

The Effectiveness of STEAM (Science, Technology, Engineering, Art, and Math) to Improve Students' Achievement in Electrochemistry

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Abstract

This research have goals to determine the increase in student learning outcomes using STEAM learning is better than improving student learning outcomes using direct instructions in Electrochemistry Before treatment, 25 pretest questions were given . Then given a different treatment, the experimental class studied using STEAM learning and the control class studied with direct instructions. After the treatment given a post-test. In the pretest, the experimental class average was 40.11 and in the control class was 39.11. In the post-test, the experimental class was 83 and the control class was 75.40. The effectiveness of STEAM learning is 25% compared to Direct Instructions. The conclusion of this research is learning outcomes using STEAM learning are better than Direct Instructions. The difference in student learning outcomes using STEAM with student learning outcomes using the lecture method is 19%.

Keywords:

STEAM, Students Achievement, Electrochemistry.

1. Introduction

Since the future of the country and the next generation are actually the responsibility of the teacher, they must pay attention to the requests and expectations of the community for education. It is the responsibility of the teacher to educate students, so they must be able to instill in them important life lessons. Science and technology

skills are imparted to students by their teachers. Students may receive training from their teachers. Learning is an activity to acquire knowledge, skills, improve behavior, attitudes and change personality towards a better direction. Learning is a system consisting of components such as: objectives, materials, methods and evaluation which are interrelated.

Education now requires schools to produce students not only cognitively smart, but also have skill. As time goes by, this increasingly rapid technological development has changed the way we communicate, also with the way the teacher carries out the learning process. We cannot deny that education plays a crucial role in preparing students to have 21st-century skills in the globalized and rapidly changing world of today. Students frequently have more information than teachers do. Therefore teachers are required to follow the latest developments both regarding strategies, approaches or methods in the learning process.

Chemistry as part of science is an important and inseparable science in life (Herlina, 2022). Chemistry is one of the lessons that requires skills in solving chemistry problems in theories, concepts, laws, and facts. One of the goals of learning chemistry in senior high school is for students to understand chemical concepts and their interrelationships and their application in both everyday life and technology. To achieve this goal, professional teachers are needed, can grow and increase student learning motivation, so that they are not bored with the learning process. Teachers should be able to encourage students to learn by utilizing their

potential optimally (Nurfadilah & Siswanto, 2020).

In learning chemistry, students have difficulties. One of them is the abstract concept of chemistry, many difficult terms to understand, teacher-centered learning, and the inability to link one concept to another or to a relevant context. (Ridwan et al., 2021) Chemistry is abstract matter. We learning about knowledge in around of us that cannot we see directly (Nurfadilah & Siswanto, 2020). As chemical educators, we may find some comfort in knowing that many of the same questions about teaching and learning that vex us today also vexed our predecessors. Looking back at discussions of pedagogy from an earlier time is not to seek specific answers but rather to see how others have answered such questions to their own satisfaction (Rice, 2002).

STEM is an approach to learning that is integrated with various disciplines. STEM enables students to learn academic concepts appropriately by applying 4 disciplines (science, technology, engineering and mathematics). STEM has several characteristics including technology-based, performance-based, inquiry-

based, and problem-based learning (Susanti et al., 2018). The STEM approach is a way to unify science and engineering as well as a combination of strategy and implementation of concept formation and application of ideas from science learning. The STEM learning approach can be used to educational problems in Indonesia. Learning with the STEM approach integrates these four components by focusing on solving real problems in everyday life. Through the STEM approach, the learning process will go through the application and practice of the basic STEM content in real-life situations, not only discussing science, but linking it to technology, engineering and mathematics (Pujiati, 2020).

There is a slight difference with STEM, STEAM have a new term as "A" for art. So, STEAM is standing for science, technology, engineering, art and mathematics. The STEAM approach can link to learn chemistry. This can be done by giving projects to students in working groups. In this case students can actively interact and explore in their groups so that students can observe the phenomena that occur around them in the form of facts (Nurfadilah & Siswanto, 2020). STEAM as a integration project based learning is a learning innovation that involves aspects needed to support students'

science process skills. The new focus in the world of education requires the application of these aspects in learning activities (Suryaningsih, 2021).

Based on this description, the researchers conducted research to know how the effectiveness of STEAM learning (science, technique, engineering, art, and mathematics) affected students' achievement in electrochemistry.

2. Methodology

2.1 Time and Location

This study was carried out at the public high school in Batang Angkola, North Sumatra, Indonesia. In the 12th grade, this research was done.

2.2 Population dan Sample

Population of the research is all of students in 12th grades in public high school in Batang Angkola, North Sumatra, Indonesia. The population consist of four classes of 12th grade. The sample of this reseacrh is class A as experiment class and class B as control class. Total sample become 70 students, 35 students for each class.

2.3 Research Design

In this research, the experimental class was given learning treatment using STEAM learning and the control class was given learning treatment using direct instruction. Before being given treatment, both classes were

given a pretest to find out their initial knowledge about the electrochemistry topic. After getting the pretest data, the control class was given lecture method learning and the experimental class was given STEAM learning. After that, a post-test was given in both classes. From the post-test obtained the final

data on learning outcomes. The data will be analyzed and after we analyze it, we can conclude the research results. The image (see figure 1) below depicts the full research design.

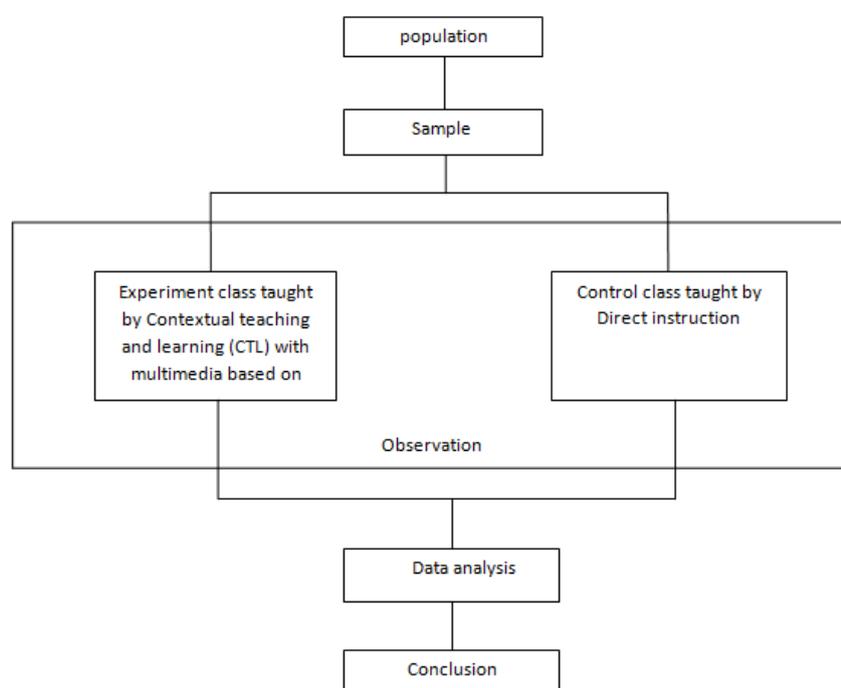


Figure 1. Research Procedure

2.4 Research Instrument

Research instrument for this treatment is 25 question multiple choice with 5 option for Pretest and Post-test.

2.5 Data Analyze

Normalized Gain

Normalized gain is for measure the effectiveness.

Improved chemistry student learning outcomes for each class is calculate using equation:

$$g = \frac{\text{posttest score} - \text{pretest score}}{\text{maximum score} - \text{pretest score}} \times 100\%$$

Student's achievement

Improving of effectiveness student's achievement calculated with formula:

$$\text{Score} = \frac{\text{gain experiment} - \text{gain posttest}}{\text{gain experiment}} \times 100 \%$$

3. Result And Discussion

Based pretest and post-test, we got data of research in experiment class and control class and gain of data.

3.1 Result of Experiment Class

In experiment class, we use the STEAM approach to learning to administer a pretest and treatment. Furthermore, following the treatment, we administered a post-test using the same electrochemistry material, and the results are shown below (Table 1).

Table. 1 Result of Experiment Class

No.	Note	Pretest	Post-test
1	Range	40.11	83
2	Deviation Standard	7.92	7.75
3	N	35	35
4	Maximum	50	90
5	Minimum	20	65

Based on the table, we obtained the following results in the experiment class: range in the experiment class, pretest 40.1, and post-test 83, with a total of 35 students. For the standard deviation in experiment class, the score in the pretest is 7.92 and, in the post-test, 7.75. The maximum score in the pretest is 50, and the maximum score in the post-test is 90. The post-test score is 65, and the minimum score is 20.

3.2 Result of Control Class

In the experiment class, we administered the pretest and provided clear instructions for the treatment; following the treatment, we administered the post-test using the same electrochemistry material, and the results are shown in the table below.

Table. 2 Result of Control class

No.	Note	Pretest	Post-test
1	Range	39.11	75,40
2	Deviation Standard	7.99	7.74
3	N	35	35
4	Maximum	50	75
5	Minimum	20	50

Based on Table 2, in the experiment class, we got results that ranged in the control class from a pretest score of 39.11 to a post-test score of 75.40 with 35 students in total. The standard deviation in the control class in the pretest is 7.99 and in the post-test is 7.74. For a minimum score of 20 and a post-test score of 50, the maximum score in the pretest is 50 and the maximum score in the post-test is 75.

We can infer from the data that the post-test score for the experiment class is higher than for the control class. The achievements of students in electrochemistry that are given to treat

STEAM learning are superior to those given by direct instruction to make students understand chemistry topics, especially electrochemistry.

3.3 Data of Gain

We obtained gain data from the pretest and post-test analyses, as shown in the table below.

Table 3. Data Gain

No.	Note	Experiment	Control
1	Range	0.71	0.55
2	Deviation Standard	0.13	0.14
3	N	35	35
4	Maximum	0.93	0.81
5	Minimum	0.43	0.16

The results were as follows Tabel 3: with a total of 90 students, the experimental class had an average data acquisition of 0.71, while the control class's average was 0.55. The maximum score is 0.93 in the experimental class and 0.81 in the control class, while the standard deviation is 0.13 in the experimental class and 1.14 in the control class. Data obtained for the minimum value show that the experimental class received 0.43 and the control class received 0.16.

Based on the figure 2, students achievement in experiment class higher than control class. And effectiveness of STEAM Learning in Electrochemistry is 25 %.

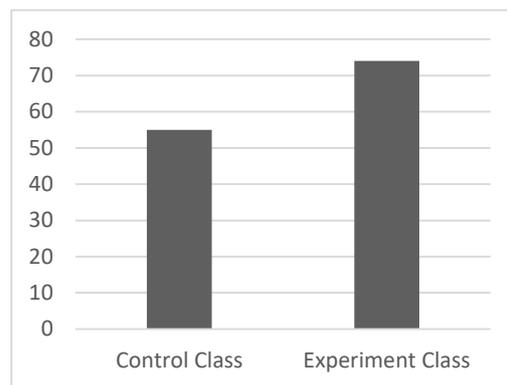


Figure 2. Presentation of Research Result

3.4 Discussion

To analyze the data, using SPSS 18, the calculation of student learning achievement was obtained from the pretest and post-test. In the pretest, the average pretest in the experimental class was 40.11 and in the control class was 39.11. This means that the initial knowledge of the two classes is almost the same. After being given different learning treatments in both classes, at the end of the meeting the post-test data were given. The experimental class is 83 and the control class is 75.40. and the comparison based on the acquisition of experimental and control pretest and post-test data is 74% and 55%. The effectiveness of STEAM learning on student learning outcomes in electrochemistry compared to student achievement taught by direct instructions is 25%.

In the research, the application of the STEAM approach to the electrochemistry topic is significantly

better than direct instruction. In the experiment class, we received scores ranging from 60 to 90. It means that the student's achievement has increased in this topic. In the control class, students' achievement was from 50 to 75, there is an increase in achievement but not higher than experiment class.

4. Conclusion

Based on the results above, it can be concluded that the learning achievement of students taught by STEAM-based learning is better than the learning achievement of students taught by the lecture method with a sig hypothesis of 0.000. So, the effectiveness of student achievement taught by STEAM-based learning is 25% compared to the learning achievement of students taught by the lecture method.

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