PERIÓDICO TCHÊ QUÍMICA
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IMPLEMENTAÇÃO DO MODELO DE APRENDIZAGEM BASEADO EM PROBLEMAS PARA AUMENTAR A AUTO-CONFIANÇA E COMPREENSÃO DE ESTUDANTES DE GRADUAÇÃO ACERCA DO CONCEITO DE ELETROQUÍMICA NA EDUCAÇÃO QUÍMICA

IMPLEMENTATION OF PROBLEM-BASED LEARNING MODEL TO INCREASE SELF-CONFIDENCE AND UNDERGRADUATE STUDENTS UNDERSTANDING OF THE ELECTROCHEMISTRY CONCEPT IN CHEMICAL EDUCATION

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RESUMO

A química é uma das disciplinas científicas consideradas difíceis para a compreensão dos seus conceitos microscópicos e macroscópicos por parte dos alunos. Os estudantes também afirmam que esta disciplina é tediosa e complicada. Eles são incapazes de conectar o que é mostrado na estrutura visual ao processo e fenômeno. No contexto da automotivação dos estudantes universitários, há mais chances de expandir a estimulação da aprendizagem. Este estudo teve como objetivo melhorar a autoconfiança e o domínio de conceitos dos estudantes de ensino de química usando a aprendizagem baseada em problemas. Foi utilizado o método quase-experimental com o design do grupo de controle pré-teste-pós-teste não equivalente. A população incluiu todos os alunos da aula de eletroquímica da Universidade Lampung em 2019. A técnica de amostragem proposital empregada dividiu a amostra em dois grupos. O primeiro grupo foi chamado Classe A e foi considerado como a classe experimental - usando aprendizado baseado em problemas -. O segundo grupo, Classe B, foi considerado como a classe de controle - usando o modelo convencional em que o professor aplicava o método de fala na entrega dos materiais durante a aula -. A autoconfiança e o domínio de conceitos da classe A têm um valor n-Gain maior que a classe B e o resultado do tamanho do efeito é que a classe B tem um efeito maior que a classe A. Com base no resultado, pode-se concluir que a aprendizagem baseada em problemas tem um grande influência na melhoria da autoconfiança e do domínio de conceitos sobre o tema eletroquímico.

Palavras-chave: *aprendizagem baseada em problemas, autoconfiança, domínio de conceitos e eletroquímica*

ABSTRACT

Chemistry is one of the scientific disciplines considered difficult for students to understand its microscopic and macroscopic concepts. Students also claim that this discipline is tedious and complicated. They are unable to connect what is shown in the visual structure to the process and phenomenon. In the context of self-motivation among university students, there is a higher chance of expanding the stimulation of learning. This study aimed to improve self-confidence and the mastery of concepts of chemistry teaching students using problem-based learning. The quasi-experimental method was used with the design of the non-equivalent pre-test-post-test control group. The population included all students in the electrochemistry class at Lampung University in 2019. The purposeful sampling technique employed divided the sample into two groups. The first group was called Class A and was considered as the experimental class - using problem-based learning -. The second group, Class B, was recognized as the control class - using the conventional model in which the teacher applied the speech method in the delivery of materials during the class -. Class A's self-confidence and mastery of concepts have a higher n-Gain value than class B, and the result of the effect size is that class B has a more significant effect than class A. Based on the outcome, one can conclude that problem-based learning has a significant influence on improving self-confidence and mastery of concepts on the electrochemical theme.

Keywords: problem-based learning, self-confidence, concept mastering, and electrochemistry.

1. INTRODUCTION:

Either teachers or lecturers must develop their competence in teaching. Chemistry lesson needs experiences (Toshio, 2015; Ezazi and Nourian, 2016). A study has shown that students have difficulty experienced in solving a problem relating to the ability to visualize the structure and the processes that happened at a minimal level and relating between the phenomenons in chemistry at another level (Sunyono and Sudjarwo, 2018). Chemistry commonly refers to failure, boring, and the reluctance of most students (Nurhadi, 2004; Ayyildiz, and Tarhan, 2018). The condition can cause students hard to catch up with the materials given (Keller, 2016). The factor that causes the problems in chemistry is namely models, methods, and strategies that are not precisely used or not optimum used and the chemistry lesson itself.

Chemistry is a branch of science that involves either microscopic or macroscopic concepts, which cause students hard to understand and reluctant to continue their studies in chemistry (Sirhan, 2007). The ability to understand the idea must be improved moreover. (Sunyono and Meristin, 2018) shown that chemistry lesson must be guided to increase the student multi-representation both verbally and visually in order their ability to associate the chemistry phenomenon can be improved. Commonly students experience difficulty understanding the concept are namely misconception, incapable of interpreting information to relate to the chemistry topic given (Michaliskova and Proksa, 2018). More explained explicitly by (Tamani *et al*., 2015) that senior high school students do not have ideas and contact related to the thermodynamics concept.

The understanding of students' learning can help the teacher to manage strategies in teaching. A correct learning model applying is needed to solve the problems. Other researchers used problem-based learning (PBL) to solve chemistry problems are (Maysara, 2016; Ayyildiz, and Tarhan, 2017; Acar-sesen and Tarhan, 2013). The Basic concept of PBL model is to provide the basic concepts, instructions, references, or links and skills needed in the learning where the teacher becomes facilitator (Leou, Abder, Riordan, and Zoller, 2006; Yazar Soyadı, 2015). This is intended so that students enter the learning atmosphere more quickly and get an accurate 'map' of the direction and purpose of learning (Pratiwi, Cari, Aminah, and Affandy, 2019; Rani, 2018; Rudibyani, 2018). Furthermore, this is needed to ensure students get the primary key learning material, so there is no possibility of being missed by students as can happen if students learn independently. The concepts given need not be detailed, preferably in the form of outlines so that students can develop them independently in-depth (Nagarajan and Overton, 2019; Pratiwi *et al*., 2019). Problem-based learning is recently used widely and improved because this model has an underlying assumption that the students can solve the problems in their daily life so that the students have learned (Marra *et al.*, 2014).

The problem-based learning model is a learning model that presents contextual problems that stimulate students to learn. In classes that apply problem-based learning, students work in teams to solve real-world problems (Isaksen and Lauer, 1998; Madhuri, Kantamreddi, and Prakash Goteti, 2012; Raiyn and Tilchin, 2015). In this model, the students will be faced with the daily problems that relate to the topic given to activate the prior knowledge, and then the experience will be brought in collaboration in a small group to discuss the problem given (Affandy, Aminah, and Supriyanto, 2019; Pratiwi *et al*., 2019; Raiyn and Tilchin, 2015).

Schmidt *et al.*, (2011) shown something to be concerned about the problem given, it must: 1) Authentic 2) Adapted from prior knowledge 3) involve the students in discussion 4) guided to learning issues identification 5) stimulate self-directed learning (SDL) and 6) attractive. The effect of applying PBL with the pre-test/post-test method in learning compared to the conventional method in engineering students can increase the achievement (Yadev *et al.*, 2011).

In the PBL, the teacher gives the instructions then the student constructs their knowledge independently based on the guidance from the teacher. A teacher is a good facilitator in involving the students in collaboration, discussion, communication, and training their logic and critical thinking. The teacher that applied PBL helps the students to develop their ability that needed in daily life activities are namely cooperative, analysis, communicative, researching, synthesis, and problem solving (Abanikannda, 2016).

With PBL meaningful learning will occur. Students who learn to solve a problem will apply the knowledge they have or try to find out the knowledge needed (Isaksen and Lauer, 1998; Yazar Soyadı, 2015). Learning can be more meaningful and can be expanded when students are dealing with situations where the concept is applied (Isaksen and Lauer, 1998; Rosidin, Maskur, Kadaritna, and Saputra, 2019). Besides the cognitive aspect, namely the ability to mastering the concept, the affective aspect also needs to be concerned in chemistry learning. One of the characters is self-confidence. Self-confidence is the positive attitude of an individual in developing good values for both the environment and themselves. (Schmude, Serow, and Tobias, 2011). There is no study related to problem-based learning model and self-confidence in chemistry learning at school. The students in their studies need confidence.

Self-confidence can improve the achievement of the student academically in the cognitive test (Kleitman and Stankov, 2005). A class that has a diversity of student input will give pressure on their self-development. Moreover, self-confidence can be influenced by gender, just like showed in the study of Federicova *et al*l, (2018). Self-efficacy became a part of the self-esteem of a person. Around 46.82% of Mulawarman students showed self-efficacy to pass organic chemistry (Erika, 2017). The data of the Program for International Student Assessment (PISA) has shown that self- efficacy of the student affects their achievement both in academics and their attitude. To practice and improve the self-confidence of the students, the specific learning model is needed (Erika, 2017).

The proposed problem statement in this study is that "How does the application of PBL model improve the self-confidence and concept mastery of the student?"

Therefore, this study aimed to evaluate the effect of applying PBL model to the self-confidence and the concept mastery of the student in electrochemistry material at the university level.

2. MATERIALS AND METHODS:

The research method is quasi-experimental with a non-equivalent pretest-posttest control group design (Fraenkel, 2012; Sugiyono, 2013) to compare the PBL model and the conventional model. The design is shown in Table 1.

Table 1. *Research design (Fraenkel, 2012; Sugiyono, 2013)*

Class	Treatment		
Experimental	O_1	X	O_2
Control	O_1	-	O_2

Note: O_1 is pre-test; X is the PBL model, and O_2 is the post-test.

The participants who took part in the research consisted of 50 students in total for both classes (experiment and control class). Regarding the gender, it covers 30 female and 20 male students by age ranging from 20 to 21 years old. They sat in the first semester from the running academic year of 2019/ 2020 in their university calendar. There was no special exclusion or inclusion applied as the sample intended supposed to be diverse from age, gender, and character background. They had declared their agreement about to involve in the data collection from their responses to be used for scientific purposes without any term and conditions apply. They were two classes taken covering class A as the experimental that used a problem-based learning model and class B as the control group that used the conventional model. The random sampling was used as a sampling technique. The dependent variable in this research is the PBL model; the independent variable is self-confidence and concept mastery, while the control variable is the electrochemistry topic.

The type of data in this research was test result data of pre-test and post-test on concept mastery and self- confidence, the questionnaires of self-confidence, and also observation result of teaching-learning activity as the primary data. This research was used instruments to collect the data. Tools used in this research were pre-test and post-test questions about concept mastery that consist of 5 essay questions and 10 on questionnaires about self-confidence that comprised of 15 statements as described in Appendix 1 and 2. Besides that, there was an assignment paper, namely an observation sheet of PBL activity.

The validity and reliability of the instrument were analyzed with SPSS v.22 for windows software. The question validity was determined by comparing the r-table value (the fixed score of data showing the effectiveness) with the r-calculate value (the gained score data processing to see the significance) spreading by the range scale score is 1-100. The criteria are if the rtable < rcalculate then the question is valid. Cronbach's Alpha determined the reliability with the requirements of reliability degree (Arikunto, 2013; Istiyono, Mardapi, and Suparno, 2014; Mardapi, 2012).

The next is to know that the result applies to the population so that the t-test was conducted. Before it, the normality and homogeneity test was done to the pre-test and post-test results and the value of n-gain using SPSS v.22 for windows software. The normality test was determined by the value of significance (Sig). In the Shapiro-Walk column. In contrast, the homogeneity test was established by the value of sig. in the Test of Homogeneity of Variance Column.

3. RESULTS AND DISCUSSION:

3.1. Validity and Reliability

The result of the self-confidence instrument test is shown in Table 2 and Table 3 for the mastery concept. Based on Tables 2 and 3, all questions are valid. The result calculation of the instrument reliability test showed based on the value of Cronbach's Alpha is 0.904 for mastery concept and 0.958 for self-confidence, which means the instrument test has high criteria of reliability, so the test was stated valid and reliable.

3.2. The result of Pre-test and Post-test

The average of pre-test and post-test value of mastery concept of the student is shown in Figure 1. Based on Figure 1, the average pre-test value of the control class is 47.29, and the experimental class is 35.00. While for the average post-test value of the control class is 71.97 and the experimental class is 80.45. It showed that the value of the experimental class was more significant than the control class.

The averages value of self-confidence can be seen in Figure 2. As shown in Figure 2, the average initial value of the control class is 63.45, and the experimental class is 63.14, while after treatment, the value of the control class is 73.31 and the experimental class is 83.88. It showed that the value of self-confidence in the experimental class is greater than the control class.

Then the result of the n-gain value of concept mastery and self-confidence was observed. All the data processing result were generated for all aspects by considering the n-Gain value for the self-confidence form initial and final ability. The n-Gain value for concept mastery was generated from pre-test and post-test that was tested to the experimental class using PBL model and the control class using conventional one.

The result of the data processing result was shown in Figure 3. Based on Figure 3, the average n-gain value of self-confidence in the experimental class is 0.53 with the "medium" criteria, and the control class is 0.26 with "low" criteria. While the average n-gain value of concept mastery in the experimental class is 0.71 with "high" criteria, and the control class is 0.29 with "low" criteria. It showed that the average n-gain value in the experimental class has greater than the control class. The difference of n-gain caused by the treatment, the PBL model in the experimental class and the conventional model in the control class.

3.3. The result of normality and homogeneity test

Based on the normality test of self-confidence n-gain value in the experimental class known that the significant value is 0.311 is greater than 0.05 so can be concluded that the hypothesis where PBL contributed positively to the students understanding on chemistry concept was accepted or the data comes from the normally distributed population. Then, the significant value for self-confidence n-gain of the control class was 0,069 has greater than 0.05, so it means the hypothesis H0 was accepted or H1 was rejected, or the data comes from the normally distributed population. The normality test of concept mastery n-gain value in the experimental class has a significant value 0.754, while for the control class is 0.379, both of them were greater than 0.05, so the hypothesis H0 was accepted or H1 was rejected, or the data comes from the normally distributed population.

The sig obtained the homogeneity test of self-confidence n-gain value is 0.080, and for the concept, mastery is 0.271. The result showed that significant value is higher than 0.05 it means H0 was accepted or the variance of the population was homogenous.

3.4. The result of Independent Sample T-Test

The result of two average difference tests for self-confidence showed in Table 4, while the concept mastery aspect showed in Table 5.

Table 4. *Independent sample t-test self-confidence test value*

Class	The average value of n-Gain	*p sig (2-tiled)*
Experimental	0.53	0.000
Control	0.26	

Both the result was showed that the sig 2-tailed value is 0.000 < 0.05; it means that H0 was rejected, and H1 was accepted, or the average of n-gain in both aspects was higher in the experimental class with the PBL model than the control class with the conventional model. Hermawati stated that the concept of mastery of learning would be better if there were optimum students' involvement in the learning process (Hermawati, 2012). Fuaidah (2017) showed the contextual approach-based worksheet could improve the self-confidence of the student in mathematics learning.

Table 5. *Independent sample t-test value*

Class	The average value of n-	*p sig (2-tiled)*
Experimental	0.71	0,000
Control	0.31	

3.5. The calculation result of Effect Size

After the t-test of pre-test and post-test in both aspects self-confidence and concept mastery, then the value of tcalculate was used to calculate the effect size. The result of self-confidence showed in Table 6 and the concept mastery showed in Table 7.

Table 6. *Self-confidence Effect size Value*

Class	T_{count}	*Effect size*	Criteria
Experimental	-17.31	0.81	Large
Control	-10.73	0.63	Medium

Table 7. *Concept mastery Effect size Value*

Class	T_{count}	*Efeect size*	Criteria
Experimental	-21.634	0.87	Large
Control	-10.189	0.60	Medium

3.5. Implementation of the PBL model

The result in the experimental class showed in following Table 8.

Table 8. *Implementation of the PBL model*

Meeting	%	The average	Criteria
1	75.00	85.87	Very high
2	89.58		
3	93.05		

According to Table 8, the average value of the PBL model implementation in the experimental class increased from the first meeting to the third meeting, and it has “very high” criteria. These criteria showed that the learning activity ran well. The aspect that assigned in the implementation occupied the learning enthusiasm, student activity, team-work, and the last was the result.

The analysis result of the PBL model implementation with very high achievement showed that the student improved in the experimental class. The improvement of student's activity in the experimental class showed that learning activity ran effectively. This result in line with Warsita’s statement that a learning activity will run effectively if the student involved actively in organizing and founding the information. (Warsita, 2008). Wulandari (2011) stated the one of learning model that can solve the problem is the PBL model.

Students who learn to solve a problem will apply the knowledge they have or try to find out the experience needed (Adolphus, Alamina, Aderonmu, Education, and State, 2013; Bacong and S, 2015; Hake, 1998). In this situation, students integrate knowledge and skills simultaneously and apply them in relevant contexts. Learning can be more meaningful and can be expanded when students are dealing with cases where the concept is used. The facilitator presents the scenario or problem, and in the group, students carry out various activities (Lsaksen and Lauer, 1998; Wenno, 2010). First, brainstorming is carried out through all group members expressing opinions, ideas, and responses to scenarios freely, so that various alternative viewpoints can emerge. Each group member has the same right in giving and conveying ideas in discussions and documenting their own views in the working paper.

Also, each group must look for terms that are less well known in the scenario and try to discuss their intentions and their meanings. If there are students who know the meaning, immediately explain it to other friends. If there is a part that cannot be solved in the group, it is written in the group problem. Furthermore, if there is a part that cannot be solved in the group, it is written as an issue in the group's problem. Second, to make alternative selections to choose more focused opinions. Third, determine and carry out the division of tasks in groups to find references to solve the issues that were obtained. The facilitator validates the choices students make. At the end of the step, students are expected to have a clear picture of what they know, what they don't know, and what knowledge is needed to bridge it (Adolphus *et al*., 2013; Retno, Sunarno, and Marzuki, 2019). To ensure each student follows this step, defining the problem is done by following the instructions.

The PBL model is a learning model that

collaborate in problem-solving and founding the concept independently. This model is sufficient to improve creative thinking skills because the student was given the freedom to state their ideas from the inside of themselves and the environment that supports their learning activities (Tan, 2009).

Abanikannda (2016) stated that problem-based learning became a practical pedagogic approach insight of affective and pedagogic changes. Especially in the medical, architecture, and engineering fields for more than forty years.

Uce (2016) stated that in science learning, the PBL model helps the students to improve their ability in learning science procedures are namely observation, measurement, communicating, prediction, determining variables, suggesting a hypothesis, planning, experiment, and many other.

Hermawati stated that the concept mastery would be better if the students were getting involved in the learning activity processes. (Hermawati, 2012).

4. CONCLUSIONS:

It can be concluded that the applying of the PBL model has a significant effect on improving the self-confidence and concept mastery of the student in the electrochemistry topic. Problem Based Learning (PBL) is a learning model that encourages to be more active and maximize the ability of self-confidence to get solutions to problems in the real world. By implementing the PBL model, students can become more competent in solving and taking answers to a problem. Also, this method designs issues that motivate them to gain valuable knowledge so that they have their learning strategy and the ability to participate in discussion groups. The learning process uses a systemic approach to solving problems or challenges needed in everyday life. It has shown by the "very high" average percentage of the PBL implementation. The average n-Gain value of self-confidence is "medium" and "high" for concept mastery and also the value of size effect that categorized as "huge."

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Table 2. *The result of self-confidence instrument validity test*

Questions on Self- Confidence	r_{count}	r_{table}	Criteria
1	0.448	0.554	Valid
2	0.426	0.565	Valid
3	0.420	0.562	Valid
4	0.501	0.555	Valid
5	0.410	0.588	Valid
6	0.447	0.555	Valid
7	0.510	0.543	Valid
8	0.448	0.554	Valid
9	0.438	0.557	Valid
10	0.410	0.574	Valid

Table 3. *Results of Concept Mastery instrument validity test*

Questions on Concept mastery	r_{count}	r_{table}	Note
1	0.793	0.444	Valid
2	0.696	0.444	Valid
3	0.785	0.444	Valid
4	0,696	0.444	Valid
5	0.660	0.444	Valid

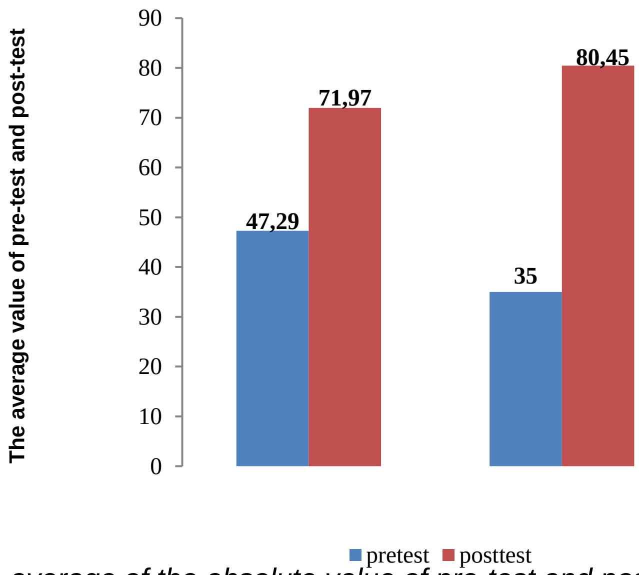

Figure 1. *The average of the absolute value of pre-test and post-test on concept mastery*

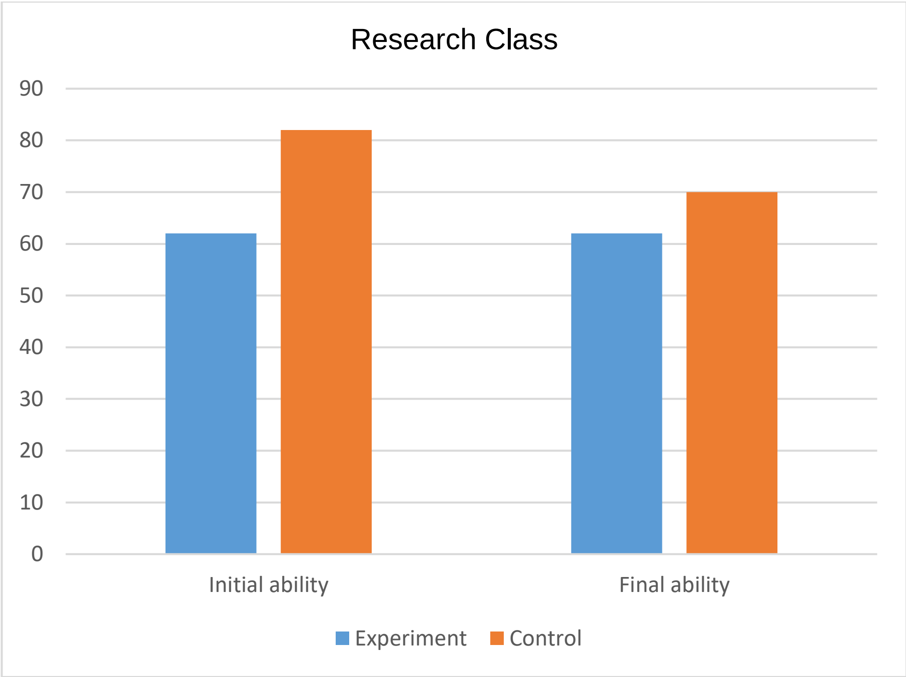

Figure 2. *The average of the absolute value of self-confidence*

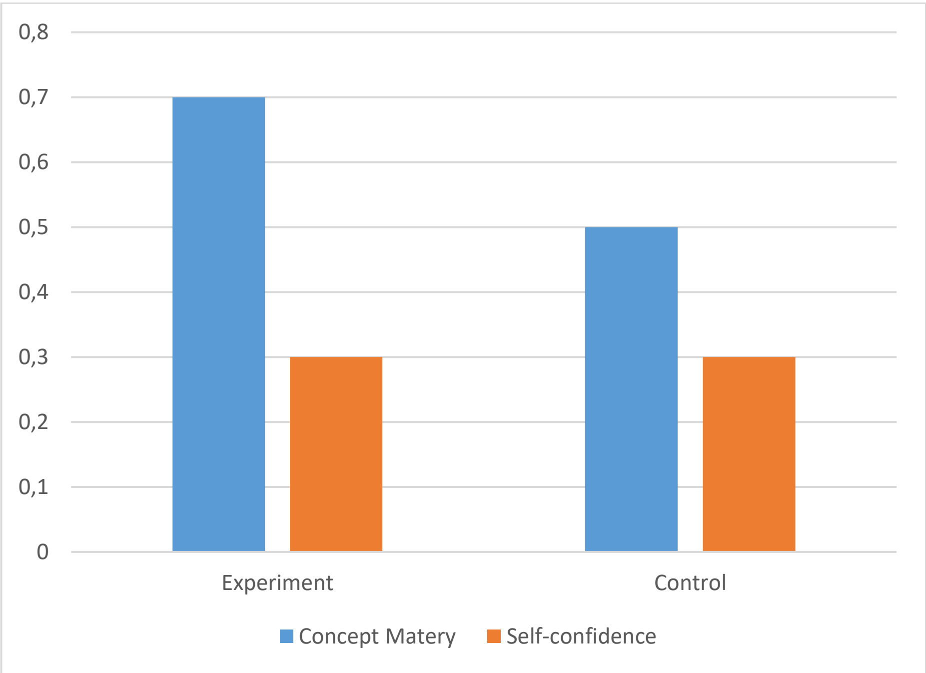

Figure 3. *The average of the absolute n-Gain value for self-confidence and concept mastery*

Appendix 1. The Students' Questionnaire on Self-Confidence

No	Questions	Never	Sometimes	Often	Always
1	When I see a new problem on the chemistry course, I can use what I have learned to solve the problem				
2	I can see what I can know to design and build something mechanical that works				
3	In laboratory activities, I can use what I have learned to design a solution				
4	I can effectively lead a learn to design and build a hands-on project				
5	I know where I can find the information that I need to solve severe problems				
6	I can use what I have learned to teach myself how to construct a chemistry formulation				
7	I can explain chemistry or related science to my friends to help them understand				
8	I can understand the basic concepts of chemistry easily				
9	I can get good grades in chemistry				
10	I can get good grades in laboratory practice				

Appendix 2. The Students' Test on Concept Mastery

No	Concept Mastery Indicator	Correct Answers (n =100) (%)	Correct Reasons (n =100) (%)
1	Understanding the principles of chemistry quantities measurement direct and indirectly, carefully, thoroughly, and objectively.		
2	Understanding the natural phenomena and their regularities in chemical reactions.		
3	Understanding the concept of reactions and oxidations and its changing concerning the laws of chemical equation.		
4	Analyzing concepts and principles of chemical reactions in various problem solving and technology products		
5	Understanding concepts and principles of chemical reactions and its application in various problem solving		