Improving Motivation and Mathematics Learning Achievement by Using Science, Technology, Engineering, Art, and Mathematics (STEAM) in Calculating Volume by Rotating an Area with an Integral Topic

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***Abstract*— Motivation and student learning achievement are not high. One of the efforts taken by teacher with Z generation and Alpha generation is to use Science, Technology, Engineering, Art, and Mathematics (STEAM) of learning models on calculating volume by rotating an area with integral topic. The goal is to guide students to critical, creative, collaborative and innovative thingking skills to get the concept of integration topic. This is a class action research on learning mathematics. The subject of this research is students of class XII IPA 1 SMA Negeri 3 Pekanbaru. The research consists of two cycles. Each cycle consists of six stages: focus, detail, discovery, application, presentation, link. Based on the results of the study, motivation and learning achievement can be improved by using STEAM of learning models. This can be seen from the increase of learning motivation which increase from cycle 1 to cycle II by 12,56% and result of learning increase from cycle I to cycle II equal to 25%. Improve learning achievement is easy to achieve because in the use of this model students can connect, collaborate and teach other about case volume by rotating an area. The use of STEAM is designed to make the student not only can using geogebra application but they can explore their art sense too.**

Keywords—STEAM (Science, Technology, Engineering, Art and Mathematics)

I. INTRODUCTION

1.1 Background

Today, the student are very complicated. The student are combain between Z generation and Alpha generation. They are to be born into the world with smartphone, tablets and computer. They are social enterpreneur and like their learning to have meaning and purpose. The student are born into an information revolution. It is the reason that make the student have low motivation and learning Achievement in the class. Because the teacher are still not open minded to the class. The teacher are not making the student practice their lesson and teach other. So, as a teacher we have a big problem to make the student apply core skill to every day task, how to make the student approach complex challenges and approach their changing environment. The teacher need to change our style to teach. The teacher have to learn how to come in 4th industrial revolution.

During the last decade that have been a great team in the nation in education systems everything is changed in many aspects. Curriculums, physical, environment, teachers, teaching methods, assessment and students will have changed. In traditional education curriculum students take many subjects that does not relate to each other. There is no link between subject and students asked what is that for . There are no clear learning outcomes for subject. Students is bored, receptors, work individually and in 4th industrial revolution skills needed. Teachers on transmitter is knowledge, doer's and dumpling subjects together. Making it one way communication with students, exams depend on memorization more than understanding. There is no linkage with real life. Classrooms are boring, the teacher giving information with no feedback, no participation, no teamwork between students.

The whole world is connected and people have access to each other's easily. The traditional education does not fit for this any more, then your unconditional education stress on enhancing in 4th industrial revolution skills as perseverance: problem solving, creativity, critical thinking, entrepreneurship skills, and team work.

The teacher acts as a mentor and a facilitator for students and organizes information given to students in an easy understand able way. Assessment is project oriented authentic step by step. It is based on teamwork and collaboration to create the art project within the assigned time and given resources. Students are now engaged participating eager to learn and ready to be the next generation of entrepreneurs. It's the reason a STEAM education system which fits in 4th industrial revolution requirement.

STEAM aims to helping students enhance their critical thinking skills and recognize the intersection of art, science, technology, engineering, and math. It gives students tools and methods to explore new and creative ways of problem-solving, displaying data, innovating, and linking multiple fields. The arts and STEM subjects naturally complement and inform each other, so implementing STEAM principles into education allows for more understanding, innovation and a cohesive education in the classroom.

In fact, the problems encountered in class XII IPA 1 SMAN 3 Pekanbaru, the motivation and learning achievement of students in the mathematics learning process are still low. Low student learning Achievement can be seen in the following table:

TABLE I. AVERAGE DAILY TEST SCORE FOR MATHEMATICS SUBJECTS

No	Topik	Number of Students Completed		Number of Students Not Completed	
		Orang	*%*	*Orang*	*%*
1	Volume Benda Putar	12	33,3	24	66,7

In table 1, the learning Achievement of class XII IPA 1 are presented in mathematics with 36 students and KKM 85 in the even semester of TP. 2018/2019 SMA 3 Pekanbaru.

As many as 66.7 % of students did not complete the topics volume by rotating an area. So if it is based on complete learning standards, 90% of students 90% of competencies / objectives (Ministry of National Education, 2009), the learning Achievement achieved by students of class XII IPA 1 in mathematics learning are still low. This is due to the low activity and learning Achievement of mathematics in the topic volume by rotating an area in that year. Therefore, the authors try to improve these conditions by making a few changes. Changes made are by using Science, Technology, Enginering, Art, and Mathematics (STEAM) of learning models in the Volume by rotating an area topic.

1.2 Problem Identification

Based on the above problem identification, can the authors identify the problems that arise are: Motivation learn math students not optimal, student learning achievement have not been optimal. The student are still not connect, colaborate and teach other in the classroom, active students are few, learning model that has been applied has not been able to achieve the expected goals.

1.3 Research objectives

The purpose of this research are improving of motivation and learning Achievement of students in class XII IPA 1 of SMA Negeri 3 Pekanbaru using Science, Technology, Enginering, Art, and Mathematics (STEAM) of learning models. However, this study also using critical and creative thinking as the implementation in 4th Industrial Revolution. The Skill of student to thrive in 4th Industrial Revolution :

- Complex problem Solving
- Critical Thinking
- Creativity
- People Management
- Coordinating with others
- Emotional Inteligence
- Judgement and decision making
- Service Orientation
- Negotiation
- Cognitive Flexibility

According to Siswono (2018), Critical thinking and creative thinking are representative of higher order thinking. That is because thinking ability is the highest cognitive competency that students have to need in class. Thus, it can be said that higher order thinking consists of critical thinking and creative thinking.

Siswono (2018) explains too that critical thinking is a process of using thinking skills effectively to help someone make something, evaluate, and apply decisions according to what is believed or done. Some thinking skills related to critical thinking are comparing, distinguishing, estimating, drawing conclusions, influencing, generalizing, specializing, classifying, sorting, predicting, validating, proving, connecting, analyzing, evaluating patterns."

Creative thinking is a series of actions taken by people using their intellect to create new ideas from a collection of memories that contain various ideas, information, concepts, experiences, and knowledge. This understanding shows that creative thinking is marked by the creation of something new from the results of various ideas, information, concepts, experiences, and knowledge that exists in his mind.

The choice of STEAM learning model is because this model has several advantages such as: the topic received by students is more because the student learning by doing. STEAM is an art project task. Every uniq student can collaborate their capabilty to other. In addition, students can also develop topic from volume by rotating an area of questions presented during the learning process. Another advantage is that it can make students skilled in working on problems. The student have to compare how to find the voleme by rotating area between geogebra aplication with accounting manually. During the activity, students help each other and exchange ideas to solve the given problem. Its equal with the learning pyramid that the student teach other is the goal. The practice exercises and the sharing of problem solving processes make students skilled in working on various existing problems.

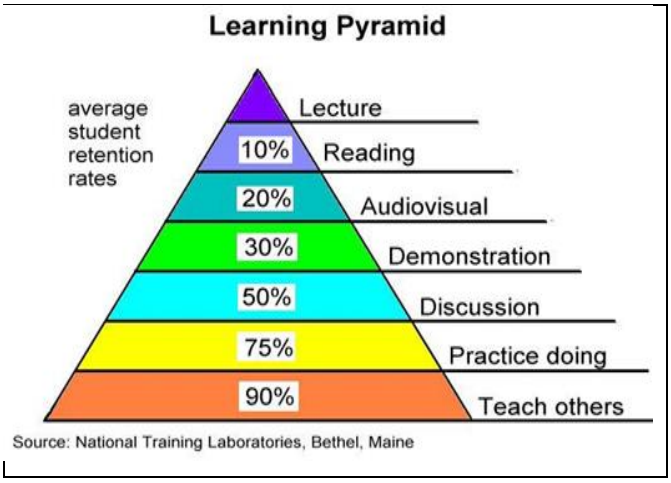

Fig. 1. Learning Pyramid

So it is clear that the use of the Science, Technology, Enginering, Art, and Mathematics (STEAM) learning model will create classrooms in which students will be active participants not just passive observers, and responsible for their learning. The application of the Science, Technology, Enginering, Artsd, anda Mathematics (STEAM) learning model will greatly help teachers to make students more confident in overcoming various problems that arise because students are accustomed to dealing with various problems and making project together.

II. METHODOLOGY

2.1 Form of Research

This study is a class action where in this classroom action research is a practical research that aims to improve and to overcome the weaknesses in learning in the classroom. By implementing this activity is expected to find a solution that can solve the problems that exist in learning in the classroom.

2.2 The Science, Technology, Enginering, Art, and Mathematics (STEAM) Learning Model

The Science, Technology, Enginering, Art, and Mathematics (STEAM) learning model is one of the learning models that is oriented to project base learning. Learning activities facilitate students to understand various mathematical problems that are solved individually and in groups with making a project.

2.3 Characteristics of the Science, Technology, Enginering, Art, anda Mathematics (STEAM) Learning Model

The characteristics of the STEAM learning model are the existence of project assignments. This is indicated by the presentation of a math project assignment sheet containing practice questions applying mathematical topic that must be completed by students. The project work is carried out in groups. This group learning activity enables the emergence of various ideas and opinions of students, in developing topic through mathematical problems. This group learning make decision the project that they making as art project.

The hope of developing topic through these problems is to make students more skilled in solving mathematical problems. They are making several individually project using geogebra application, but only decision one of them to apply in art project as the group project. This activity becomes the experience of students in exchanging ideas and training to work on various forms of mathematical problems. It aims to better understand the concept of mathematical topic in every student. Students can self-correct about topic that has been understood and topic that is not understood.

2.4 Syntax of the STEAM Learning Model

The STEAM learning model has six step to creating a STEAM centered classroom, as follows :

a. Focus

In this step, we choose important questions to answer or problems to solve. It's important to have a clear focus on how these questions or issues relate to your chosen STEM and Art content field.

b. Detail

During the detail phase, you look for elements that contribute to a problem or question. When you observe correlations with other fields or why the problem exists, you begin to find into a lot of background information, skills, or processes that students already have to answer those questions.

c. Discovery

Discovery is about active research and deliberate teaching. In this step, students research current solutions, as well as what doesn't work based on existing solutions. As a teacher, you can use this stage to analyze the gaps students may have in a skill or process and to teach those skills or processes explicitly.

d. Application

This is where the fun happens! Once students dive into a problem or question and analyze the current solution as well as what still needs to be addressed, they can begin to create their own solution or composition to the problem. This is where they use the skills, processes, and knowledge taught at the discovery stage and apply them.

e. Presentation

Once students have created their solution or composition, it's time to share it. It is important that the work is presented for feedback and as a way to express based on the student's own perspective around the question or issue at hand. It is also an important opportunity to facilitate feedback and help students learn how to give and receive input.

f. Link

This step closes the loop. Students have the opportunity to reflect on the feedback shared and on their own processes and skills. Based on that reflection, students can revise their work as needed and come up with better solutions.

2.5 Location and Subject Research

This research was carried out in class XII IPA 1 of SMA Negeri 3 Pekanbaru. This research was conducted in the odd semester of 2019/2020 on the subjects of mathematics, which was implemented in line with the implementation of learning in the classroom. The subjects of this study were the students of class XII IPA 1 of SMA Negeri 3 Pekanbaru, amounting to 36 students.

2.6 Research Cycle

Planning Stage consists of creating a Lesson Plan (RPP), learning motivation indicators, an observation sheet of learning activities, and an observation sheet on the ability of students in solving the given problem. The action stage consists of focus, detail, discovery, application, presentation, link. Observations made was the observation process of the implementation of mathematics learning using Science, Technology, Enginering, Art, anda Mathematics (STEAM) learning model. Media of teaching using observation sheet, activity and student motivation sheet. After the data is collected in cycle I, the data was analyzed by the researcher along with the observer, the weaknesses that occur in cycle I set the actions to overcome these deficiencies for the next cycle.

2.7 Research Instruments

Instruments in this class action research are as follows: Lesson Plan (RPP), students' paper test, Observation sheet, teacher activity sheet, field note sheets.

2.8 Data analysis technique

Data Analysis Techniques Motivation and Student Learning achievement:

Average value = (number of observed values) / (ideal number of values) x 100%

Information :

76% - 100% = High Once

56% - 75% = Height

26% - 55% = Low

0% - 25% = Low Once

III. Research and Development Results

3.1 Research Results

Based on the problems in learning, an action has been planned consist of planning, implementation, observation, and reflection, so that students can improve motivation and learning achievement.

3.1.1. Description of Cycle I

All topics and methods that have been used in the work must be stated clearly and subtitles should be used when necessary.

A. The first meeting

The first meeting is held on Monday, September 2 2019. At the beginning of learning the teacher conveys the learning objectives on the subject volume by rotating an area so that students can to solve problems related to volume by rotating an area.

As an apperception at the beginning of the focus stage, the teacher gives several questions related to the concept volume by rotating an area. At the development stage, the teacher forms students' learning groups into 3 groups where each group consists of 12 students. Each group was given questions and each group worked on the problems by first doing a literacy process related to the questions given. Literacy can be as diverse as book literacy or website literacy by searching on the internet using each student's mobile phone. The teacher acts as a facilitator in learning activities and monitors the discussion. The detail dan discovery stage are doing here. The teacher provides guidance to groups who have difficulty in carrying out procedures for solving the given problem.

After completing the questions the students are directed to arrange each answer about the questions given and present the results of group work in front of the class. The presentations are conducted by several groups and the teacher acts as a facilitator if there are mistakes in the concepts conveyed by students.

After completing the questions in groups, the teacher gives seatwork to students in the form of questions to be done individually as a stabilization for students in working on various kinds of problems related to volume by rotating an area. The teacher provides guidance to students in order to build discipline in working on problems individually. The teacher explain about geogebra application to help te student understanding volume by rotating an area topic.

In the closing stage, students are asked to summarize and make important notes of learning activities and the teacher provides exercises geogebra application to do at home so that students better understand the subject matter that is given.

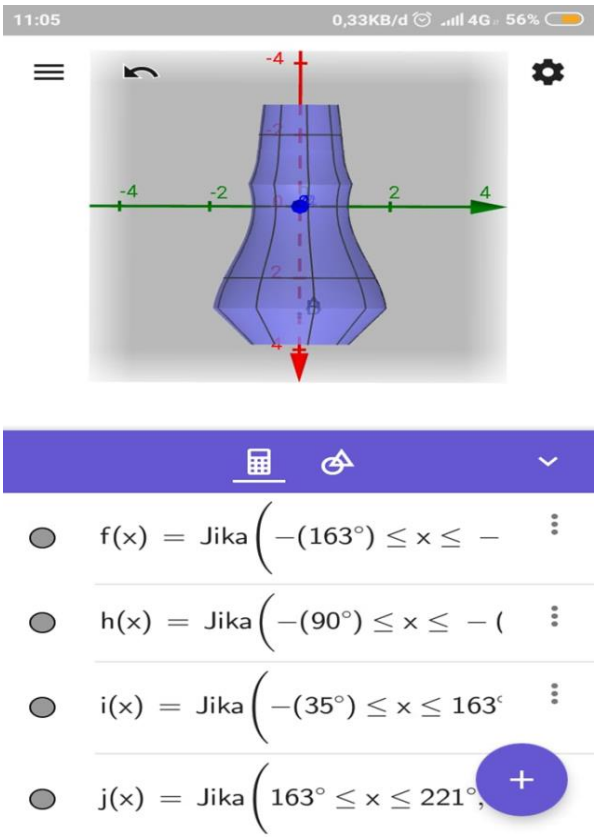

Fig. 2. Geogebra Aplication that the student create individually 1

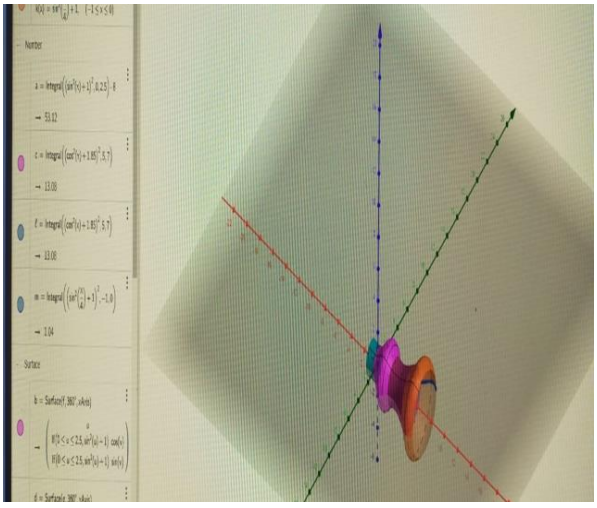

Fig. 3. Geogebra Aplication that the student create individually 2

B. Second meeting

The second meeting was held on Friday, September 6, 2019. At the beginning of the meeting the teacher said that students would learn about solving the problem of the volume by rotating an area and learning objectives on that day. As an apperception, the teacher appoints several students to make the homework results that have been given.

C. Student Learning Achievement

Student learning Achievement in this study were seen from the score of understanding of mathematical concepts in the test carried out at the end of the first cycle, the assessment was carried out in accordance with

the criteria and scale specified. Learning Achievement of students in the first cycle can be seen in the table below:

TABLE II. STUDENT LEARNING ACHIEVEMENT IN MATHEMATICS LEARNING USING STEAM MODEL CYCLE I

Category	Number of Students	%	Completed
Score ≥ 75	18	50,00	Completed
Score < 75	18	50,00	Not Completed

D. Reflection

In the reflection stage, various obstacles and problems encountered during the first cycle were collected, the alleged causes of the obstacles were then analyzed and a solution was found so that improvements were made in cycle 2.

3.1.2. Description of cycle II

To carry out learning that has been prepared, it is necessary to pay attention to the presentation of topic that is appropriate to student development. The implementation in cycle II corrects the weaknesses and shortcomings that occur in cycle I. In the implementation of this cycle II action the activities that are focused on the group project that they decision to apply with plasticine art. After the group finish their project. The group compare the result volume by rotating an area between geogebra application with manually counting. The result of activities was more focused on improvements to the weaknesses identified in cycle I. Cycle II consisted of two meetings, after two meetings a cycle II test was held. To optimize learning Achievement in cycle II the following activities will be carried out:

A. The first meeting

The first meeting in the second cycle was held on Monday, Oktober 7, 2019. At this meeting the teacher reminded that the learning to be carried out that took place was still using the STEAM model and asked students to concentrate and discipline in carrying out learning activities.

Fig. 4. Student presentation STEAM model learning

Fig. 5. Student making the art project

B. Second meeting

The second meeting was held on Friday, Oktober 11, 2019. Based on observations at the second meeting, the teacher's activities applying the STEAM model by incorporating elements of high order thinking were carried out according to plan. Activities of students in the question and answer experience increased because students have understood the topic provided through the method used. For the activities of practicing the steps STEAM has increased and the presentation of the work by students has increased because students have begun to understand about STEAM model learning. The student can see the real object that they make together with group and they are understand how to to compare the volume by rotating an area manually and using geogebra aplication.

Fig. 6. One of The group student art project

Fig. 7. Geogebra Aplication and the art project

C. Student Learning Achievement

Student learning Achievement in this study were seen from the score of understanding of mathematical concepts in the test carried out at the end of the second cycle. the assessment is carried out according to the criteria and scale specified. Learning Achievement of students in the second cycle can be seen in the table below:

TABLE III. STUDENT LEARNING ACHIEVEMENT IN MATHEMATICS LEARNING USING STEAM CYCLE II MODEL

Category	Number of Students	%	Completed
Score ≥ 75	27	75	Completed
Score < 75	9	25	Not Completed

During the second cycle of learning, gradually the level of understanding of students' concepts increases marked by an increase in the ability of students to analyze the concepts of volume by rotating an areas.

Fig. 8. Geogebra Aplication making individually

D. Reflection

In the reflection stage, various obstacles and problems encountered during the second cycle were collected, the alleged causes of the obstacles and the chosen solution.When reflecting, the researcher uses the reflection guidelines as listed in the appendix. From the results of the study, it can be concluded that the motivation and learning Achievementof students have increased. Activities and learning Achievement of students have reached the criteria determined in this study so that research can be stopped.

As one of the learning models of the many existing learning models Science, Technology, Enginering, Art, anda Mathematics (STEAM) of learning models places the teacher as a facilitator, the teacher guides students where needed. In this method students are encouraged to solve their own problems, analyze themselves so they can find a concept and solve problems that have been given by the teacher individually or in groups.

The teacher as a facilitator helps students to have the character of discipline to think at a high level, namely to think critically and creatively in order to understand the concepts and skills that students have previously had to gain new knowledge. Thus increasing learning activities and is expected to ultimately improve student learning Achievement.

3.2 Discussion

A. Student Learning Activities

Increased student activity in cycles I and II can be seen in the following table:

TABLE IV. COMPARISON OF STUDENT ACTIVITIES IN THE LEARNING PROCESS WITH STEAM MODEL CYCLE I AND CYCLE II

No	Learning Activities	cycle I (%)	cycle II (%)	Increasing (%)
1	Questions and answers between students and between students and teachers	70,00	86,00	16,00
2	Work on and discuss the worksheets given in groups	80,00	86,00	6,00
3	Practicing the STEAM model in the learning process	86,00	91.67	5,67
4	Presenting the results of group work in front of the class	80,00	100,00	20
5	Work on questions independently with discipline	70,00	86,00	16,00
6	Concluding the subject matter	80,00	91,67	11,67

Based on cycle I reflection and cycle II reflection it can be seen that there has been an increase in students' mathematics learning activities and Achievement in learning to apply the STEAM model. In the activity concluded the subject matter with the teacher during the learning process continued to increase. Even at the end of learning using the STEAM model, almost all students were involved in inferring the topic.

B. Student Learning Achievement

In addition to knowing the increase in learning activities of students, in this study also saw an increase in student learning Achievement seen from the ability to understand mathematical concepts of students. Following this, a discussion of student learning Achievement, carried out in cycles I and II.

TABLE V. COMPARISON OF STUDENT LEARNING ACHIEVEMENT IN THE

Category	Number of Students		Persentase		Completed
	Cycle I	*Cycle II*	*Cycle I*	*Cycle II*	
Score ≥ 75	18	27	50,00	75,00	Completed
Score < 75	18	9	50,00	25,00	Not Completed

LEARNING PROCESS WITH STEAM MODEL CYCLE I AND CYCLE II

In accordance with the appendix about the recapitulation of student learning Achievement, it is also known that the learning Achievement of students in the first cycle reached an average of 50,00% and in the second cycle reached 75%. This illustrates that most of the students have obtained learning Achievement above the KKM. Improved learning Achievement can also be seen from the following graph:

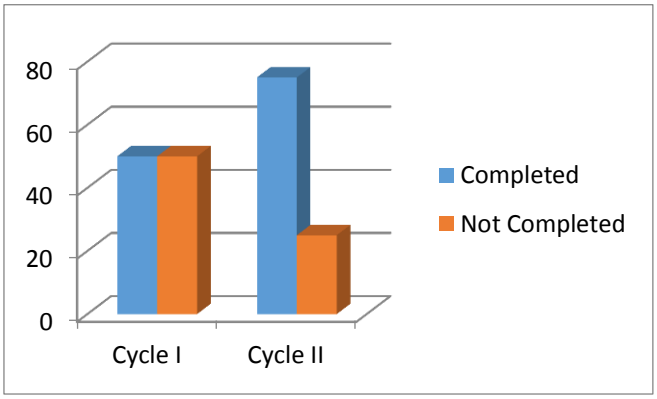

Fig. 9. Percentage of Student Learning Achievement

Increased student learning Achievement, seen from the better ability of students to define, identify concepts, recognize the correct calculation procedures and understanding comparasion volume by rotating area between using geogebra aplication and counting manually from the results of group work. However, the ability of students according to the criteria for understanding the concept is still sharpened again so that students are accustomed to understanding the concepts of mathematics.

IV. CONCLUSION

4.1 Conclusion

The result of research by applying high order thinking skills using Science, Technology, Enginering, Art, anda Mathematics (STEAM) of learning models in the mathematics subject volume by rotating an area in class XII IPA 1 SMA NEGERI 3 PEKANBARU TP. 2019/2020, the following conclusions are obtained.

a. The application of the learning models Science, Technology, Enginering, Art, and Mathematics (STEAM) can improve the learning activities of students in class XII IPA 1 of SMA Negeri 3 Pekanbaru on the topic volume by rotating an area. Student activities have increased from cycle I to cycle II. on the six indicators observed namely working on and teach other, practicing the steps of the STEAM model, presenting the results, working on the questions individually, concluding the topic with the teacher.

b. The application of the STEAM model and high order thinking can improve the learning Achievement of students in class XII IPA 1 SMA NEGERI 3 PEKANBARU on the topic volume by rotating an area. In the first cycle, the number of students who completed reached 18 people or 50 percent, and in the second cycle the number of students who completed increased to 27 people or 75 percent.

4.2. Suggestions

Based on the results of research conducted in class XII IPA 1 SMA NEGERI 3 PEKANBARU on TP. 2019/2020, suggestions can be made as follows:

1. In applying learning with the STEAM model, teachers should make careful planning so that learning runs systematically. Careful planning makes effective use of time.
2. To guide students to make discoveries, teachers are advised to make questions that require students to think at a high order thinking to lure students to find the right answer.
3. Learning with high order thinking skills using the STEAM model can improve the motivation and learning Achievement of students in class XII IPA 1 SMA NEGERI 3 PEKANBARU on the volume by rotating an area topic. For further researchers who want to conduct research using character education with high order thinking skills using the STEAM model, it is advisable to first socialize the methods to be used with students. Further researchers are advised to provide new innovations so that the geogebra application using the STEAM model becomes more familiar to students.

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