest is in the low category with the highest percentage of 53.6%. After being given treatment using the reaction rate learning module with the STEM approach through Google Classroom, the posttest results of students were in the high category with the highest presentation of 46.4%.

Table 7. Thinking Aspect Data Elaboration

Category	Creative Thinking Result Data			
	Pretest	%	Post-test	%
Very High	0	0	0	0
High	0	0	13	46,4
Medium	0	0	12	42,9
Low	15	53,6	0	0
Very Low	13	46,4	3	10.7
Total	28	100	28	100

Analysis of students' creative thinking for each aspect of creative thinking can be seen in Figure 2 which determines that the use of the reaction rate learning module with the STEM approach through Google Classroom can improve students' creative thinking skills where the percentage before being given the average percentage treatment is in a low category, namely 24 %, after being given treatment using the reaction rate learning module with the STEM approach through Google Classroom, the average percentage is in the high category, namely 67.1%



	Fluency	Flexibility	Originality	Elaboration	Average
Pretest	38.7	20.1	19	18	24
Posttest	80.4	63.4	74	50.9	67.1

Figure 2. Average Creative Thinking Ability

The N-gain test was carried out to measure the increase in students' creative thinking abilities before and after using the STEM module. N-gain analysis data can be seen in Table 8 which shows an increase in students' creative thinking skills after being applied to the reaction rate learning module with the STEM approach through Google Classroom, namely the N-Gain in the fluency aspect of 0.72 is in the High category, the flexibility aspect is 0, 55 is in the medium category, the originality aspect is 0.70 in the High category and the Elaboration aspect is 0.40 in the medium category.

Table 8. N-*Gain*

Aspects	Percentage			
	Pretest	Post-test	N-Gain	Category
Fluency	38.7%	80.4%	0.72	High
Flexibility	20.1%	63.4%	0.55	Medium
Originality	19 %	74 %	0.70	High
Elaboration	18 %	50.9%	0.40	Medium
Average	23,9%	67.1%	0.59	Medium

Discussion

Creative thinking can simply be interpreted as a student's skill to create or find something useful in life (Nurjanah & Cahyana, 2021). Creative thinking is part of where Creativity itself is the ability to see or think of extraordinary, unusual things, combine seemingly unrelated information, and spark new solutions or ideas that are reflected in fluency, flexibility, originality, and detailing in thinking The aspect of fluency requires the number of answers generated. The flexibility aspect requires a person to produce a variety of ideas so that there is no rigidity in thinking (Al-Hafidh, 2020; Wrobel et al, 2020). In the aspect of originality, a person is required to give a different answer from the others. Meanwhile, the elaboration aspect requires someone to think in search of deep meaning in solving problems (Munandar, 2012). These four aspects of creative thinking are included in the 10 creative thinking items given to students during the pretest and posttest (Munandar 2012; Fuad et al 2017).

The fluency aspect means that students can answer fluently by giving lots of ideas (Rahman et al., 2017). The highest percentage value for the level of creative thinking of students before being given learning (pretest) is in the medium category, which is 36.7%. While the highest percentage of students' creative thinking levels after being given learning using the reaction rate module with the STEM (post-test) approach is in the Very High category, which is 85.7%. The results of working on question number 1 pretest on the indicator of fluent thinking students have been able to explain the meaning of reaction rate by looking at examples but student answers are still not quite right, in posttest answers students can answer questions about understanding reaction rate based on examples correctly and correctly. The scientific approach to the reaction rate module is that students are given information about examples of reaction rate events in everyday life so that learning that presents the real world experienced by students is realized (Subramaniam et al, 2012; Roberts and Cantu, 2012) meaning that through the Science approach, students do not only memorize concepts but also how students understand science concepts and how they relate to

everyday life. For questions, number 2 and 8 the pretest on the indicator of fluent thinking students have been able to design simple experiments regarding measuring reaction rates and seeing the effect of concentration on reaction rates but student answers are still not quite right, in posttest answers students can design experiments correctly and precisely. This is in the technical approach to the reaction rate module where students are given examples of designing and operating a procedure. Fluent thinking has also been fulfilled, as seen by students who have been able to design their own designs and steps for experimental activities to be carried out. This is in line with research (Wulandari, Liliasari, & Supriyanti, 2011) which states that students are trained to do detailed things, such as making practicum procedures and determining tools and materials according to questions and experimental steps.

The Flexibility aspect means being able to produce diverse ideas, being able to change ways or approaches, and have different directions of thought (Munandar, 2012; Sirajudin *et al* 2021).The percentage of flexibility aspect achievement. The percentage of achievement in the aspect of flexibility can be seen in Table 5. The highest percentage value for the level of creative thinking of students before being given learning (pretest) is in a low category, which is 46.4%. While the highest percentage of students' creative thinking levels after being given learning using the reaction rate module with the STEM (posttest) approach is in the High category which is equal to 78.6%. The results of working on questions number 3 and 9 pretest on the indicator of flexible thinking, students have not been able to provide answers in more than one way to determine the reaction rate and reaction order. Reaction rate material contains concepts combined with mathematical abilities which sometimes make it difficult for students to understand them. Because of this, the low learning outcomes obtained by these students indicate that students still have a low understanding of chemical concepts (Elyani, et al. 2019). The mathematical approach to the reaction rate module is that students are given practice questions and how to solve them which will train students' abilities. The results of the posttest were considered successful if students could determine the rate of reaction and the order of the reaction in different ways, but in the question of determining the order of reaction, the average student only answered in the usual way.

The original aspect is being able to show new and unique expressions (Sirajudin et al 2021). The highest percentage value of the level of students' creative thinking before being given learning (pretest) is in a low category, which is 36.4%. While the highest percentage of students' creative thinking levels after being given learning using the reaction rate module with the STEM (post-test) approach is in the Very High category, which is 46.4%. The results of working on questions number 6 and 7 on pretest questions with original thinking indicators, students are able to understand the meaning of the questions but student answers are still not quite right. In answer number 6 post-test, students can answer questions correctly. One of the factors that affect the rate of reaction is temperature, so that food can last longer, a technological and scientific approach is needed, such as refrigerators and freezers that can keep food longer and not spoil quickly. In question number 7 posttest students can answer about the effect of concentration on how quickly the drug reacts in the body. In learning science, students not only learn how to understand a concept but also how students acquire scientific process skills and apply them to a problem. Students better understand the material being taught because students can play an active role in their learning so that indicators of students' scientific process skills are achieved (Setiawan et al, 2021).

The Elaboration aspect (detailing) means being able to enrich and develop ideas or products and add more interesting solutions (Sirajudin et al 2021). The highest percentage value for the level of creative thinking of students before being given learning (pretest) is in a low category, which is 53.6%. While the highest percentage of students' creative thinking levels after being given learning using the reaction rate module with the STEM (post-test) approach is in the High category, which is 46.4%. The results of students' pretest work on the detailed thinking indicator stated that students had not given correct and appropriate answers. The results of the posttest have increased compared to the results of the pretest answers. In question number 4 Students can answer the lowest reaction rate based on the table but not all students can specify what things affect it based on the data in the table. In question number 5 students were given a diagram of the energy level of a chemical reaction using a catalyst and without using a catalyst, the average student answer had not given satisfactory results regarding the concept of a catalyst in chemical reactions. Elaboration is one of the stages where students can systematically describe ideas in detail and complexly (Bayyinah, An'nur, & Suriasa, 2014).

The average percentage value of students' creative thinking for each aspect can be seen in Figure 2. The achievement of students' creative thinking after being given learning (post-test) using the reaction rate module with the STEM approach through Google Classroom obtained the highest presentation on the Fluency aspect, namely 80.4 %. The second highest percentage on the Originality aspect was obtained at 73.5%. The highest percentage of the three aspects of flexibility was 63.4% and the percentage for the elaboration aspect was 50.9%. The use of learning modules with the STEM approach has a significant impact after giving the posttest. This is because the STEM module is a module that has high adaptive power to the

development of science and technology. It is said to be adaptive because it can make adjustments quickly and flexibly to the development of science and technology. In addition, according to (English & King. 2015), the STEM approach is to prepare students who can think scientifically and can utilize technology to face the future.

The N-Gain test is used to describe the increase in students' creative thinking skills. Based on the N-Gain test seen in Table 8, it can be seen that the use of the reaction rate module with the STEM approach through Google Classroom for the four aspects of creative thinking has an average (pretest) on the fluency aspect of 38.7% and a final score (post-test) is 80.4% with an N-Gain of 0.72 is included in the high category, in the aspect of flexibility the initial value (pretest) is 20.1% and the final value (post-test) is 63.4% with an N-Gain of 0.55 which is included in the medium category, in the originality aspect the initial score (pretest) is 19 % and the final score (post-test) is 74% with an N-Gain of 0.70 in the High category, in the elaboration aspect the initial value (pretest) is 18 % and the final score (post-test) is 50.9% with an N-Gain of 0.40 which is in the medium category.

Based on the description above, it can be concluded that students' creative thinking skills from the four aspects of creative thinking, namely fluent thinking, flexible thinking, original thinking, and detailed thinking, the results showed that the indicators that improved the most were fluent and original thinking. The results of this study are in line with research conducted by Kristiani, et al (2017), that the average achievement of students' creative thinking abilities before and after learning is significantly different and has a large effect. The STEM module contains materials and exercises and provides information about the topics to be studied to help students learn independently and actively. discuss exercises or problems that require fluency, flexibility, and new ideas, such as aspects of creative thinking. This is in line with research (Jawad and Majed 2021), that the strategies used in the STEM approach, including cooperative learning, brainstorming, and others, are strategies that involve students in the educational process and link experience with mathematical theories, principles, and laws, which all build student competence. Creative thinking skills, especially fluency, flexibility, and ingenuity. The relational skills in the STEM approach are the most appropriate for developing these skills because they help students find theoretical relationships between; liver problems; Relations between specific subjects, students must use a variety of relationships, similarities, etc.

4. CONCLUSION

Based on the research objectives and research results it can be concluded that there is an increase. before the learning process, students' creative thinking skills in the aspect of fluent thinking were in the medium category, aspects of flexible, original, and detailed thinking were in the low category with the average presentation of the four aspects being in the low category, namely 24%. After implementing the reaction rate learning module with the STEM approach through google classroom students' creative thinking abilities in aspects of fluent and original thinking are in the very high category while in the flexible and detailed thinking category they are in the high category with the average presentation of the four aspects being in the high category namely 67.1% and the average N-Gain value of 0.59 is in the medium category.

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