Self-Efficacy of Students Senior High School in Problem Based Learning Model of Chemical Equilibrium Topic

M Handayani¹,a), ISY Louise²,b)

¹Postgraduate of Chemistry Education, Yogyakarta State University, Indonesia
²Chemistry Education Department, Faculty of Mathematics and Natural Science, Yogyakarta State University, Indonesia

a) meliahandayani7@gmail.com

Abstract. The contextual learning model used in chemical equilibrium topic is problem based learning. Problem based learning facilitates students to analyze problem in daily life, using appropriate learning resources, and organize information into a conceptual framework. Self-efficacy is a feeling of confidence or student’s belief to carry out the task and achieved good result. This study aims to analyses students’ self-efficacy skills profile in chemical equilibrium topic using problem based learning model. This study used quasi experiment with post-test only design and used cluster random sampling. Self-efficacy of students was measured by 30 item statements questionnaire sheets. The result of this study indicated that student’s self-efficacy in problem based learning model achieved good category in some indicator. The higher score of students’ self-efficacy contained in indicator overcome the difficulties, complete the assignment, solve the problem, getting good result, apply efficacy in daily life, cooperate and communicate in team.

Keyword: problem based learning, self-efficacy, scientific approach, chemical equilibrium topic

1. Introduction
The 21st century is a transformation of technology and industry in all aspect. Challenges in 21st century require students to develop competitive skills that focus on creativity, solve the problems, communicate and cooperate [1]. Soft skills are the center of attention in education and industry. Neff explain the determination of success is not on technical skill / hard skill, but in the quality of soft skill [2]. Students learn how to cooperate and communicate in self-efficacy.

Self-efficacy is a person’s belief in his or her own ability to do a task with a certain level of proficiency [3]. Self-efficacy becomes the main determinant in measuring self-belief of student [4]. Minister of education number 23 in 2016 about the standard assessment, result of the study include aspect of attitude, knowledge, and skill [5]. The result study in 2014 is one of senior high school in Yogyakarta showed 42.69% or below 50% of students who had high level of self-efficacy [6]. From survey data, students’ self-efficacy still has a chance to be increase. Lack of self-efficacy make students have a low struggling ability, in other side the importance of self-efficacy was not felt by some students.

Students’ self-efficacy should better in some condition, so self-belief in person ability still can be improved. The development of self-efficacy on students is important, because when students have
high self-efficacy they will have better performance and have the ability to solve problems in learning [7]. High self-efficacy has the opportunity to carry out an activity and develop a positive attitude. Students who have a high self-efficacy are given the opportunity to choose the type of question that more challenging [8]. Students with low efficacy tend to like the types of question that are not challenging, and usually will take the opportunity to work on questions with the same level of difficulty. Students with problem-based learning model are expected to feel challenge in analyze case and provide solution to solve problem. In an educational context, self-efficacy is an important variable that have positive effect on the level of students’ motivation [9]. Students who have high motivation tend to have high belief about what students can do, anticipate possibilities will occur through action and plan programs for the future.

The dimension of self-efficacy in each individual consists of three components that have important implication performance. The first is magnitude level, this dimension relates with difficulty level of the task. Individual will try behavior that they feel to do and avoid beyond the limits of abilities. Second is the strength level, this dimension related to the level of strength an individual or expectation regarding of his abilities. Weak hope is easily broken by experience that not support, strong expectation encourage individual to survive in effort. The third is generality level, this dimension relates with area behavior where individual can survive in effort. Generality can be assessed from the same level of activities, abilities, affective, type of situation that faced and individual characteristic in according life goal [3].

Problem solving skills are needed in order to prepare a generation that is ready to work and career in the era of global economic [10]. In the global era, the state continues to strive and improve the quality of education, especially for developing countries. For supporting problem solving abilities, the teacher can vary with the learning model. One of the interactive model and has student center character in learning process is problem based learning model [11].

Problem based learning is a learning model which has facilitates students to analyze problems in daily life, use appropriate learning resource, and organize information into a conceptual framework [12]. Problem based learning has the same characteristic as self-efficacy which is able to guide students to feel confident and more desire to try assignment and solve problem as well as possible [13]. Akinoglu explained the activities with problem based learning are carry out by dividing students into small class and the teacher act as a facilitator in the discussion activities [14]. The existence of a problem based learning model is expected to have a positive impact on self-efficacy.

Problem based learning model have five stage of learning process, are (1) given orientation about the problem, (2) organize students to study, (3) conduct individual and group investigation, (4) develop and present result, (5) analyze the problem solving process [15]. The advantage of problem based learning are: being able to increase learning motivation, able to encourage high level of thinking, encourage students to optimize metacognition abilities, making learning more meaningful [16] so, expected students can enthusiast in learning process especially focus on investigation, giving solution, and collaborative in a group.

Contextualization is one part of creating character education that is useful, culture, and beneficial for the formation of a civilized community [17]. Contextual learning is a learning concept that helps teachers associates the content of subject matter with real world condition. The subject matter of this study is chemical equilibrium. Chemical equilibrium has characteristic with the material which real and requires understanding concept, need to high logical reasoning in solving the problems [18]. For example correlation the principle of chemical equilibrium on making ammonia, formation stalagmite and stalactite, how to make the ammonia and sulfuric acid can produce a maximum product, and what factor must be analyze.

One of learning models which compatible with the characteristics of chemical equilibrium material is problem based learning. Learning model is a technique in designing and applying to obtain information, skill, concept, and ideas [19]. Problem based learning model is expected to provide positive result for self-efficacy of students. The objective of this study is to analyze profile of students’ self-efficacy abilities in chemical equilibrium topic using problem based learning model.
2. Research methods

2.1. Research design and samples
Quasi-experiment with posttest only design was used in this study. In this study two class were used, one class an experimental class and one class as a control class. Student in experimental class was given treatment with problem based learning, while the control class was given treatment by learning approach that used in the school, scientific approach.

Determination of the sample was done by using two stages cluster random sampling technique. The first stage is to determine the school that used to study. The populations in this study are all students of eleven grades from science department in senior high school of special region Yogyakarta with cluster category in moderate abilities. There are six senior high school which has characteristic: (1) have A grade for accreditation, (2) use the 2013 curriculum, (3) an average national examination score of 61-63, (4) each class consist of 28-30 students, and (5) the school have completely laboratory facility. Among six senior high schools in Yogyakarta, one school was chosen randomly. From these criteria so selected 11th Senior High School.

The second cluster random sampling stage is to determine the class used as a sample study. Some of science class in 11th senior high schools were conducted an equality analysis to measure differences based on students’ initial knowledge. ANOVA analysis result is sig.1.27 > 0.05, it is mean no difference in the initial knowledge of students’ science class in 11th grade. Furthermore, because it does not have difference from the seven classes could be randomly, and then it obtained XI science 6 and XI science 7 as a sample study. Number of students in xi science 6 consists of 31 students and xi science 7 consists of 30 students.

2.2. Techniques and data collection instruments
Self-efficacy was measured by using scale. Respondents were ask to give a check mark on answer category. Developing self-efficacy questionnaire based on likert scale modified. The self-efficacy scale contains 30 statement that consist 15 positive statement and 15 negative statement. Each statement on the questionnaire has used 5 scales for positive statement and negative statement was presented on Table 1.

| Table 1. Scoring of questionnaire of self-efficacy |
|-----------------------------------------------|
| Positive statement | Negative statement | Score |
| Never             | Always              | 1     |
| Rarely            | Often               | 2     |
| Sometimes         | Sometimes           | 3     |
| Often             | Rarely              | 4     |
| Always            | Never               | 5     |

The distribution of questionnaire aims to find out information about a problem that can provide answer according to statement given. The questionnaire is given at the end of meeting after students take part in learning process. The dimension in self-efficacy in each individual lies in three components, are magnitude, strength, and generality [3]. Three components made into six indicator, from indicator made into five statements in both positive and negative forms that shown in Table 2.

The quality of learning can be achieved through measurement which is measured by the level of validity and reliability. Theoretical validity will be done after the instrument is developed, then consult with expert judgment. The lecturer will examine the instrument based on aspect of self-efficacy according the criteria in scoring. The instrument then had been revised based on suggestion from validator. Empirical validity carry out by testing instrument on 280 students. The reliability estimation analysis at 0.69 which mean the reliability were sufficient.
#### Table 2. Indicator of self-efficacy

| Dimension  | Indicator                                                                 | Item Number |
|------------|---------------------------------------------------------------------------|-------------|
|            | Feeling and being able to overcome the difficulties of working on assignment | 1, 2, 3     |
|            | Feeling of belief to solve problems related to equilibrium material        | 4, 5, 6, 7, 8 |
| Strength   | Feeling sure to be able to do the task in accordance with order            | 9, 10, 11, 12, 13 |
| Generality | Feeling of belief to get good result                                       | 14, 15, 16, 17 |
|            | Feeling of beliefs able to cooperate and communicate well during learning process | 18, 19, 20 |
|            | Feeling of belief to apply self-efficacy in daily life                     | 21, 22, 23, 24, 25 |
|            |                                                                           | 26, 27, 28, 29, 30 |

2.3. Data analysis techniques

Total students which follow this study are 61, but there are 3 students not allowing in data analysis because the student not follow completely during learning process. Data analysis of this study took 29 students from experimental class and 29 students from control class. The data analysis use to determine profile self-efficacy based on the score of questionnaire.

Categories of self-efficacy are done by classifying the score obtained from questionnaire converted into a category based on ideal assessment. The steps in quantitative descriptive analysis are as follows: (1) recap the questionnaire data score, (2) make ideal score ranges and rating categories, (3) categories the score according to the ideal score. Self-efficacy category made into five categories, are very good, good, sufficient, less good, and bad. Determination of ideal rating categories refers to the suggestion of Widoyoko [20] with the highest score is 150 and the lowest score is 30, ideal of rating categories presented in Table 3.

| Table 3. Ideal rating categories |
|----------------------------------|
| Category      | Score Range         |
| Very good     | 126 < X             |
| Good          | 102 < X ≤ 126       |
| Sufficient    | 78 < X ≤ 102        |
| Less good     | 54 < X ≤ 78         |
| Bad           | X ≤ 54              |

3. Result and discussion

Learning activities with problem based learning model was implemented based on syntax of Arends [15], started by giving problems to students, the purpose of giving problem is students are able to analyze problems in daily life related with material. Students are divided into six groups for each class to make good condition in discussion and teamwork session. During the learning process students allowed to look for references from various sources to facilitate in solving problem. The result discussion in small group will be discussed together in large group then drawn a conclusion. At the other meeting, students began to explore the concept by carry out practical activities, then students were given time to associate and communicate observation result with theories. At the end of meeting, students were given time to fill out self-efficacy questionnaire.

3.1. Category of self-efficacy

Self-efficacy category was viewed according ideal rating category. The result of self-efficacy was presented in Table 4.
Table 4. Category of self-efficacy

| Category     | Experimental Class | Control Class |
|--------------|--------------------|---------------|
|              | f | %   | f | %   |
| Very good    | 3 | 10.34 | - | -   |
| Good         | 18 | 62.06 | 19 | 65.51 |
| Sufficient   | 8 | 27.58 | 9 | 31.03 |
| Less good    | - | -   | 1 | 3.44 |
| Bad          | - | -   | - | -   |

Based on Table 4 it can be seen that students in experiment and control class have good self-efficacy categories with the value of each class respectively 62.06 and 65.51. Although in experimental class on good category was lower score than control class, but in experimental class also has very good category.

3.2. Students’ self-efficacy in several indicator

Self-efficacy score in each class has been divided into each indicator of self-efficacy. The score of each indicator obtained from measurement in percentage form that presented in Figure 1.

Figure 1. The percentage self-efficacy of students in each indicator

Figure 1 six indicator will be describe one by one. The first is overcome difficulty. Student in experimental class and control class have ability in to do assignment till hardest part and able to make lab report completely without asking friend each other. Both of them almost have the same score in 74 and 73. This show the ability in two class is not much different. The second is solving the problem. In this part student have ability to make good plan in compiling lab tool and material carefully. Student score in this indicator not much different with score 64 and 62.

The third indicator is doing the task. In this part measure ability to do practicum correctly, students try to lab work in accordance with procedure. Students in experiment and control class have same abilities with score 74. The fourth is get good result, students’ optimist can do chemical equilibrium test correctly. Students in both of class have the same belief with score 66 and 65. The five cooperate and communicate with the score 75 and 71. The experiment class has a high score in ability to cooperate and communicate, this occurred before the implementation of practical activities, students in experimental class conduct discussion in preparing practical work. The last is applying self-efficacy in daily life. Students have belief able to solve problem in daily life with score 68 and 67.

The main score for each indicator in experiment class more supreme in several indicator including the ability to overcome the difficulties, ability to solve the problem, ability for getting good result, and
ability to cooperate and communicate. In this study shown that problem based learning model has a positive impact on students’ self-efficacy, even though some students are still shy in asking or answering question. This study accordance with result study from Mataka & Kowalske [21], students which participate with problem based learning class increase in self-efficacy beliefs through mastery experience. Study of self-efficacy is supported by Bandura theory which explain if individual are faced on tasks that arrange according to the level of difficulty, the possibility of students to choose on easy level, medium, even difficult depend on ability[3]. Measuring of self-efficacy must use specific domain such as how well students can work on assignment to completion [22].

Bodner, Savery & Duffy explain problem based learning using constructivist principle can encourage in terms of: (1) conducting authentic assignment, (2) supporting learning environment to bring up ideas, (3) encouraging students to develop themselves in completing assignment [20]. In other study, there is a positive correlation between self-efficacy and performance of students after students follow problem based learning [23].

4. Conclusion
The conclusion for this study is profile of students’ self-efficacy in experimental class have a good category. Students’ in experimental class more supreme in several aspect, are in overcoming difficulties, solving problems, working the task, getting good result, cooperation and communicating.

References
[1] Griffin P, Mc Graw B, and Care E 2012 Assessment and teaching of 21st century skills (Dordrecht: Springer)
[2] Sailah I 2008 Pengembangan softskill di perguruan tinggi (Jakarta: LPPM-IPB)
[3] Bandura 1997 Self efficacy: the exercise of control (New York: W H Freeman and Company)
[4] Kurbanoglu N I 2010 The relationships between university students’ chemistry laboratory anxiety, attitudes, and self efficacy beliefs AJTE 35(8) 48-59
[5] Kementrian Pendidikan dan Kebudayaan Republik Indonesia 2016 Peraturan Mentri Pendidikan dan Kebudayaan republik Indonesia Nomor 23 tentang Standar Penilaian Pendidikan
[6] Wulandari S and Rachmawati M A 2014 Efikasi diri dan stress akademik pada siswa sekolah menengah atas program akselerasi Psikologika 19(2) 246-252
[7] Ferrel B and Barbera J 2015 Analysis of students self-efficacy, interest, and effort beliefs in general chemistry CERP 16(2), 318-337
[8] Villafane S M, Garcia C A, and Lewis J E 2014 Exploring diverse students trends in chemistry self efficacy through out a semester of college level preparatory chemistry CERP 15(2) 114-127
[9] Hassankhani H, Aghdam, A M, Rahmani A, and Mohammadpoorfard Z 2015 The relationship between learning motivation and self efficacy among nursing students Res.and Dev.Med.Educ, 4 97-101
[10] Sani A R 2014 Pembelajaran saintifik untuk implementasi kurikulum 2013 (Jakarta: Bumi Aksara)
[11] Aryanti F, Surtikanti H, and Riandi 2017 Penerapan model problem based learning (PBL) berbantuan teknologi informasi dan komunikasi untuk meningkakan kemampuan berpikir kritis siswa pada konsep pencemaran lingkungan. Biosfer: Jurnal Biologi dan Pendidikan Biologi 2(1) 14-20
[12] Gunter T and Alapat S K 2017 The effects of problem based learning (PBL) on the academic achievement of students studying “electrochemistry” CERP 18(1) 78-98
[13] Ramrain U and Ramaila S 2017 The relationship between chemistry self efficacy of south african first year university students and their academic performance CERP 19(1) 60-67
[14] Krisnawati E, Susilo H, and Gufur A 2018 ICT based-problem based learning on students cognitive learning outcomes Jurnal Pendidikan Sains 6(2) 38-42
[15] Arends R I 2012 Learning to teach 9th edition (New York: The McGraw-Hill Companies)
[16] Abidin Y 2014 *Desain sistem pembelajaran dalam konteks kurikulum 2013* (Bandung: PT Refika Aditama)

[17] Sahlan and Prasetyo 2012 *Desain pembelajaran berbasis pendidikan karakter* (Yogyakarta: Ar-Ruzz Media)

[18] Sari and Muchlis 2014 Implementasi model pembelajaran tipe kooperatif tipe TPS dengan pendekatan kontekstual untuk melatih sikap jujur dan tanggung jawab siswa kelas XI IPA pada materi kesetimbangan *Unesa Journal of Chemical Education* 3(1) 10-20

[19] Joyce B, Weil M, and Calhoun E 2009 *Model of Teaching* (New York: Pearson Education Inc)

[20] Widoyoko E P 2009 *Evaluasi program pembelajaran* (Yogyakarta: Pustaka Pelajar)

[21] Mataka L M and Kowalske M G 2015 The influence of pbl on students’ self-efficacy beliefs in chemistry *CERP* 16(4) 929-938

[22] Villafane S M, Xu X, and Raker J R 2016 Self efficacy and academic performance in first semester organic chemistry: testing a model of reciprocal causation *CERP* 17(4), 973-984

[23] Loh K H 2017 The relationship between academic self efficacy and learning performance in problem based learning environment *WASJ* 35(8) 1568-1573