Comparison of peer-tutoring learning model through problem-solving approach and traditional learning model on the cognitive ability of grade 10 students at SMKN 13 Bandung on the topic of Stoichiometry

A Z Hayat1*, W Wahyu2 and Kurnia2
1Chemistry Department (SPs), Universitas Pendidikan Indonesia, Bandung, Indonesia
2Chemistry Department, Universitas Pendidikan Indonesia, Bandung, Indonesia

*Corresponding author’s e-mail: ajenzhayat@yahoo.com

Abstract. This study aims to find out the improvement of cognitive ability of students on the implementation of cooperative learning model of peer-tutoring by using problem-solving approach. The research method used is mix method of Sequential Explanatory strategy and pre-test post-test non-equivalent control group design. The participants involved in this study were 68 grade 10 students of Vocational High School in Bandung that consisted of 34 samples of experimental class and 34 samples of control class. The instruments used include written test and questionnaires. The improvement of cognitive ability of students was calculated using the N-gain formula. Differences of two average scores were calculated using t-test at significant level of \( \alpha = 0.05 \). The result of study shows that the improvement of cognitive ability in experimental class was significantly different compared to the improvement in the control class at significant level of \( \alpha = 0.05 \). The improvement of cognitive ability in experimental class is higher than in control class.

1. Introduction

Vocational secondary school (SMK) is an educational institution that provides skills to its graduates so that they are able to directly enter the working industry. However, it does not mean that SMK neglects the importance of providing knowledge to its graduates to continue their study to college. Thus, learning process in SMK does not emphasize only on cognitive skills but also takes care of affective and psychomotor skills. It is intended that graduates who later will continue to college or directly work have adequate quality of skills, attitudes and knowledge.

For year 10 students of SMK, chemistry is a new subject even though it has been slightly discussed in science lesson in junior high school (SMP). In chemistry subject, Stoichiometry topic in particular, there are problems from simple to complex, which can usually be solved individually, but for complex problems require some help from others who are more skillful.

In one class there are students who have more understanding than others. Intelligent students will more quickly receive and understand the subject matter. However, there are some students who are less in understanding the lesson so that they are left behind. However it can be optimized by applying peer tutoring method.
The presence of students who are more intelligent than others in the classroom can also be used as peer tutors or as teacher’s assistant in the learning process. Peer tutoring method can be applied to assist students and train bright students for the purpose of enrichment.

The problem studied is whether there are significant differences between students taught by peer tutoring method and by traditional method. This study aims to find out whether there are significant differences between the two methods and to know which learning outcomes are better between the two methods.

According to Vygotsky in Zone of Proximal Development henceforth is abbreviated as ZPD for a series of tasks that are too difficult for a child to be learned alone can be learned with the help of a more capable adult or child. Vygotsky’s emphasis on ZPD confirms his belief in the importance of social influences, especially the influence of teaching through the cognitive developmental approach of students [1,2].

In the national curriculum, affective aspect should be applied to all subjects so that students have good characters and morality. According to Lickona there are three basic conditions for creating a moral community in the classroom: (1) Students know each other. (2) Students respect each other, strengthen, and care for each other. (3) Students feel as part of the group and feel responsible through their group approach [3]. These three requirements can be implemented if the teacher in delivering the learning uses the appropriate way. One suitable way for the three conditions to be implemented is the implementation of peer tutoring cooperative learning model through problem solving approach.

Cooperative model of peer tutoring is a teaching / guiding model assisted by students’ own friends. Peer tutoring learning model was pioneered by the John F. Kennedy Center and the Department of Special Education at Peabody College, at Vanderbilt University. The peer tutoring learning model by the John F. Kennedy Center and the Department of Special Education is called Peer-Assisted Learning Strategies (PALS) [2]. In PALS (peer-assisted learning strategies), teachers identify students who need help to master a particular skill and select other students who master certain skills to help students who need help then pair them so that the couple will work together productively to overcome problems they face.

If information is to be retained in memory and related to information already in memory, the students must engage in some sort of cognitive reorganization or cognitive elaboration. Furthermore Slavin states that one of the most effective elaborations is to explain the material to others [4]. Peer teaching benefited students on the acquisition of learning outcomes received by both teachers and students [4,5]. The statement supports that peer tutoring cooperative learning model can improve cognitive ability of students.

One way to implement cooperative learning model of peer tutoring effectively is through problem solving approach. According to Sudirman the method of problem solving is a way of presenting the lesson material by making the problem as a starting point for discussion to be analyzed and synthesized in an attempt to find solutions or answers by students. Therefore the chemistry lesson for the topic of Stoichiometry can be presented with the implementation of cooperative learning model of peer tutoring through problem solving approach [6].

Peers can influence the motivation of children through social comparisons, competence and social motivation, joint learning, and peer group influences [2]. In the social constructivist approach the role of peer tutoring and peer role can help to learn the subject matter one to another through group discussion. Peer tutoring improves achievements for tutors and students who are given tutorials. More recent studies view peer groups as having a positive or negative role, depending on their motivational orientation [2]. If peer groups have high standards of achievement, then the group will help student achievement. But if low achieving students join peer groups who are also underachievers, student academic achievement may get worse.

According to Surya, there are several advantages of peer tutoring method such as (1) a more intimate relationship between pupils and tutors (2) efficient (3) enrichment activities for tutors and (4) can increase the sense of responsibility [7]. Nevertheless there are drawbacks that teachers should know students who have more understanding, tutor supervision should be done well and the tutoring process
will be hampered when the students assisted feel inferior. Problems in this method include if in the class there is no capable students who are willing to become peer tutor.

Understanding the basic chemistry means understanding a set of related concepts where early mastery is a support for the next stage of mastery. Stoichiometry is one of the subjects in chemistry lessons related to mathematical calculations, thus demanding learners to think critically and creatively. Learners should understand the existing concepts of stoichiometric and self-discipline in doing assignment. In addition, the ability of learners in receiving lessons in the class is not evenly so that if the concepts of stoichiometric are only reviewed by individual learners, it will be difficult. This is the basis for delivering the teaching materials using peer tutoring learning model through problem solving approach.

2. Methods
The research method used is mix method of Sequential Explanatory strategy and pre-test post-test non-equivalent control group design.

The participants involved in this study were 68 grade 10 students of Vocational High School in Bandung that consisted of 34 samples of experimental class and 34 samples of control class. The instruments used include written test and questionnaires.

Sampling technique used in this research is purposive sampling technique. It is because the purposive sampling technique is based on certain characteristics that are considered to have a close connection with the characteristics of the population and can provide the required data in the study.

Obtained sample of class X AK 2 as experimental class of thirty-four students were given method of peer tutoring and class X AK 5 as control class as many as 34 students were given the traditional method. Both the experimental and control groups were subjected to certain treatment within a certain time period and then both groups were subjected to the same measurements.

While the instruments used in the study consisted of Essay questions and questionnaires. In the early stages of the study students were given a pre-test on Stoichiometry. After that later in the implementation phase, peer tutor learning model is applied through problem solving approach. Furthermore, in the last stage, students were given a post-test with the same problem as given in the pre-test, in addition students were also given a questionnaire and some student representatives were interviewed to get the data needed in the study. The data collected were analyzed descriptively.

Pre-test and post-test instruments are tested by validity test, differentiation, difficulty and reliability. To determine the normality, homogeneity and differences between the experimental and control classes, the data obtained from the pre-test and post-test stoichiometric learning results were processed and analyzed using Microsoft Excel 2007 and the IBM SPSS 24 program.

3. Results and Discussion

3.1. Research results
Data of pretest and posttest grade of experiment class and control class of processing result of Microsoft Excel 2007 and IBM SPSS 24 program can be seen in the following table 1.
Table 1. Result of independent sample t-test difference of students’ cognitive ability

| Levene’s Test for Equality of Variances | t-Test for Equality of Means | 95% Confidence Interval of the Difference |
|----------------------------------------|-----------------------------|----------------------------------------|
| F                                      | Sig. | t  | df | Sig. (2-tailed) | Mean Difference | Std. Error Difference | Lower   | Upper   |
| Pre-test Score                         |      |    |    |                |                |                        |         |         |
| Equal variances assumed                 | 0,019| 0,891| 0,009| 66             | 0,992           | 0,029               | 3,115   | -6,191  | 6,250   |
| Equal variances not assumed             | 0,009| 65,99| 0,992| 0,029          | 3,115           | -6,191              | 6,250   |

Based on Table 1, the value of significance is (p) = 0,992 > 0,025. Thus, it can be concluded that there is no significant difference between pre-test of cognitive ability of students in experimental class and control class.

Table 2. Result of independent sample t-test difference of students’ cognitive ability

| Levene's Test for Equality of Variances | t-Test for Equality of Means | 95% Confidence Interval of the Difference |
|----------------------------------------|-----------------------------|----------------------------------------|
| F                                      | Sig. | t  | df | Sig. (2-tailed) | Mean Difference | Std. Error Difference | Lower   | Upper   |
| Post-test Score                        |      |    |    |                |                |                        |         |         |
| Equal variances assumed                 | 3,1  | 0,08| 0,009| 6,06           | 19,41           | 3,20                  | 13,01   | 25,80   |
| Equal variances not assumed             | 6,0658,9| 0,000| 19,41| 3,20           | 13,00           | 25,82                  |

Based on Table 2, the value of significance is (p) = 0,000 < 0,025. Thus, it can be concluded that there is significant difference between the post-test score of students’ cognitive ability in experimental and control class. The result shows that there is influence from the implementation of cooperative learning model of peer-tutoring with problem-solving approach on the students’ cognitive ability.
### Table 3. Result of independent sample t-test improvement of students’ cognitive ability

|                      | Independent Samples Test |                      |                      |                      |                      |                      |
|----------------------|--------------------------|----------------------|----------------------|----------------------|----------------------|----------------------|
|                      | Levene’s Test            | t-Test for Equality of Means |                      |                      |                      |                      |
|                      | for Equality of Variances|                      |                      |                      |                      |                      |
|                      | F                        | Sig.                 | t                    | df                   | Sig. (2-tailed)      | Mean Difference      | Std. Error Difference|
| N-Gain               | 1.75                     | .19                  | 8.55                 | 66                   | .000                 | 26.441               | 3.09078              | 20.270               | 32.612               |
|                      | 8.55                     | 63.38                | .000                 | 26.441               | 3.09078              | 20.265               | 32.616               |

Based on Table 3, a value of significance of \( p = 0.000 < 0.025 \) obtained. The value of significance is lower than the level of significance of 0.025. This indicates that there is significant difference in the cognitive ability between the class taught using cooperative learning model of peer-tutoring with problem-solving approach and the class taught using traditional learning model. The improvement of cognitive ability in the experimental class or class taught using cooperative learning model of peer-tutoring with problem-solving approach is higher than the traditional learning model.

#### 3.2. Discussion

In this study, researcher tried to compare the two methods of learning that are the method of peer tutoring through problem-solving approach and the traditional method. In this method the researcher chose 10 students as peer tutors and each peer tutor handled three other students.

The selection of peer tutors was performed through a test. Ten students with the highest score were taken as candidates for peer tutors. The selection also takes into account the final semester test chemistry score of the students and the ability of students to interact in the classroom. This is so that the tutor has a good ability in giving guidance and explanation to the students.

Learning activities were done in 7 meetings. In each meeting, students sat in group in accordance to their respective tutors. In the study the researchers explained the main points and gave examples of calculations and exercises to students. Furthermore, the tutor guided independent activities with students such as working on exercises and material discussions.

In the learning process, the role of peer tutors in the classroom is needed, where teachers (researcher) supervised and answered students’ difficulties if the tutor cannot explain. Constraints faced in peer tutoring learning include lack of readiness of tutors in learning. So, sometimes tutors also have not fully understood the material.

The control class was taught using the traditional method. In the class, the researcher explained the main points and gave examples of calculations and exercises to students. In the class each student was given some tasks that must be done. Tasks were given to make students to get used to practicing working on questions. Tasks given can be done at school and completed outside of school.
Table 4. Statistic of descriptive score of students’ cognitive ability

| Class         | Number of students | Ideal Score | Result of Essay Pre-test | Result of Essay post-Test | Mean of N-Gain |
|---------------|--------------------|-------------|---------------------------|---------------------------|---------------|
|               |                    |             | x_min x_max | x          | x_min x_max | x          |               |
| Experimental  | 34                 | 100         | 5.00 64.00 | 28,1471 | 60.00 99.00 | 76,2647    | 0.67         |
| Control       | 34                 | 100         | 5.00 62.00 | 28,8529 | 30.00 82.00 | 56,8529    | 0.41         |

Based on Table 4, it appears that students' cognitive abilities were similar before treatment was given. This can be seen from the pre-test average score of experimental and control classes, which is not much different. The pre-test score of experimental class is 28,1471 and control class is 28,8529. The post-test average score of experimental class is 76,2647 and control class is 56,8529. Therefore, the difference of post-test scores between experimental and control class is 19,412. Based on the N-Gain score, it appears that the improvement of cognitive ability of students in experimental class is higher than students in control class.

From the test result, the difference of two average between the experimental class and the control class using the t-test found that the significance value (p) = 0.000 <0.025 this means that the experimental class and control class have a significant difference. Testing is continued with the test of cognitive enhancement. The calculation shows that the value of significance (p) = 0.000 <0.025 this means that peer tutoring method through problem solving approach is better than traditional method. Students who are taught by peer tutoring methods have better cognitive ability; this is because in learning the students are required to always work together in solving the problem, so that students are trained and ready to receive lessons in class.

Peer tutoring methods are better than traditional methods because students in receiving lessons understand more by using the language of their age, this is seen when tutee asks the tutor.

4. Conclusion
From the results and the discussion above, it can be concluded that there are significant differences between students who were taught using peer tutoring method and traditional method. Learning outcomes of peer tutoring method are better than lecture method. Both methods have achieved mastery of learning outcomes. Teachers should be able to apply peer tutoring methods in the classroom by empowering intelligent students. The use of peer tutoring method should be able to find tutors who have good qualities in this case tutors can be drawn from students with good chemical and mathematical scores. Supervision on the tutors should be done well.

5. References
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