Science generic skills of ‘chemistry’? prospective teachers: A study on collaborative learning using Exe-media

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Abstract. Collaborative learning is a learning model that guides students to gather ideas and data to solve common problems. In this study, collaborative learning was integrated with Exe-media on reaction rate and salt hydrolysis to improve prospective teacher generic science skills. Specifically, this study aims to investigate Exe-media effectiveness to improve prospective teacher generic science skill. This study employed methods of a quasi experiment with a nonequivalent control group design. The subject of this research are prospective teachers of class Kim'B as experiment class and Kim'C as control class of Department of Chemistry Education, Faculty of Mathematic and Natural Science, Universitas Negeri Medan. Experiment class received treatment in form of learning used collaborative learning using Exe-media. Control class received treatment in form of learning used conventional model using power point as media. Data was collected through pretest and posttest results from prospective teacher in both classes. A t-test was used and it is found that level of significance is 0.002 (sig. < 0.05) proving that collaborative learning using Exe-media is effective to improve prospective teachers’ generic science skill.

1. Introduction
The Indonesian National Qualifications Framework (KKNI) based learning process is expected to be a solution in order to develop a better learning process in Indonesia. Because of this goal, the improvement of human quality resources must be a top priority, especially the teachers or prospective teacher who will be the main foundation in the learning process so that the goal of improving can be achieved as expected. In order to improve the quality of prospective teacher, many studies have been conducted which aim to hone the ability of teachers candidate so that later they become teachers who can help their students to better understand the essence of what they are learning so that learning becomes more beneficial for students. One of the capabilities that must be owned by students in the process of learning science is generic skills.

Learning science substantially has several aspects: equality between processes and products, actively taking part in investigations, the ability to think inductively and deductively, and enhancing behavior [18], [19]. Science is a human discipline for understanding nature through proper observation of goals, together with using procedures and explaining logically to get conclusions [25]. Science is a part of knowledge about nature that produces bright visions, ideas, intellectuals, and insights, but...
nowadays, science is not only part of knowledge, but also a way of discovery or scientific method [10].

Collaborative learning is a study model that guides students to gather ideas and data to solve common problems [4]. Learning with collaborative emphasized the thought thinking process skills [13], [14]. Collaborative learning enhances students’ critical thinking [7] and creative thinking [4]. Besides, the aid of using collaborative learning consist of: (1) expansion of higher-level thinking, verbal communication, self-management, and leadership skill; (2) encouragement of students interplay; (3) escalate in students conservation, self-esteem, and commitment; (4) exposure to and an upgrading in understanding of disparate perspectives; and (5) arrangement for real life and employment circumstances [4], [14], [18].

Audio visual is a media that involves the sense of hearing and vision in one process. Nature reservations that can be sent through the media are in the form of verbal and non-verbal messages. Reservations that are heard and seen can be presented through audio-visual programs such as films, videos, and television [17]. Video technology can help teachers to identify propositions faced in class and as an effective solution to present learning in a structured way that provides a real opportunity to pay attention and review endless learning [29].

Based on its characteristics, there are benefits in applying learning media in video displays such as: (1) overcoming the limitations of distance and time; (2) the video can be repeated if needed to add an explanation; (3) instructions are delivered immediately and are comfortable to remember; (4) broadening students’ thoughts and opinions; (5) broadening students’ imagination; (6) clarifying things that are noetic and giving illustrations that are even more realistic; (7) has a high influence on students’ emotions; (8) explains the process and skills, able to show stimuli that reflect the expected goals and responses; (9) all students can learn from video, both students who are smart or who are not smart; and (10) develop their interest and drive for learning [17].

Exe-media is one of the audio visual media. Learning using Exe-media can make consisted of communicating in both writing and oral, planning the experiment, predicting hypothesis, interpreting the observation, observing, measuring, and using tools and material [12]. Implemented of this media can improve students’ thinking process like critical thinking and creative thinking skills [26]. And also, can improve the students’ problem solving skills [22], [30].

Generic science skills are cognitive aspects related to affective and psychomotor aspects that can be explored further by prospective teachers. Generic science skills can be used to learn many concepts and solve any science problem [23]. Generic science skills are skills that can be used to learn various concepts and solve various scientific problems [27]. Generic science is a skill produced by several structures of the learning process using a scientific approach [20]. There is not one standard definition of generic science skill indicators [15]. Generic science skills are part of critical thinking skills, problem solving skills, interpersonal skills, curiosity, creativity skills, and integrity [2]. Generic science skills can be categorized into 10 indicators including: (1) direct observation; (2) indirect observation; (3) scale awareness; (4) symbolic language; (5) logical frame; (6) logical consistency; (7) the law of cause and effect; (8) modeling; (9) logical inference; and (10) abstraction [24].

Based on some expert elucidation, it can be concluded that science generic skills are the ability to think based on knowledge related to cognitive aspects, affective aspects, and psychomotor aspects possessed by prospective teachers through the learning process. In science, generic skills can be used to learn many concepts and solve problems.

The purpose of this study is to established effectiveness of the use of collaborative models using Exe-media to improve prospective teacher science generic skills.

2. Research Methodology

2.1. Location and Time

This study was conducted in Department of Chemistry Education, Faculty of Mathematic and Natural Science, Universitas Negeri Medan, Medan. The study was conducted in the even semester of the academic year in 2016/2017.
2.2. Type of Research
This study used quasi experimental design with nonequivalent control group design. This study consist two groups both are experiment and control class with purposive sampling technique. In experiment class, prospective teacher was taught used collaborative learning using Exe-media and control class prospective teacher learned conventionally using power point media.

2.3. Population and Sample
Population of this study are prospective teachers of class Kim’B as experiment class and Kim’C as control class. Each class consisted of 38 prospective teachers. The experiment class of this research was given learning Exe-media about reaction rate and salt hydrolysis. Sample was purposed to improve prospective teachers’ science generic skills.

2.4. Data Collection Technique
Data is collected in some steps, (1) giving pretest to all class groups, (2) giving Exe-media to experiment class group and power point to control class group, (3) giving posttest to all class groups. Data collection format is served in Table 1.

| Group | Pretest | Treatment | Posttest |
|-------|---------|-----------|----------|
| EC    | X₁      | P         | X₂       |
| CC    | Y₁      | Q         | Y₂       |

Note:
EC : Experimental class
CC : Control class
X₁ : The initial skills of the experiment class
X₂ : Final experiment class skills
Y₁ : The initial skills of the control class
Y₂ : Final control class skills
P : The use of collaborative learning using Exe-media
Q : The use of conventional learning using power point

The treatment process was held in four sessions for 12 hours of meeting. The first meeting discussed the reaction rate using Exe-media in 3 hours. The second meeting discussed a number of subjects that could be changed by the process in 3 hours. The third meeting discussed about salt hydrolysis using Exe-media in 3 hours. The fourth meeting discussed a number of subjects that could be changed by the process in 3 hours. The objects discussed are reviewed physically and chemically reviewed. Through this process, students from the experimental class receive worksheets to observe and understand all information collected using Exe-media but on the other hand, prospective teachers of control class receive learning using power points as media.

Data collection based on generic science skill indicators instrument [3], [24], [26]. This study consists of 10 facets consisting of 26 indicators as shown in Table 2. According to generic science skills, experimental data can be collected through science generic skills tests. Science generic skills tests consist of 30 multiple choice questions and 20 essays. Data on the results of science generic skills were obtained from the pretest as the initial skill and the posttest as the final skill.
Table 2. Science Generic Skill Indicators

| Science Generic Skill Facet | Indicator |
|-----------------------------|-----------|
| Direct Observation          | a. Using as many senses as possible in observing natural experiment/phenomena |
|                             | b. Gathering the facts of the experiment or the natural phenomenon |
|                             | c. Searching for differences and similarities |
| Indirect Observation        | a. Using a measuring instrument as a sensing device in observing experiment or natural phenomenon |
|                             | b. Collecting facts from experimental result of physics or natural phenomena |
|                             | c. Looking for difference and similarities |
| Awareness of the Scale      | Recognizing natural objects and high sensitivity to numerical scales as microscopic or macroscopic scale |
| Symbolic Language           | a. Understanding symbol and terms |
|                             | b. Understanding the quantitative meaning of units and magnitudes of equations |
|                             | c. Using mathematical rules to solve problems or phenomena of natural phenomena |
|                             | d. Reading a diagram, table, and mathematical mark |
| Logical Frame               | Look for a logical relationship between two concepts |
| Logical Consistency         | a. Understanding the rules |
|                             | b. Rule-based arguments |
|                             | c. Described the problem based on rules |
|                             | d. Drawing the conclusion of a phenomenon based on rules presiding laws |
| Cause and Effect Law        | a. Expressing the relations between two or more variables in a specific natural phenomena |
|                             | b. Estimating the causes of natural phenomenon |
|                             | c. Revealing phenomena or problems in the form of sketches of image or graphs |
|                             | d. Expressing formula in formulas |
|                             | e. Applying alternative problem solving |
| Modeling                    | a. Make a table of available data |
|                             | b. Suggest alternative solutions to problems |
| Logical Inference           | Added a new concepts |
| Abstraction                 | a. Describing or abstracting concepts or events in to the real-life everyday life |
|                             | b. Creating visual animations of abstract microscopic events. |

2.5. Data Analysis Technique
The research data were analyzed based on the gain score, normality test, homogeneity test, and t-test using SPSS 21. The gain score was used to see the difference between the posttest and pretest scores. Scores are used to understand the increase in students’ science generic skills after undergoing treatment. Science generic skills acquisition scores can be calculated using this formula:

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gainscore = \frac{score_{posttest} - score_{pretest}}{score_{maksimal} - score_{pretest}}
\]  \hspace{1cm} (1)

The gain score values can be categorized as shown in Table 3. Normality test is used to see whether science generic skills data is normally distributed or not. The data used in the normality test was obtained from the pretest. The normality test results can be concluded as distributed by “Kolmogorov-Smirnov” if sig. > 0.05.
Table 3. Conversion of N-gain Into Category

| Scale       | Category |
|-------------|----------|
| 0.01 – 0.29 | Low      |
| 0.30 – 0.69 | Medium   |
| 0.70 – 1.00 | High     |

Homogeneity test is used to see the similarity of variance in the experimental and control classes. The data used in the homogeneity test was obtained from the pretest. Homogeneity test results are based on “Levene Statistics” if sig. < 0.05, the variance can be concluded is not the same and if sig. > 0.05, the variance can be concluded to be the same.

Hypothesis testing in this study was carried out using an independent t-test. Independent t-test is used to determine the difference in the average of generic skills between the experimental class and the control class. The basis for decision making in any independent effort that survives this test can be based on the sig. (2-tailed). If the value of sig. (2-tailed) > 0.05 then H₀ will be accepted and Hₐ will be rejected but if the value of sig. (2-tailed) < 0.05 then H₀ is rejected and Hₐ is accepted.

H₀ : Collaborative learning used Exe-media not effective to improve the science generic skill of prospective teachers
Hₐ : Collaborative learning used Exe-media is effective to improve the generic science skill of prospective teacher

3. Result and Discussion

This research was conducted at the Department of Chemistry Education, Faculty of Mathematics and Natural Sciences, Medan State University, Medan, Indonesia. This study consisted of two classes, both the experimental class and the control class. In the experimental class, prospective teachers are taught to use collaborative learning using Exe-media to improve generic science skills. In the control class, teacher candidates learn conventionally by using power points.

The study began with a pretest and continued with learning sessions in 4 meeting sessions both in the control class and experiment, and ended with a posttest. Pretest aims to see the prospective teacher's generic science skills begin. The learning process is held in four sessions for 12 hours in total. The first meeting in 3 hours discussed the rate of reaction using Exe-media. The second meeting in 3 hours discussed a number of subjects that could be changed by the process. The third meeting in 3 hours discussed about salt hydrolysis using Exe-media. Four meetings in 3 hours discuss several subjects that can be changed by the process. All sessions are intended to provide treatment to the control and experiment classes. Posttest aims to determine the final generic science skills of prospective teachers after receiving treatment. The average posttest and pretest results are shown in Table 4.

Table 4. Average Score of Posttest and Pretest

| No | Class   | Pretest | Posttest |
|----|---------|---------|----------|
| 1  | Control | 40.43   | 56.34    |
| 2  | Experiment | 41.14  | 70.28    |

According to the table, after getting treatment, control and experimental class showed an increase in generic science skills. However, the average increase (pretest and posttest scores) of the experimental class was higher than the control class. So it can be concluded that the increase in the generic science skills of prospective teachers in the experimental class is higher than the control class. This shows that learning using collaborative learning using Exe-media is more effective than conventional learning using power points. Learning using Exe-media can make consisted of communicating in both writing and oral, planning the experiment, predicting hypothesis, interpreting the observation, observing, measuring, and using tools and material [12].
Analysis of improvement in science generic skills can be seen and categorized based on acquisition scores as shown in Table 5.

Table 5. Average Gains Score

| No | Class    | Gain  | Category |
|----|----------|-------|----------|
| 1  | Control  | 0.3654| Medium   |
| 2  | Experiment | 0.7115| High     |

The gain score analysis in this study shows that the experimental class gain score is higher than the control class gain score. According to table 5 it can be categorized that the increase in generic science skills of teacher candidates in the control class is low but on the other hand it is high in the experimental class.

Testing the hypothesis in this study using an independent t-test. Parametric statistical testing conditions on independent t-tests have gone through normality and homogeneity. The results of the normality test are shown in Table 6 and the homogeneity test is shown in Table 7.

Table 6. Test of Normality

| Class | Kolmogorov-Smirnov\(^a\) Statistic | Df | Sig. |
|-------|-----------------------------------|----|------|
| Pretest Control | .093 | 38 | .256* |
| Score Experiment | .144 | 38 | .256* |

\(^a\). “This is a lower bound of the true significance”

Normality tests are held to determine whether generic science skills data in control and experimental classes are normally distributed or not. The results of the normality test in table 6 indicate that the significance (sig.) Of the control and experimental class is higher than 0.05 (0.256 > 0.05). It can be concluded that control and experimental class data are normally distributed.

Table 7. Test of Homogeneity of Variances

| Levene Statistic | df1 | df2 | sig. |
|------------------|-----|-----|------|
| Pretest Score    | 3.678 | 1 | 74 | .076 |

Homogeneity test is done to see whether generic science skills about control and variant of experimental class are based on homogeneous Levene Statistics. According to the homogeneity test in table 7 shows that the significance (sig.) Is higher than 0.05 (0.076 > 0.05). This shows that the control and distribution of the experimental class are homogeneous.

According to the results of normality and homogeneity tests, it shows that the data are normally distributed and homogeneous. Data that is normally distributed and homogeneous can be tested using independent t-test. Independent t-tests are presented in Table 8.

Table 8. Independent Samples t-test

| Equal variances Assumed | T | Df | Mean Difference | sig. (2-tailed) |
|-------------------------|---|----|-----------------|-----------------|
|                         | 12.635 | 74    | 31.67345         | .002            |
| Equal variances not assumed | 12.635 | 74    | 31.67345         | .002            |
According to the table, independent t-test results can be used to decide whether $H_0$ will be accepted or rejected. Sig value (2-tailed) of the independent t-test is 0.002. This shows that the value of sig. (2-tailed) 0.002 < 0.05, so $H_0$ is rejected and $H_1$ is accepted.

Based on experimental results and control class analysis, it can be concluded that collaborative learning using Exe-media about reaction rates and salt hydrolysis is effective for improving the science generic skills of prospective teachers. This consists of the theory that science generic skill facets of the skills of prospective teachers developed in this study can be achieved through science media developed. The use of technology has a positive effect especially for millennial prospective teachers [9]. Exe-media as an information and communication technology tool can consist of communication both in writing and orally, planning experiments, predicting hypotheses, interpreting observations, observing, measuring, and using tools and materials [12]. Science Exe-media are developed according to the strengths expressed [14]. In addition, the science learning using Exe-media developed has its own advantages in fostering learning motivation of prospective teachers [8]. Learning through direct experience, deliberate learning, simulation, and represent reality in daily life that can be effectively accepted by prospective teachers [6]. In addition, Exe-media used in learning can clarify and simplify the delivery of messages so that they do not become verbal and learning varies so that prospective teachers are not bored in accepting lessons [5]. It is also appropriate that science learning integrated with Exe-media can influence prospective science generic skills [16].

Generic science skills can help prospective teachers to understand concepts and solve problems in learning [28]. Generic science skills are part of the ability to communicate in problem solving [11], [18]. Generic science skills have a very important role in supporting learning, especially in science learning because it can emphasize aspects of the process [1].

4. Conclusion

Based on the results of data analysis and discussion it can be concluded that the learning used collaborative learning using Exe-media about reaction rates and salt hydrolysis is effective for improving the science generic skills of prospective teachers. This result is based on the acquisition of the average score of the experimental class which is better than the average score of the control class with a high category. Learn used Exe-media can make complete communication both in writing and orally, plan experiments, predict hypotheses, interpret observations, observe, measure, and use tools and materials. In addition, learning by using Exe-media is easier to remember and can increase the attention of prospective teachers about the reaction rate and salt hydrolysis.

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