Science Technology Society (STS) learning approach: an effort to improve students’ learning outcomes

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Abstract. The aim of this study was to examine the differences of students’ cognitive learning outcomes on chemical equilibrium topic through the Science Technology Society (STS) learning approach. Design of this study was quasi-experimental. Specifically, posttest only group design was adopted. The number of sample in this study are 60 students 11th grade. Selection of the sample conducted with a purposive sampling technique. The experimental group was taught by the STS approach, while the control group was scientific approach. The instrument for data collection was chemistry achievement multiple choice questions. Instrument test shows 23 out of 30 questions created were valid. The reliability value obtained was 0.73. Data was collected using the test in the form of score, and analyzed by the t-test. This research concluded that students who were taught Science Technology Society (STS) approaches have better cognitive learning outcomes than the control group. These results suggest the implication of the STS approach can be used as a learning approach to improve students’ cognitive learning outcomes.

1. Introduction
The impact of the rapid change in society to education is that education should prepare generation to have a certain skill needed by the society. These skills are called 21st century skills. Partnership for 21st Century Skills has developed consist of life and career skills, learning and innovation skills, and information media and technology skills [1]. The results of 21st century science and technology developments are widely used for the benefit of society and bring impact to every aspect of life, both positive and negative impacts on the environment and society. To be able to interpret the impact of technological development as a result of the development of science and technology, students need to understand the concept of science itself, which can be measured through student learning outcomes. Learning outcome is part of the learning activities. Essentially, students’ learning outcomes are defined as behavioral changes in the cognitive, affective, and psychomotor fields. The dimensions of revised Bloom’s taxonomy that has several levels: Remember, Understand, Apply, Analyze, Evaluate, and Create [2]. The main indicator in determining the cognitive learning outcomes of students is the achievement of students’ absorption of learning materials taught, either individually or in groups. Measurement of students’ cognitive learning outcomes is usually done by determination of Minimum Learning Competence Criteria. Banarjee and Vidyapati [3] mentioned that the achievement of students’ cognitive learning outcomes influenced by the approach and learning method used. Selection...
of appropriate approaches and methods of learning can affect the improvement and development of knowledge received by students in learning chemistry. Chemical equilibrium, one of the materials learned by XI grade students, is a concept that needs to be studied in a definite, concrete way that requires understanding of macroscopic, submicroscopic, symbolic phenomena and the connectedness of all levels [4]. In the science learning, STS approach is an integrated between science, technology, and society. Social and technological issues are key characteristics of the STS learning approach. Through the STS learning approach, students learn science in the context of real experience [5]. Through the STS approach, students will be learned through phenomena or cases that occur in the community, which is an implication of science and technology.

![Figure 1. The correlation between mutual elements of science, technology, and society [6].](image)

STS learning approach based on constructivism theory that emphasizes the development of the concept in cognitive structure independently by students. The learning approach emphasizes that students can think, assess, solve problems, and make decisions. The constructivist foundation of STS is an advantage that can equip students to face the challenges of competition in the 21st century. The STS learning approach requires that students be included in setting, planning, implementing, how to obtain information, and evaluation of learning. The principle of learning STS is a discussion of issues in society related to science and technology, so that issue in the community is the organizer in learning STS. The implementation of the STS learning approach is aimed at engaging students in problem-solving activities they have identified. Students focus on problems and questions related to problems in the environment and daily life [1]. To be able to interpret the impact of science and technology, students need to understand the concept of science itself, which can be measured through student learning outcomes. Therefore, the aims of this study was to examine the effect of Science Technology Society (STS) learning approaches towards students’ learning outcomes on chemical equilibrium subject.

2. Method
Design of this study was quasi-experimental. Specifically, posttest only group design was adopted. The study was carried out with 60 students with two groups: 30 students in the experiment group, and 30 students in the control group. Purposive sampling technique was used. The experimental design considered of chemistry learning hours in each class, and the average test score were almost the same. The independent variable of this research is the STS learning approach and dependent variable is students’ cognitive learning outcomes. The instrument for data collection was chemistry achievement test which has developed by researcher. The empirical validity test of the research instrument was conducted on 60 students of XII Science grade. Learning activities in the experiment class were carried out by group discussion methods using STS learning approach phase and STS-related worksheet. In the control class, learning activities were carried out by class discussion using the scientific approach learning phase.
Table 1. Number of questions.

| Chemical Equilibrium Subject | Cognitive dimension | Question Number |
|------------------------------|---------------------|-----------------|
|                              | C₁                  | C₂              | C₃   | C₄, C₅, C₆ |
| Reversible-irreversible reaction |                     | 2               |      |             |
| Concentration effect         |                     |                 | 24, 29|             |
| Volume effect                |                     |                 | 23, 25, 27, |             |
| Pressure effect              |                     |                 | 26, 28, |             |
| Temperature effect           |                     |                 | 21, 22|             |
| Catalysis effect             |                     | 30              |      |             |
| Shift equilibrium            |                     |                 | 7    |             |
| Equilibrium constant         |                     | 6               |      |             |
| The value of the equilibrium constant |                 | 8, 9, 12, 13, 14, | 15  |
| Substance composition        |                     | 16              |      |             |
| Dissociation degree          |                     |                 |      |             |

The results of the instrument test show 23 out of 30 questions created were valid; each item had 5 options. The reliability value obtained KR-20 measurement was 0.73. This value indicates that the multiple choice relative categories used to measure students’ cognitive learning outcomes have the good reliability. The hypothesis of this study is: there is a differences of students’ cognitive learning outcomes on chemical equilibrium topic through the Science Technology Society (STS) learning approach.

3. Results

The aim of this study was to examine the differences of students’ cognitive learning outcomes on chemical equilibrium topic through the Science Technology Society (STS) learning approach. Posttest data was collected for the analysis using t-test. However, prior to the t-test, a statistical prerequisite analysis is required normality data using the Kolmogorov-Smirnov test and the homogeneity data by Levene’s test. The t-test can be tested if the data obtained to normal and homogen distributed. After the prerequisite analysis, the posttest data was analyzed by using t-test to determine the effect of STS learning on cognitive learning outcomes. The test criteria was normally distributed populations if the probability of significance value (p>0.05). Then, the criterion on experiment class and control group variance is homogeneous if the probability of significance value (p>0.05).

Table 2. Normality Test Result

|                       | Experiment Group | Control Group |
|-----------------------|------------------|---------------|
| Sig.                  | Result           | Sig.          | Result          |
| Normality Test        | 0.123            | Normal        | 0.200           | Normal         |

Based on the above table it can be seen that the significance value of the normality calculation results for each class is greater than the significance value (α=0.05). It means that the data comes from normally distributed populations.

Table 3. Homogenity Test Result

|                  | F     | df₁ | df₂ | Sig. | Result |
|------------------|-------|-----|-----|------|--------|
| Homogenity Test  | 2.815 | 1   | 58  | 0.143| Homogen|

For the homogenity test can be seen that the value of significance obtained was 0.143 greater than the significance value (α=0.05) it means that the data was homogen. Assumptions for parametric statistical tests can be done. Independent sample t-test conducted to analyze there was a difference on students’ cognitive learning outcomes.
Table 4. t-test Result

| Group                  | Sig.   | Result |
|------------------------|--------|--------|
| Experiment and Control | 0.002  | Different |

According to the result of paired sample t-test, shown by the value of significance (2-tailed) (0.002) was less than 0.05. It means there was a difference on students’ cognitive learning outcomes between experimental group and control group. Descriptive analysis was conducted to describe the students’ cognitive learning outcomes.

Table 5. Descriptive Analysis of Students’ Cognitive Learning Outcomes

|                      | Experiment Group | Control Group |
|----------------------|------------------|---------------|
| Mean                 | 69.153           | 63.4727       |
| Median               | 69.56            | 65.21         |
| Maximum Score        | 82.60            | 78.26         |
| Minimum Score        | 56.52            | 47.82         |

According to descriptive analysis, experiment group has a higher average score than control group. As seen on the table above, it was understood that experiment group has higher average on cognitive learning outcomes (69.41) than control group (63.47).

4. **Discussions**

The aim of this study was to examine the differences of students’ cognitive learning outcomes on chemical equilibrium topics through the Science Technology Society (STS) learning approach. As one part of science, the topic of learning chemical equilibrium also contributes to everyday activities and industry to produce optimal products. Through the chemical equilibrium, students can understand every phenomenon scientifically [9]. However, chemical equilibrium is a material that is considered difficult by students. This is related to the level of breadth and depth of material that is quite high. This topic includes abstract concept and definitions of concepts, graph and mathematical calculations [4].

The STS approach is chosen with the consideration that learning with the STS approach is capable of developing cognitive, affective, and psychomotor abilities that are fully formed from within the student, through constructivist activities [5]. While the scientific approach used in the control class, chosen because the approach is a learning approach used by chemistry teachers in schools.

In the experimental class, every meeting is always presented a case or phenomenon and problems of everyday life in a worksheet that will be done in groups by students. Giving life phenomena related to chemical equilibrium is a major component in learning with an STS approach. Students are divided into several groups in each learning activity. Each group consists of 4 to 5 people. The concept of forming a learning group is based on the idea that joint learning will be better than individual learning. Problem solving of the given phenomenon will be more effective if solved in groups. Through group learning, students convey their thoughts, discussions, and exchange ideas that can eventually construct an understanding of new knowledge about the given phenomenon. Each student is given the opportunity to talk and share ideas, listen to ideas from other students carefully, and work together to build knowledge with friends in their group. STS learning approach in this research consists of several phase [7]:

1. invitation, to invite students to formulate problems through the everyday issues/phenomena that focus students into the material
2. exploration, to invite students to explore their understanding to build knowledge as the formation of the concept
3. explanation or application of concepts, to encouraging students to apply the concepts learned as problem solving through worksheets that have phenomena in the community as a plot of consolidation of concepts
4. follow-up, to encouraging students to establish concepts through the delivery of discussion results and assessment/evaluation.

At the invitation stage there is presented a everyday phenomenon or problem that related to equilibrium material. Problems are presented in the form of figure. Then student asked to present the proposed problems and form their own concept before the presentation. The second stage of the STS learning approach is exploration or concept formation. At this stage, students are invited to explore information from various learning sources to understand concepts related to the material being taught. Students use their understanding to answer the questions given on the worksheet. The third stage is explanation or application of the concept, at this stage the researcher gives an article related to the existing problems and their impact on the environment. Then students are required to display data, analyze data, and provide solutions from the side of modern and conventional technologies that are considered to be used, and what decisions can be taken to solve the problems. The final stages of STS is follow-up, that has been done by assessment and evaluation, asking each group to present their discussion result. At the fifth meeting, a posttest activity was conducted.

The result of the analysis shows that the learning approach of STS gave the better results on the students’ cognitive learning outcomes. In the experimental class that was taught by the STS approach the average score of students for the cognitive learning outcomes was 69.41 whereas in the control class that was studied with the scientific approach the average score of students for cognitive learning outcome was 63.47. When viewed from the acquisition of the average value on the measured variable, it appears that the experimental class taught by the STS approach has a higher mean value, on the cognitive learning outcomes. The results of this study in accordance that the STS learning approach can improve students’ concept of science [8]. The one indicator of cognitive learning outcomes achievement of students is about mastering the concept of science itself. Yager [7] state that mastering the concept of science by student is the main indicator of students’ cognitive learning outcomes. In addition, differences in the design of the STS learning approach and the scientific approach give different results to the variables measured. Learning with the STS approach helps students develop cognitive, affective, and psychomotor abilities that are fully formed from within the student [5]. In the implementation of STS learning approach, students are required to be active, not only physically active but also intellectually. Activities that support the cognitive domain is at the stage of invitation with the emergence of issues of phenomena that occur in everyday life. For example, at the first meeting, the stage of invitation arised through the phenomenon of water in a closed bottle that requires students to think critically and act scientifically in response to the phenomenon, as well as its relation to the chemical equilibrium concept. Then, the stage of formation and application of concepts, students are invited to solve problems given in an article, based on the consideration of the impact on the environment and the use of existing technology to solve the problem, thus helping students to develop the concept in their cognitive structure independently, theory of constructivism [5]. In addition, STS learning emphasizes that students can think, assess, solve problems, and make decisions. Students interpret and constructing the concept itself, so that their understanding was increase. STS learning approach focuses on solving problems and thinking processes that involve transfers concept by applying the concepts that learned at schools to the real sitation in society. Each STS aproach stages will strengthen the students’ concepts about the material concept deliver. So that, the maximum learning outcomes can be obtained. The STS learning approach can improve the mastery of concepts because STS learning encourages and motivates students to more deeply want to know the material learned, their impact on the environment, and to give students the freedom to express their ideas in the learning process, so that students feel actively involved to construct knowledge it has.

Whereas in the control group, learning activities carried out with the scientific approach as an adjustment to what is usually done by teachers in research schools. The results of the analysis show the average value of students' cognitive learning outcomes in the experimental class is higher than the average value of the control class students. The results of this study are in accordance with research conducted by Akcay & Akcuy [8] that the STS learning approach is able to improve the understanding and mastery of the concepts of science of students. Through the phenomena presented in students'
worksheets, it will generate questions from the students themselves, meaning growing curiosity. This allows students to make the knowledge they learn more meaningful. Learners shape their understanding of the problems given, and suggest possible explanations for solutions based on the initial concepts they already have and their new knowledge. The difference in the students cognitive outcomes on the differences learning approach used in this study does not mean that one of the learning approaches cannot provide a better result on cognitive learning outcomes. Theoretically, the two learning approaches used in this study were able to increase the two measured variables. The scientific approach is also actually a good learning approach. The application of the scientific approach to learning activities provides high cognitive dimension learning outcomes and the highest learning outcomes. That is, the scientific approach can also increase motivation, curiosity and self-confidence of students who are supporting cognitive learning outcomes. In addition, the five phases of scientific learning, namely observing, questioning, gathering information, associating, and communicating can train students to think critically so as to increase learning outcomes. Science teachers can use the potential of the environment/agriculture as a learning instrument developed for the learning process of certain science topics. This can support the effectiveness of learning based on the scientific approach to students' cognitive learning outcomes, so that students can understand the concept of science learning in school in real terms [10].

5. Conclusion
The aim of this study was to examine the differences of students’ cognitive learning outcomes on chemical equilibrium topic through the Science Technology Society (STS) learning approaches. The result of t-test shows that there is the differences on students’ cognitive learning outcomes, between the students on experimental class and control class. Students on the experimental class who were taught by the STS approach had a high average score when compared to the control class. Learning with the STS approach helps students develop cognitive, affective, and psychomotor abilities that are fully formed from within the student. In the implementation of STS learning approach, students are required to be active. Activities that support the cognitive domain at the stage of invitation with the emergence of issues of phenomena that occur in everyday life. These results suggest the implications of the STS approach can be used as a learning approach to improve student cognitive learning outcomes.

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