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The effects of scientific approach based jigsaw model on students' self-efficacy and achievement

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Abstract. This research aims to find out the effect of scientific approach based jigsaw model on self-efficacy and achievement of tenth grade high school student on redox reaction material. This research was a quasy experimental using post-test only design. This study involved 120 tenth grade high school students in Yogyakarta regency, Indonesia. A total of these samples classified into two classes, the experimental class using scientific based Jigsaw model and control class using direct instruction. Data collection in this study used questionnaire to collect students'–self-efficacy and test on redox topic to collect students' achievement data. Data analysis techniques in this study using Multivariate Analysis of Variance (MANOVA) to examine the effect of scientific based jigsaw model on students' self-efficacy and achievement among the experimental and control classes. The results showed that s there was significant effect of scientific based jigsaw model on students' self-efficacy and cognitive achievement. Hence, the teachers are expected to apply scientific based jigsaw model to the chemistry learning because it can increase student self-efficacy that has implications for improving students cognitive achievement.

1. Introduction

Chemical education is an important thing in the development of science and technology, but when associated with learning chemistry in high school has a bad assumption from students. Students think chemistry is the hardest lesson because it is abstract. One of the chemical material that is considered most difficult by students is a redox reaction. The results of the analysis of research from other countries namely Ireland, England and Scotland found that redox was one of the topics considered difficult due to lack of ability mathematics on students[1]. Based on the results of the National Examination obtained from the PAMER application the average value achieved by students was 54.68. It is necessary for teachers to create good and fun learning for students who can overcome these assumptions.

Good and fun learning is student-focused learning [2]. Based on observations, teachers still apply teacher-centred direct learning which has an impact on student activity weaknesses so that it is necessary to apply student-focused learning models. One model that focuses on students is the jigsaw model. The jigsaw model is one type of cooperative learning model. In general, the cooperative learning model is a learning model that encourages students to work together to form small groups and help each other and is a model suitable for all school levels [3]. Based on the results of the research shows achievement. of students after the application of the cooperative model have greater academic

achievement, namely the results obtained by the students are higher [4]. Correspondingly, the results of other research also show that the jigsaw cooperative model is effective in improving cognitive achievement compared to other cooperative models because of the acceptance of knowledge from four sources at once namely students themselves, friends of a group of students (team of origin), friends of expert teams and from educators [5]. In addition, the jigsaw model can also be juxtaposed with an approach that is in accordance with the curriculum applied at school. This is what underlies the application of a scientific-based jigsaw model.

One of the predators that influence student success in mastering the concept is self-efficacy. Students must have high efficacy in mastering a learning material because the success of a person depends on the beliefs held in the students [6]. This indicates the importance of self-efficacy towards cognitive learning outcomes. Based on observations obtained in high school researchers showed educators do not instill self-efficacy in students because when the learning process takes place students are just silent and not active in the learning process. The absence of teacher awareness of the importance of self-efficacy for students so that it has an impact on students' cognitive learning outcomes. Based on observations and grades obtained from teachers in the field of chemistry studies showed unsatisfactory results, the researchers offered a scientific-based jigsaw model to improve the efficacy and cognitive achievement. Therefore, this study aims to determine the effect of using scientific-based jigsaw learning models on self-efficacy and cognitive learning outcomes of students.

2. Methods

2.1. Research design and samples
The research design used in this study was quasy experimental using post-test only design. Hence, in this study compare the results of the post-test score of the students' self-efficacy and cognitive achievements among the experimental and control classes after the intervention were applied. Table 1 showed the research design in this study.

Table 1. Research design

No	Class	Treatment	Post-test
1	Experiment	X1	O1, O2
2	Control	X2	O1, O2

Note: X1 = Scientific-based Jigsaw Model; X2 = Direct Instruction model; O1 = self-efficacy questionnaire; O2 = test on redox topic

2.2. Research procedure
The experimental class is a class that receives scientific-based jigsaw learning. The steps in scientific-based jigsaw learning are 1) the teacher outlines learning and learning objectives 2). Students are divided into several groups consisting of 6 students who all serve as experts. 3). Each expert observed the expert assignment sheet after the same material expert group member joined into one group; 4). Faithful experts who found difficulties in learning the material given wrote the difficulties given and then asked fellow expert teams during the expert team discussion; 5). Each expert from each group discussed the same material and collected information from various sources of jam from the student worksheet; 6) The expert group students answer the questions in the expert sheet before returning to the original group and concluding the results of the discussion; 7). Teacher gives quizzes on material in the expert group to check accuracy; 8). Each student returns to the original group to communicate information sharing with one original team; 9). The teacher gave a Quiz about the material distributed to check its accuracy; 10) teachers examine and clarify what students do not seem to understand; 11) teachers give questions to assess individuals using posttest; 12). The teacher re-teaches any material that is not answered in an individual assessment as needed.

The control class is a class that receives Direct Instruction learning. steps in Direct instruction learning are: 1). the teacher determines and explains the learning material by lecture; 2). the teacher

asks the students about the material described; 3). the teacher corrects errors related to the material; 4). students are given a quiz to solve questions based on the material that has been taught. Next measure the dependent variable in the experimental class and control class. The dependent variable in the form of self-efficacy was measured using a questionnaire and the dependent variable was cognitive learning outcomes by using oxidation reduction reaction test questions which were all done at the end of the learning process.

2.3. Instruments

The research instrument used in this study was an interview guide to chemistry teachers at public Yogyakarta senior high schools to collect the existing information about the existing teaching-learning instruction, self-efficacy questionnaire to collect the data of students' self-efficacy, and test on redox topics to measure students' cognitive learning outcomes.

In conducting the research, a lesson plan on both experimental and control classes were prepared. All of the instruments including the interview guideline, self-efficacy questionnaire, and test on redox topics were validated by two experts. The two experts confirmed the theoretical validity including the content and face validity.

In addition, the empirical validity of the self-efficacy questionnaire and test on redox topics were carried out with the result of the empirical validity were analyzed using SPSS by comparing R count and R table. The result of the analysis showed that 26 valid questions from 30 questions tested and the self-efficacy questionnaire and 15 valid statements from 15 statements questionnaire given., Moreover, the instrument reliability test was also performed with the results of reliability of both instrument obtained high category

2.4. Data Analysis

The data analysis technique used in the study was Multivariate Analysis of Variance (MANOVA) to determine the effect of using scientific-based jigsaw learning models on self-efficacy and cognitive learning outcomes of students. The analysis of MANOVA technique conducted by the help of SPSS. Manually MANOVA test formulas can be written as follows [7].

$$F = T^2$$

Moreover, perason correlation was used to determine the relationship among the students' self-efficacy toward students' achievement.

3. Result and Discussion

The results of this study were taken using a test and non-test system. The test system is used by the instrument of multiple choice questions on redox topic as many as 26 questions to measure the cognitive learning outcomes of students while the non-test system is used is a questionnaire to measure the self-efficacy of students. The result of MANOVA technique to examine the effect of using scientific-based jigsaw learning models on self-efficacy and cognitive achievement of students showed in the table 2.

Table 2. Data on the results multivariate of self-efficacy and cognitive achievement

Variable	Mean Experiment	Mean control	F value	Sig
Self-efficacy	58,00	54,47	9,401	0,003
Achievement	77,45	69,57	26,942	0,000

Based on the results of the data presented in Table 2 it can be seen that there were differences in students' self-efficacy and achievement among the experimental class and the control class. The average value of the experimental class is higher than the average value of the control class so it is

clear that the model applied to the experimental class is better than the model applied to the control class.

The effect of the implementation of scientific-based jigsaw model on self-efficacy and cognitive achievement seen from the results of MANOVA test showed in the Table 2. In the MANOVA test, the significance value is smaller than the 0.05 significance value, so it can be concluded that the significance level of 5% of the implementation of scientific-based jigsaw models can affect the self-efficacy and cognitive achievement of students. In accordance with the research results of several researchers who revealed that cooperative learning can improve self-efficacy and academic achievement because in cooperative learning students work together and help each other so that self-efficacy increases and the ability to achieve achievement will be higher. There is an increase in yields and self-efficacy because the applied learning model is a fun learning for students so that giving effect to motivation this can be seen in the results of the statistical analysis obtained significantly has supported the experimental class on motivation dependent variables [8].

Better experimental class cognitive achievement from the control class indicate that a scientifically based jigsaw model has proven effective in improving students' cognitive achievement. Based on the results of previous studies that the jigsaw model is said to be effective because it shows a significant difference from the experimental class that is better than the control class [9]. This statement is supported by other research which states that jigsaw learning is effective in improving student learning outcomes and the gender of students does not affect student achievement as seen from the results of the quiz analysis of students conducted twice a week [10]. Based on the research results obtained indicate that the jigsaw model has a positive effect in improving student learning outcomes. According to a statement from another study that based on the learning experience of the jigsaw model which is a type of cooperative learning model has a positive impact on improving achievement, mutual respect and attention for each student [11].

Moreover, the Pearson correlation of the students' self-efficacy and achievement was conducted to determine the relationship among these two variables. The result of the analysis showed in the table 3.

Table 3. Pearson correlation among the self-efficacy and achievement

Aspect	Value	Self-efficacy	Achievement
Pearson Correlation	Self-efficacy	1	0.295
Sig (2-tailed)			0.001
Pearson Correlation	Achievement	0.295	1
Sig (2-tailed)		0.001	
N		120	120

In the Pearson correlation test result showed in table 3, it can be seen that there is a correlation between self-efficacy and cognitive learning outcomes of students so that it can be concluded that if the self-efficacy of students increases, learning outcomes also increase. The same results were revealed by previous research that if there is an increase in the students' self-efficacy, the achievement is increases [12]. Other research results also show the results that students who having high self-efficacy tends to have better test results than students who have low efficacy [13]. Self-efficacy is an important thing that can affect the success of students because if the students' self-efficacy is high, the students will not experience fatigue in completing the tasks assigned to them [14]. Students who have high self-efficacy are usually able to think creatively and are able to solve group problems [15]. There are 4 ways to improve self-efficacy, namely: 1). success in achieving results; 2). Learning from experience by observing others achieves results; 3). There is verbal encouragement; 4). Reducing signs of anxiety [16].

Other research also revealed the importance of self-efficacy in high school students, namely the results of research which showed that self-efficacy is an important predator of students' success in completing their first year of study at university so that educators can contribute directly to the development of self-efficacy for the success of students' academic transitions in which academic

interest and cognition are directly related to self-efficacy[17] self-efficacy is one of the keys to involving students in learning[18] self-efficacy is one of the keys to involving students in learning. If students have low efficacy, it is ensured that these students will avoid tasks that have made it fail so that the best way is that educators must emphasize the development of self-efficacy that will increase students' motivation in completing school assignment [19] The existence of a link between self-efficacy and learning outcomes is also revealed by several studies which reveal that self-efficacy and motivation are important contributors to performance improvements [20]

4. Conclusion
Based on the results of research and discussion, it can be concluded that. There is an effect of the application of science-based jigsaw learning model on cognitive learning outcomes and self-efficacy on the topic of oxidation reduction reactions in tenth grade high school. this is because in the jigsaw model there is responsibility given to students as experts on a sub topic that is not given to direct learning. the activeness of students in accepting their responsibilities as experts can improve self-efficacy that is rooted directly in improving cognitive achievement. This statement implies that chemistry learning using scientifically based jigsaw models is learning that trains students to be independent, has self-confidence and does not make the teacher as a learning resource so that with a scientific-based jigsaw learning model given a positive impact on improving self-efficacy and results cognitive learning of students.

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