Exploring of Students’ Self-Efficacy: The Beliefs while Learning Process in Buffer Solution

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Abstract: This paper concerns on the students’ self-efficacy in their each study in the context chemistry learning especially buffer solution. This study aimed to explore how student’s beliefs and underlying sources through chemistry learning process in classroom. Based on the purpose, interviews were asked to five students in High Senior School. Each of them has different level of ability in chemistry. In addition recording was used and also interviewed conducted with all participants. The emerging meanings about students’ self-efficacy were analyzed according to self-efficacy theory. This research showed that from five participants indicated different self-efficacy from each other. One participant showed high self-efficacy compared to other participants in learning chemistry. Most of them stated that mastery experience is the main source that underlying expansion the self-efficacy.

Keywords. Buffer solution; Chemistry learning; Self-efficacy.

1. Introduction
In the implementation of the 2013 curriculum required to be able to develop 3 basic domains that must be possessed, such as cognitive, psychometric, and affective. According to Bloom, Learning outcomes are classified into three different ways. Generally, these classifications are named as cognitive, psycho-motor, affective and intuitive [1]. The cognitive domain includes knowledge and thinking skills and intellectual skills. Affective domains include changes in interests and attitude. Psycho-motor domain is included into the student's motorized vision. [2]. Cognitive and affective domains can be studied together in the realm of education. this is because the effective domain is also considered important even though the cognitive domain is equally important to develop [3].

Not infrequently learning process focus more on students rather than teachers as well as conventional learning. Student’s ability to master specific all contents and skills are important but there are things that are not less important that must also be considered, it is affective domain [4]. Affective domain factors such as attitude, self-efficacy beliefs, motivation, and anxiety influence student’s learning [5]. This is the enough evidence to show that cognitive domain has correlation with affective domain [6]. Adkins said
that focus on teaching cognitive without considering the affective domain mean that forget the whole purpose of education [7].

Self-efficacy is rooted in social cognitive theory and is defined as the self-appraisal of one’s capacity to execute a specific task [8]. Self-efficacy is our belief about our personal competence or effectiveness in given area. Bandura defines self-efficacy as “beliefs in one’s capabilities to organize and execute the courses of action required to produce given attainments, regulate and carry out the actions needed to produce a given achievement [9]. There are several strategies to improve student self-efficacy, namely: Specific teaching strategies, teachers provide specific ways for example is students are asked to describe and conclude the task or material given. [10].

There is a difference between someone who has high self-efficacy and low self-efficacy. Eggen & Khaucak stated there are characteristic for people have high self-efficacy, they are accept challenging task, expend high effort, persist when goal couldn’t reach, believe they will success, discard unproductive, and perform higher efficacy [11]. Different from Bandura calls it in dimensions. The dimensions of self-efficacy are levels, generality, strength [12]. Many factors as source of self-efficacy. As a result, people with higher self-efficacy are more likely to perform difficult tasks than their counterparts with low self-efficacy[11][13].

The success of the mastery experience can increase one's beliefs level, otherwise the failure in applying the result of mastery experience can weaken efficacy, especially if the self-efficacy is not firmly planted. Secondly, the vicarious experiences are the influential way to strengthen efficacy beliefs is through learning process. The ability of self-efficacy will arise from their view of other people who succeed with a strong effort in carrying out the task when conditions are in accordance with themselves [12]. A third way is social persuasion. This source strengthens self-efficacy, convincing them that they have the ability to succeed. Lastly physiological and emotional is the way. Many people rely on their physiological and emotional states, stressful, angry, tense, and sad reactions as a form of vulnerability to poor performance outcomes [14].

Self-efficacy is said to have broad implications or impacts in academic fields that can affect student efforts, perseverance, and emotional reactions to certain tasks in school [15] [16]. On science education, perceived self-efficacy is the central element of social cognitive theory. Self-efficacy has been the interest of many researchers over past decades [17] in today's increasingly advanced age, science education need students who are resilient and motivated to perform challenging activities [18]. Learning process in science must aim to improve students’ self-efficacy to reap the benefit and put more effort into their education [19] [20]. Other stories across several disciplines suggest that self-efficacy is related to some skills [21]. Villafane, et al. researched about student self-efficacy trajectories in preparatory chemistry [20]. There is also correlation self-efficacy with academic performance that went from Nicolidau and Philippou [22]. In the learning process it is known that there is a reciprocal relationship between self-efficacy and academic performance in organic chemistry courses. It is said that when the student's self-efficacy is good, the learning performance is also good [23].

Generalization of desired expectations for the level of student self-efficacy can occur, but there are still differences that distinguish student self-efficacy on each learning topic [24]. The level of difficulty of each learning also differs from one another. Chemistry is one part of the subject that is still considered difficult by students [25]. One of them is the topic of buffer solution that is considered difficult by students. the calculation and understanding that must be mastered on this topic makes students assume it is difficult [26]. That's why self-efficacy is very important in learning. When learning process only prioritizes cognitive aspects can also decrease the whole efficiency all skills that we must be mastered. Developing cognitive skills but we forget to develop the affective domain it means the whole purpose of education would be enhanced.
This research is important because by knowing the existence of self-efficacy of students in classroom learning. Contribute to adding to the qualitative research literature about student self-efficacy. By knowing the level of self-efficacy, each participant is expected to be able to evaluate themselves in understanding the concept of chemistry. This research is also useful for teachers in the assessment process in class that not only focuses on cognitive assessment, but also on affective.

The rest of this paper is organized as follow: Section 2 describes the proposed method. Section 3 presents the obtained results and following by discussion. Finally Section 4 concludes this work.

2. Proposed Method
This section describes the proposed method.

2.1 Participant
The participants in this study were five from science students of 11th grade students at one of the high schools in Yogyakarta. Purposely, the participants selected from different ability in content chemistry, low, middle, and high. These participants consist of four females and 1 male attending chemistry class in high school. All the participants were 16 years old from senior high school.

2.2 Research design
The overall research design used in this study is descriptive qualitative [27]. The purpose of this study seek to categorize students who have high and low self-efficacy from several aspects of self-efficacy. This study also aimed to explore how students believe in studying chemistry, especially in buffer solution and come from where the source of self-efficacy is. This study involved collecting and analyzing qualitative data within a single study to obtain a deeper understanding of self-efficacy students. Data from the qualitative analysis has been used to provide a deeper understanding of students’ self-efficacy, because there was chance to converse with the participants.

2.3 Data Collection
This study used an interview process conducted on five participants. The interview consists of eight questions that aimed to explore the answers to participant answers. Interview questions are prepared and considerations refer to existing literature and discussion [28] [29]. Interview took place in front of the room, a quiet place. It was useful to encourage and ensure all participants to be confident and make good sound audio/video record. There are also additional questions were asked during the interview process to probe more statements students which cannot be clearly articulated and also to clarify the participants’ responses.

2.4 Data Analysis
The results of the interview were transferred in Ms. Word. the name of the participant is disguised. Then, the results of the transcript in the code are then displayed according to the results obtained. at the beginning of the interview, students were asked to answer some of the questions asked. The interview process was recorded and video. The second interview phase was also recorded entirely. There are also additional notes that support data from recordings and video results. All the participants’ transcript was read correctly and carefully line by line [30].
3. Result and Discussion
The results of interviews that have been transcribed and coded according to the answers of the five participants interviewed show different results from each other. Categories of five participants can be seen in the following Table 1.

| Participant | Self-Efficacy      | Source for self-efficacy                      |
|-------------|--------------------|-----------------------------------------------|
| Any         | Low Self-efficacy  | Physiological and emotional state             |
| Andy        | High Self-efficacy | Mastery Experience                            |
| Betty       | Low Self-efficacy  | Social persuasion                             |
| Cathy       | High Self-efficacy | Mastery Experience                            |
| Davy        | High Self-efficacy | Mastery Experience                            |

3.1 Students's self-efficacy
Participants were asked several questions by researchers to find out how students' self-efficacy towards chemistry learning in buffer solutions. Five participants in the interview alternately and the results obtained were different. From the five students who showed high student self-efficacy were three participants namely Andy, Cathy, and Davy. Those who have low self-efficacy are Any and Betty. There were several statements expressed by participants which showed that they had high and low self-efficacy. When asked about self-efficacy, five participants did not know what was meant by self-efficacy. Then the participants were told by the researcher that students' self-efficacy was the ability to carry out and organize the assignments given. After being told what self-efficacy is, students begin to understand that students' self-efficacy is a form of self-confidence. Self-efficacy is about people judge that neither their capabilities nor abilities to organize and also execute courses to attain good performances [8]. Self-efficacy is a domain specific based on research indicated [11].

Three participants emphasized that they have high self-efficacy while learning chemistry with topic buffer solution. For example, for question: **Do you believe you can study chemistry, buffer solution?**
Andy: I am sure I can study chemistry, the topic of buffer solution.
Cathy: Yes, sure, because of the teacher's explanation and trying to apply it in the exercise.
Davy: Sure. If you feel you can't, always try to understand the material by asking friends and teachers or trying to find yourself
Any: I doubt. learning is lazy, so the results are not appropriate.
Betty: I am not sure. If the formula I understands, but if the concept it is difficult.

Participants when asked about their beliefs in learning chemistry, the topic of some buffer solutions expressed their excitement on the topic. others said they were sure, because there was a willingness to learn, understand the concepts that had been taught by the teacher, and try to practice the questions related to the buffer solution. Eggen and Khaucak in [11] stated that someone who has high self-efficacy is someone who has confidence in doing tasks and work successfully. Whereas, whereas, low self-efficacy is shown when someone only focuses on his doubts and inability to do something. In harmony with the statement raised by Ormrod that someone who has low self-efficacy is his uncertainty in completing a task. inversely proportional to high self-efficacy that is his belief in doing good activities [31].
Another question asked to see how student self-efficacy is **What is your response if you get a difficult task regarding chemistry, buffer solution?**

Any: I am confused first.
Andy: Think first, try, or ask the teacher later.
Betty: Confused and ask the teacher.
Cathy: Do it first, then try searching from internet or books and then ask. It is better to search first.
Davy: Do it by myself. See notes. And then ask a friend if I don't understand.

Two participants said the first response felt when faced with a difficult task was confused. While, three other participants claimed that the first thing to do was think about it then try to do it. Andy and Betty confused, but Andy, Cathy, and Davy try to think first. Someone has high self-efficacy will receive difficult tasks, approach these tasks and will be eager to do it [10] [11]. Actions such as avoiding difficult assignments, and avoiding learning that many show low student self-efficacy.

The next question is **What is your action on the difficult and challenging chemical task / problem? and When you have tried to do this difficult task, and have not found the desired results, what is your action?**

Any: I will find the ways first. Then tried and asked. And if I haven't found an answer yet, I will ask the teacher maybe. Ask for friends. Whoever can teach.
Andy: According to me, Search for other source information from the internet. If I don't find an answer, I have already counted but I haven't found it, I will ask to other classes, friends who know.
Betty: I will ask. If I am confused I will ask the teacher. If I can't, it's really will inconsequential.
Cathy: Try to do it. Try to learn about the basics concepts. Later it will be implemented. If it's still possible, try it. If it's difficult, still try to search from the other source.
Davy: Try to do it first. Ask others who are more capable

Someone is said have high self-efficacy seen from the effort and persistence in doing and completing the things that are ordered. As a whole of the five participants interviewed that participants indicated that there was more effort and persistence in studying chemistry, buffer solutions. Shown from the results of interviews obtained. There was a great effort, trying to rise from failure, persistent when the goal has not been achieved, and taking more time to work on tasks that have not been resolved or considered difficult is a characteristic trait of someone having high self-efficacy [11].

The next question is **when you're not sure about studying chemistry, how do you feel?**

Any: Stress. Confused becomes stressful.
Andy: No stress. If the intention of learning means to be done
Betty: Not too stress.
Cathy: No stress
Davy: Not too stress.

There was a sense of uncertainty to do chemical tasks or chemical questions, there was stress that engages the participant. there are also those who do not feel stressed because they assume that all these tasks when
they are intended to be learned will be done. Usually when someone is unable to control his anxiety and anxiety in doing something, in this case chemistry learning showed low self-efficacy. [11]

3.2 Sources for self-efficacy beliefs
There were four sources of self-efficacy. According to Bandura [8,12-14], someone has self-efficacy arises from mastery experiences, vicarious experiences, social persuasion as well as emotional and psychological states. From the results of the interview, there are three sources of Self-efficacy expressed by participants that can foster a sense of self-efficacy in learning chemistry, those were mastery experiences, social persuasion and emotional and psychological states. Andy, Cathy, and Davy assumed that their sense of self-efficacy spring up from mastery experience. Mostly, the participants who considered their studying strategy to learn about chemistry, buffer solution can improve self-efficacy to gain the understanding of chemistry topics [28]. Self-efficacy promotes cognitive task and the use of studying strategies, which enhances one’s performance. Therefore, a bidirectional relationship can be considered to exist between studying strategy and self-efficacy [32]. Any said that physiological and emotional state is a source of Self-efficacy in learning chemistry. Some people also depend on emotional and psychological conditions (physiological and emotional states) in themselves. They will make the condition when experiencing stress as a vulnerability which results in their performance being low [33]. Finally, Betty revealed that he obtained self-efficacy from social persuasion. Social persuasion (social persuasion) is the third way that strives to grow and strengthen one's self-confidence in acting to achieve success. A person who is verbally verbal will utilize his ability to master certain activities. Social persuasion (social persuasion) is the third way that strives to grow and strengthen one's self-confidence in acting to achieve success. A person who is verbally verbal will utilize his ability to master certain activities [33]. This can be seen from the fragments of conversations resulting from interviews.

Andy: Because of the experience from before. I have a lot of practice task too.
Betty: Because there is an invitation to take a chemistry course. I become more understanding and more confident to learn chemistry
Cathy: I always try my best to understand the topic and try to apply it in the task of chemistry
Davy: I often study alone, always try to find information about the chemistry assignment. So I have a lot of knowledge and be sure to learn

3.3 Effect of self-efficacy on students’ abilities
The effect of self-efficacy in several cognitive domains was also investigated by several researchers. self-efficacy is known to have an influence on changes in student performance, the learning process of self and student academic achievement [34].

3.3.1 Self-efficacy for cognitive
For cognitive abilities, students are asked some questions related to the their understanding the topic about buffer solution. Participant answers questions about the theory of buffer solutions. From the results of interviews obtained that Andy, Cathy, and Davy understand about the theory. Proven by the result from their answer from interview. The results of student interviews, pointed their individual mastery of in knowing and perceiving the concept of buffer solution. Participants were asked Explain the theory of buffer solution?
Andy: the buffer solution is a solution that can maintain pH. There was acid buffer solution and base buffer solution.
Betty: Buffer, that's the solution that can ... hmmm
The second answer above showed that there was a difference in knowledge between participants. There was a study that investigated the self-efficacy in chemistry of first-year chemistry students at a South African university as well as the impact of self-efficacy in cognitive skills [35].

3.3.2 Self-efficacy for psycho-motor

At this stage, the researcher wants to know the self-efficacy analysis on the buffer solution in laboratory. When asked questions about the tools and materials used at the time of the lab, all participants were only able to name some of the tools and materials used. From the 5 participants involved in this study, only one participant was able to name clearly the chemicals used more than the others, namely Andy by mentioned 4 chemicals and 3 laboratory tools. But as a whole the participants answered with little confidence in the answer, there is still some hesitation to put forward the answer. Explain laboratory tools and materials used in the buffer solution practicum?

Andy: I see. Those are CH₃COOH, NaOH, HCl, NH₃, Erlenmeyer and tube.

Previous research also said there was a connection between students' self-efficacy and psycho-motor aspects. Self-efficacy of students is a variable that is very important and influential in practicing in a chemical laboratory [36].

4. Conclusion

Self-efficacy is the ability of students to organize and organize all tasks assigned. someone is said to have high self-efficacy when you are able to accept all the difficult tasks, confident in his ability to complete the task that will be seen from the performance produced. in contrast to low student self-efficacy, it will tend to avoid difficult tasks because there is no trust and confidence in their ability to do the task. the performance results shown also have not shown good and satisfying results. Self-efficacy has important planning in the learning process. chemistry, especially the topic of buffer solution is also a difficult topic, so the high self-efficacy of students supports their ability to understand and complete assignments on the topic. These findings indicate that when participants were interviewed about self-efficacy when studying chemistry, the topic of buffer solutions. those who have high self-efficacy are Andy, Cathy, and Davy. Source for self-efficacy from the participants come from Physiological and emotional state, Mastery Experience, and Social persuasion.

References

[1]. Sönmez, V. (2012). Program geliştirmede öğretmen elkitabı.(17. Baskı) [Teacher’s Handbook of Curriculum Development (17th Ed.)] Ankara: AnıYayıncılık.
[2]. Bloom, B. S., Engelhart, M. D., Furst, E. J., Hill, W. H., & Krathwohl, D. R. (1956). Taxonomy of educational objectives: The classification of educational goals. Handbook I: Cognitive domain, Longman, New York.
[3]. Lynch, D.R., RussellJ.S., Evans, J.C., & Sutterer, K.G. (2009). Beyond the cognitive: the affective domain, values, and the achievement of the vision. Journal Of Professional Issues In Engineering Education And Practice. 135 :47-56.
[4]. Griffith, K. G., & Nguyen, A. D. (2006). Are educators prepared to affect the effectivedomain? Nat. Forum Teach. Educ. J.16(3),1-4.
[5]. Kan, A., & Akbas, A. (2006). Affective factors that influence chemistry achievement (attitude and self-efficacy) and the power of these factors to predict chemistr achievement, Turkish Sci. Educ, 3(1), 76–85.
[6]. Bloom B. S. (1979). New views of the learner: implications for instruction and curriculum, Childhood Education, 56:1, 4-11.
IOP Conf. Series: Journal of Physics: Conf. Series 1233 (2019) 012017    doi:10.1088/1742-6596/1233/1/012017

[7] Adkins, S. (2004). Beneath the tip of the iceberg. American Society for Training & Development. 58(2), 28–33.
[8] Bandura, A. (1993). Perceived self-efficacy in cognitive development and functioning. Educational psychologist. 28(2), 117-148.
[9] Woolfolk, A., (2007). Educational psychology tenth edition. Boston: The Ohio State University (Pearson).
[10] Santrock, J.W. (2010). Educational Psychology. New York: McGraw-Hill.
[11] Eggen, P., & Kluwak, D. (2010). Educational psychology. New Jersey, NJ: Pearson Merrill Prentice Hall.
[12] Bandura, A. (1997). Self-efficacy: the exercise of control. New York: Freeman.
[13] Bandura, A. (1997). Self-efficacy: toward a unifying theory of behavioral change, Psychol.Rev. 84 (2):191-215.
[14] Bandura, A. (1996). Social cognitive theory of human development. In T. Husen & T. N. Postlethwaite (Eds.). International encyclopedia of education (2nd ed., pp. 5513-5518). Oxford: Pergamon Press.
[15] Lent R. W., Brown S. D. and Larkin K. C. (1984). Relation of self-efficacy expectations to academic achievement and persistence. J. Couns. Psychol., 31(3), 356.
[16] Pajares F. and Kranzler J. (1995). Self-efficacy beliefs and general mental ability in mathematical problem-solving. Contemp. Educ. Psychol. 20(4), 426-443.
[17] Baldwin, J., Ebert-May, D., & Burns, D. (1999). The development of a college biology self-efficacy instrument for non-majors. Science Education, 83:397–408.
[18] Fairbrother, R. (2000). Strategies for learning, in Monk M. and Osborne J. (ed.). Good practice in science teaching. What research has to say, Philadelphia, PA: Open University Press, pp. 7–24.
[19] Bandura, A. (1997), Self-efficacy: toward a unifying theory of behavioral change, Psychol.Rev, 84 (2):191-215.
[20] Villafañe S. M., Garcia C. A. and Lewis J. E., (2014), Exploring diverse students’ trends in chemistry self-efficacy throughout a semester of college-based college majors. Chem. Educ. Res. Pract., 15(2), 114–127.
[21] Betz, N., & Hackett, G. (1983), The Relationship of mathematics self-efficacy expectations to the selection of science based college majors. J. Vocat. Behav., 22(3), 329-345.
[22] Nicolaidou, M., & Philippou, G. (2004). Attitudes towards mathematics, self-efficacy and achievement in problem-solving. Euro. Res. Math. Educ. III, Thematic Group 2, pp. 1-11.
[23] Villafañe, S. M., Xu, X., & Raker, J. R. (2016). Self-efficacy and academic performance in first-semester organic chemistry: testing a model of reciprocal causation. Chem. Educ. Res. Pract. 17, 973-984.
[24] Bandura A., Blanchard E. B. and Ritter B. (1969). Relative efficacy of desensitization and modeling approaches for inducing behavioral, affective, and attitudinal changes, J. Pers. Soc. Psychol. 13(3), 173-199.
[25] Sirhan, G. (2007). Learning difficulties in chemistry: an overview, Journal Of Turkish Science Education, 4 (2), 2-20.
[26] Sutherland, E. (2004). Beneath the tip of the iceberg, American Society for Training & Development. 58(2), 28-33.
[27] Bandura, A. (1993). Perceived self-efficacy in cognitive development and functioning. Educational psychologist. 28(2), 117-148.
[28] Woolfolk, A., (2007). Educational psychology tenth edition. Boston: The Ohio State University (Pearson).
[29] Santrock, J.W. (2010). Educational Psychology. New York: McGraw-Hill.
[30] Eggen, P., & Kluwak, D. (2010). Educational psychology. New Jersey, NJ: Pearson Merrill Prentice Hall.
[31] Bandura, A. (1997). Self-efficacy: the exercise of control. New York: Freeman.
[32] Bandura, A. (1996). Social cognitive theory of human development. In T. Husen & T. N. Postlethwaite (Eds.). International encyclopedia of education (2nd ed., pp. 5513-5518). Oxford: Pergamon Press.
[33] Lent R. W., Brown S. D. and Larkin K. C. (1984). Relation of self-efficacy expectations to academic achievement and persistence. J. Couns. Psychol., 31(3), 356.
[34] Pajares F. and Kranzler J. (1995). Self-efficacy beliefs and general mental ability in mathematical problem-solving. Contemp. Educ. Psychol. 20(4), 426-443.
[35] Baldwin, J., Ebert-May, D., & Burns, D. (1999). The development of a college biology self-efficacy instrument for non-majors. Science Education, 83:397–408.
[36] Fairbrother, R. (2000). Strategies for learning, in Monk M. and Osborne J. (ed.). Good practice in science teaching. What research has to say, Philadelphia, PA: Open University Press, pp. 7–24.
[37] Bandura, A. (1997), Self-efficacy: toward a unifying theory of behavioral change, Psychol.Rev, 84 (2):191-215.
[38] Villafañe S. M., Garcia C. A. and Lewis J. E., (2014), Exploring diverse students’ trends in chemistry self-efficacy throughout a semester of college-based college majors. Chem. Educ. Res. Pract., 15(2), 114–127.
[39] Betz, N., & Hackett, G. (1983), The Relationship of mathematics self-efficacy expectations to the selection of science based college majors. J. Vocat. Behav., 22(3), 329-345.
[40] Nicolaidou, M., & Philippou, G. (2004). Attitudes towards mathematics, self-efficacy and achievement in problem-solving. Euro. Res. Math. Educ. III, Thematic Group 2, pp. 1-11.
[41] Villafañe, S. M., Xu, X., & Raker, J. R. (2016). Self-efficacy and academic performance in first-semester organic chemistry: testing a model of reciprocal causation. Chem. Educ. Res. Pract. 17, 973-984.
[35] Ramnarain, U., & Ramaila, S. (2018). The relationship between chemistry self-efficacy of South African first year university students and their academic performance. *Chemistry Education Research and Practice, 19*, 60-67.

[36] Alkan, F. (2016). Development of Chemistry Laboratory Self-Efficacy Beliefs Scale. *Journal of Baltic Science Education, 15*(3) 2016.