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The Effectiveness of the 3E Learning Cycle to Increase Mastery Concept of Material Solubility and Product of Solubility

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Abstract: The effectiveness of the 3E Learning Cycle to Increase Mastery Concept of Material Solubility and Product of Solubility. This study24 aims to describe the effectiveness of the 3E Learning Cycle (LC 3E) in Improving the Mastery of Solubility and Solubility Product Concepts. The population of this study was all students of class XI MIA SMAN 1 Natar 2018/2019. The sampling technique was purposive sampling, obtained class XI MIA 1 as the experimental class and XI MIA 4 as the control class. The method in this research is quasi-experimental with Non Equivalent Control Group Design. The data analysis technique is the difference between two means by t-test. The results showed that the average mastery of the n-gain concept in the experimental class and control class respectively 0.68 and 0.45 was the same as the moderate category. The t-test results show that there is a significant difference in the mastery of the n-gain concept between the experimental class using LC 3E and the control class using conventional learning. This shows that LC 3E is effective in improving the mastery of the concept of solubility and solubility product.

Keywords: LC 3E, mastery of the concept, product of solubility and solubility

Abstrak: Efektivitas Learning Cycle 3E untuk Meningkatkan Penguasaan Konsep Kelarutan Materi dan Hasil Kali Kelarutan. Penelitian ini bertujuan untuk mendeskripsikan keefektifan Learning Cycle 3E (LC 3E) dalam Meningkatkan Penguasaan Konsep Produk Kelarutan dan Kelarutan. Populasi penelitian ini adalah seluruh siswa kelas XI MIA SMAN 1 Natar 2018/2019. Teknik pengambilan sampel adalah purposive sampling, diperoleh kelas XI MIA 1 sebagai kelas eksperimen dan XI MIA 4 sebagai kelas kontrol. Metode yang digunakan dalam penelitian ini adalah eksperimen semu dengan Non Equivalent Control Group Design. Teknik analisis data perbedaan antara dua cara dengan uji-t. Hasil penelitian menunjukkan bahwa rata-rata penguasaan konsep n-gain pada kelas eksperimen dan kelas kontrol masing-masing 0,68 dan 0,45 sama dengan kategori sedang. Hasil uji t menunjukkan bahwa terdapat perbedaan yang signifikan penguasaan konsep n-gain antara kelas eksperimen yang menggunakan LC 3E dan kelas kontrol yang menggunakan pembelajaran konvensional. Hal ini menunjukkan bahwa LC 3E efektif dalam meningkatkan penguasaan konsep kelarutan dan hasil kali kelarutan.

Kata kunci: LC 3E, penguasaan konsep, hasil kali kelarutan dan kelarutan

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- **INTRODUCTION**

Natural Sciences (IPA) is systematic and universal knowledge that discusses a set of data that is generated based on the results of observations and experiments (Nastiti & Hinduan in Mahendrani, 2015). Science is concerned with finding out about nature systematically, so that Science is not only the mastery of a collection of knowledge in the form of facts, concepts, principles, but also a process of discovery (Mardwi, 2018). In line with this opinion, Widi & Eka (2014) stated that science is a group of knowledge that has special facts, namely studying factual natural phenomena, either in the form of events or causal relationships.

One branch of science is chemistry. Chemistry is a branch of science that studies matter which includes the structure, arrangement, properties and changes of matter, as well as the energy that accompanies it (Murtiningrum, 2013). In general, chemistry learning in schools only explains concepts, laws, and theories verbally without going through the process of discovering these concepts, laws, principles, and theories, thus causing the ¬ the interaction that occurs in only one direction and student interactions with students are rare (Compiler Team, 2008).

Based on the results of observations and interviews with chemistry teachers at SMA Negeri 1 Natar, it was obtained that the minimum completeness criteria (KKM) for students was 78 and the results of student achievement on the solubility material and the solubility product were 60%. This is still far from the teacher's expectation of at least 85%. This is because the dominant learning activity uses the lecture method. Learning in the classroom is dominated by teachers (teacher centered learning), only one-way communication occurs, and rarely does practicum and practicum only to prove theory, so that students become passive and are not guided to find concepts, as a result low student conceptual assumption.

Curriculum 2013 (K-13) is a character-based and competency-based curriculum (Drafting Team, 2013). Learning models that are in accordance with K-13, namely the applied learning process affects the ability of students to develop through cognitive approaches and attitudes with learning societies based on management. ¬ education, namely inquiry-based learning. (Drafting Team, 2013). According to Gulo (in Al-Tabani, 2014) the statement of inquiry strategy means a series of learning activities that involve all students' abilities to search for and take responsibility systematically, critically, logically, and analytically so that they can formulate their own findings by self-confident. To be able to develop these abilities, it is necessary to have a learning model that encourages students to search for, discover, and develop their own knowledge concepts.

One of the basic competencies (KD) of class XI MIA even semester that must be achieved in K-13 is KD 3.14 Predicting the formation of sediment from a reaction based on the principle of solubility and data of solubility results (Ksp) and KD 4.14 Processing and processing ¬ analysis of experimental data to predict the formation of ¬ sediment. To achieve KD, you can use a learning cycle learning model.

The 3E learning cycle model (LC 3E) is a teaching procedure that refers to inquiry activities and the stages in this learning model are suitable for increasing conceptualization, because it is oriented towards student activities, scientific concepts, exploration, deepening understanding. , and apply the concept to new situations (Sadi & Cakiroglu, 2010). The LC 3E learning model is a learning model based on student-centered constructivism theory which is implemented through a series of learning stages organized in such a way that students can master competences by participating (Palennari & Adnan, 2010). There are three stages in the learning model, namely the exploration stage (exploitation), the concept discovery stage (explanation), and the conceptual application stage (Lawson, 1988).

At the exploration stage, students work together in small groups and try their initial knowledge and make observations, for example students are given problems or phenomena in everyday life, such as NaCl salt which can dissolve in air in CaCO3 water contained insoluble in seawater. Then, to see why CaCO3 salt does not dissolve in air like NaCl salt, students did the experiment, so that the experimental data was obtained which would then be analyzed by the students. At this stage, students learn to seek and learn systematically, critically, logically, and analytically. At the concept discovery stage, students will discuss the questions that have been given based on the data from their observations and collect their own concepts of knowledge that they get according to the phenomena, so that students can relate facts with theory. At this stage students are guided to find concepts. Furthermore, at the concept application stage, students develop to apply the concept to new situations of the same or higher level.

Some research results related to the strength of the learning cycle learning model to improve concept mastery among them (1) Fitriana (2013) suggests that LC 3E learning can improve students' mastery of concepts on non-electrolyte and electrolyte solution material for class X SMA Negeri 1 Bukit Kemuning. (2) Nunggal (2013) states that LC 5E learning can improve students' inference skills and conceptual mastery in the material of reaction rate in class XI IPA MAN Poncowati. Based on the description that has been stated above, this article will explain the power of the LC 3E learning model to improve mastery of the concept of solubility material and solubility product.

▪ METHOD

The study population was all students of class XI MIA SMA Negeri 1 Natar for the 2018/2019 academic year with a total of 288 students. Sampling in this research was carried out by using purposive sampling technique. Based on the information provided by the chemistry teacher regarding the characteristics of the XI MIA class students of SMA Negeri 1 Natar, it is known that class XI MIA 1 and XI MIA 4 have almost the same cognitive abilities. The sample used as the experimental class, namely class XI MIA 1 and class XI MIA 4, was used as the control class.

The method used in this research is quasi experience with a non-equivalent control group design which is carried out on the two research classes. The experimental class used the LC 3E learning model, while the control class used conventional learning.

The variables in this study are the independent variables, the most advanced variables, and the control variables. The independent variable is the learning model used, namely the LC 3E learning model. The dependent variable is the conceptualization. The control variables are material solubility and product solubility (Ksp).

The learning tools in this research are the syllabus, lesson plans, and worksheets with the LC 3E learning model, while the instruments used are the pretest posttest questions and student activity sheets. The validity test of this instrument was carried out by means of judgment by the supervisor. The data obtained in this study were the pretest and posttest data on mastery of concepts, as well as student activities.

After obtaining the pretest data, then calculating the pretest average score using the following formula.

$$\text{Average score} = \frac{\sum \text{Pretest score}}{\sum \text{Student}}$$

After calculating the pretest average score, then the two mean similarity test was carried out. Before the two mean similarity test is applied, the prerequisite test is carried out first, namely the normality test and the homogeneity test using SPSS 23.0. The criterion for the normality and homogeneity test is accept H0 if sig. (*2-tailed*)> 0.05, which means that the sample comes from a normally distributed population and the two research classes have homogeneous variances.

The sample in this study comes from a population that is normally distributed and the two research classes have homogeneous variances, so that the two-average similarity test is carried out by a para¬metric statistical test, namely the t test using *independent sample t -test* using SPSS 23.0.

Hypothesis formulation:

$H_0 : \mu_1 = \mu_2$ (The average score of the pretest mastery of the first class concept of the explaining experiment use the LC 3E model equal to the mean pretest scoreusing conventional learning)

$H_1: \mu_1 \neq \mu_2$ (The pretest average score of the experimental class concept mastery using the LC 3E model is not the same as the average score of the pretest class using conventional learning).

Information:

µ1: The average score of the experimental class mastery pretest that uses model LC 3E.

µ2: The average score of the pretest of mastery of class concepts using learningconvention¬onal.

Furthermore, the experimental class applied the LC 3E learning model and the control class with conventional learning. Then the two classes were post-tested. The pretest and posttest data are used to calculate the n-gain of concept mastery with the formula according to Meltzer (2002):

$$n\text{-}gain = \frac{\text{Posttest scores - pretest scores}}{\text{Maximum score-pretest score}}$$

After the ¬n-gain data is obtained, then calculate the n-gain average with the following formula:

$$n\text{-}gain \text{ average} = \frac{\sum n\text{-}gain \text{ all students}}{\sum \text{All student}}$$

The n-gain classification according to Hake (1998) is as presented in Table 1.

Table 1. Classification *n-gain*

The size <g>	Interpretation
(<g>) ≥ 0,7	High
0,3 ≤ (<g>) < 0,7	Moderate
(<g>) < 0,3	Low

Then the prerequisite test is carried out, namely the normality and homogeneity test. The result of the test is that the data is normally distributed and homogeneous, then a hypothesis test is carried out with the two-mean difference test with a parametric statistical test, namely the t test using the *Independent sample t-test* using SPSS 23.0.

Hypothesis formulation:

H0: $\mu 1 \leq \mu 2$ (the average n-gain of conceptualization with the LC 3E learning model is lower or equal to the average n-gain of acquisition concept of students with conventional learning).

H1: $\mu 1 > \mu 2$ (the average n-gain of student conceptualization with the LC 3E learning model is higher than the n-gain average of students' conceptual mastery with conventional learning) .

Information:

$\mu 1$: n-gain mean of student conceptualization with LC 3E learning model.

$\mu 2$: n-gain is the average control of students' concepts with conventional learning.

▪ RESULTS AND DISCUSSION

Based on research conducted at SMA Negeri 1 Natar, data obtained from the test results in the form of concept mastery pretest and posttest scores and student activity data. The data is then processed using Microsoft Excel and SPSS 23.0 applications.

The results of the two mean similarity test

After obtaining data in the form of concept mastery pretest and posttest scores from the experimental class and the control class, then calculate the average pretest score of each class to find out the students' understanding of the initial concepts in the experimental class and in the control class. . The mean score of the conceptual pretest is presented in Figure 1.

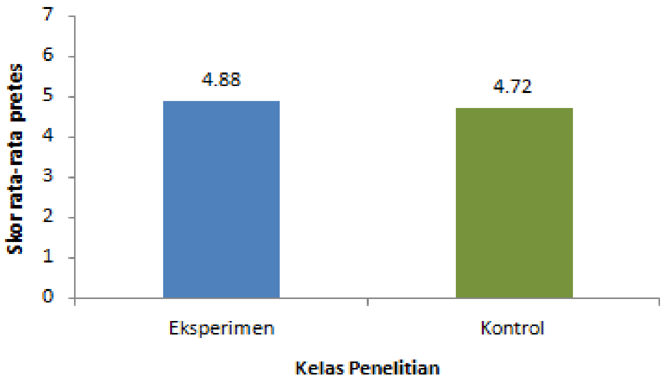

Figure 1. Mean pretest score mastery of concepts

In Figure 1, it can be seen that the pretest average score of concept mastery in the experimental class using the LC 3E learning model with the control class where conventional learning is not much different, this shows that the initial ability of students' concept mastery in both the experimental class and the control class is almost same. To find out the significant similarity, the two mean similarity test with the t test is applied. Before this is done, the prerequisite test is carried out first, namely the normality test and the homogeneity test to determine whether the data is normally distributed and homogeneous to the concept mastery pretest score in the experimental class and the control class. The results of the normality test are presented in Table 2.

Table 2. Test for normality of average scores the concept mastery pretest.

Pretest Score	*Kolmogorov-Smirnov*		
	Static-tick	df	Sig
Experiences	0,122	36	0,192
Control	0,130	36	0,128

The normality test is carried out using the *Kolmogorov-Smirnov* test, with the normality criteria at the *Kolmogorov-Smirnov* sig value. > 0.05. ¬ based on the normality test, it appears that sig. the concept mastery pretest in the experimental class and control class is greater than 0.05. This shows that accept H0, which means that the conceptual control pretest score data obtained from the experimental class and the control class come from a normally distributed population.

Then the homogeneity test was carried out using SPSS 23.0 with the *levene statistical* test, with the criteria being homogeneous if the value was sig. > 0.05. The value of sig is obtained. the concept mastery pretest in both the experimental class and the control class is 0.990, so it is greater than 0.05, then accept H0, which means that the two research classes have homogeneous variances. Based on the results of the normality and homogeneity tests that have been carried out, it was found that the pretest scores of conceptualization from the experimental class and the control class met the criteria for data with normal distribution and homogeneity. Then the two mean equality test was carried out using a parametric statistical test, namely the t test using the *Independent sample t-test*. Based on the results of the SPSS 23.0 *output*, it shows that sig. (2-tailed) obtained is 0.704, so that it is greater than 0.05 then accept H0, which means the average score of the concept mastery pretest in the experimental class that uses LC 3E learning is the same as the average score -a mean mastery of concepts in control class with conventional learning.

Concept mastery *n-gain* data

After calculating the average score of the concept mastery pretest, then calculating the average *n-gain* to determine the increase in the pretest and posttest scores of the two classes. The following is the *n-gain* data on the average concept mastery in the experimental class and control class which is presented in Figure 2.

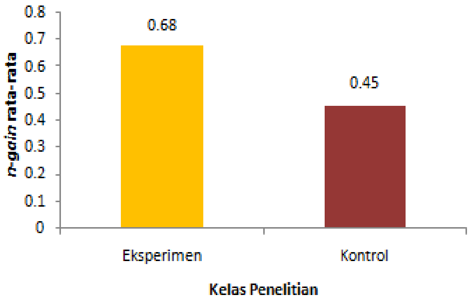

Figure 2. Average n-gain mastery of concepts

Based on Figure 2, it can be seen that the *n-gain* average of concept mastery in the experimental class and control class is different, even though they are both in the moderate category. To find out the significant difference, a difference test of the two means was carried out.

Before the two-average difference test is carried out, the prerequisite test is first carried out, namely the normality and homogeneity test of the *n-gain* data on average mastery of concepts. The following are the results of the *n-gain* normality test for the average mastery of concepts in the experimental class and control class which are presented in Table 3.

Table 3. The results of the n-gain normality test the experimental class average and control class

n-gain	*Kolmogorov-Smirnov*		
	Statistic	df	Sig
Experiment	0,126	36	0,163
Control	0,126	36	0,159

This normality test is carried out using the *Kolmogorov Smirnov* test, with normality criteria at the *Kolmogorov-Smirnov* sig value. > 0.05. Based on Table 3, it shows that the results of the n-gain normality test for mastery of concepts in the experimental class and control class are obtained sig. greater than 0.05, then accept H0, which means the average *n-gain* data on concept mastery obtained from the two classes of a normally distributed population.

Then the homogeneity test was carried out using SPSS 23.0 with the *levene statistical test*, with the criteria being homogeneous if the value was sig. > 0.05. The value of sig is obtained. The *n-gain* of concept mastery obtained in the experimental class and control class is 0.272, so it is greater than 0.05, so accept H0, which means that the two research classes have homogeneous variances. Based on the results of the normality and homogeneity tests that have been carried out, it was found that the average n-gain of the conceptual mastery of the experimental class and control class met the criteria for normal and homogeneous distribution of data, so the test for the difference between the two averages was carried out using the parametric statistical test, namely the t test. using the *Independent sample t-test.*

The two-mean difference test was used to determine the significant *n-gain* difference in concept mastery between the experimental class and the control class. ¬ based on the output of SPSS 23.0, Sig. *(2-tailed)* which is 0,000. Hence Sig. *(2-tailed)* obtained <0.05, then accept H1, namely the average *n-gain* of mastery of concepts in the experimental class using the LC 3E learning model is higher than the *n-gain* average of mastery of the concept of the control class using conventional learning. Based on this, there is a significant *n-gain* difference in concept mastery between the experimental class using the LC 3E learning model and the control class with conventional learning, so it can be concluded that the LC 3E learning model is effective. to improve the conceptualization of material solubility and solubility results.

To find out why the LC 3E learning model is effective for increasing the mastery of the concept of solubility material and solubility results, it will be explained the stages of the LC 3E learning model carried out during the study.

Exploration stage (exploration)

The exploration stage is the first stage of the LC 3E learning model. At the first meeting in the experimental class, the teacher distributed LKS 1 to each group that had been formed previously and provided indicators, as well as learning objectives. The teacher observes that some students look confused and this is the first time they have this kind of learning. At this stage, the teacher first asks questions about the solubility of salt, then students are given a discourse that contains phenomena or problems, data, and initial information to develop and understand deeper concepts.

In LKS 1 learning, the teacher gives a problem or phenomenon in daily life to students, such as NaCl salt can dissolve in seawater while CaCO3 salt contained in shellfish is difficult to dissolve in seawater, then continued by introducing the presence of other salts besides NaCl and CaCO3 salts. After that, students are given problems, such as "If 1 gram of CaCO3 and 1 gram of NaCl salt is provided, then both are dissolved in 100 ml of distilled water, what do you think the ratio of the mass of CaCO3 and NaCl substances are soluble? "," Which is the most soluble amount of substance between CaCO3 and NaCl? "," Is there a difference in solubility between CaCO3 and NaCl compounds? ", and" What is the meaning of solubility? ". However, students still find it very difficult to receive information and are still being guided by the teacher.

Then the students did experiments regarding the solubility of the gam¬ram, some of the students were still playing and not conducive, so the students were less active in experimenting, then when weighing and adding salt. Little by little the students still look stiff and unfamiliar, so the teacher directs and guides the students to get used to weighing and adding salt little by little. This shows that students are not accustomed to doing experiments.

In the lesson in LKS 2, students are asked to observe and complete the table for the product of solubility (Ksp) and solubility (s) for each of the basic insoluble salts, then write down the reaction equation, the number of ions, the Ksp formula and the solubility of the salt. In the learning process students begin to be conducive and begin to observe and understand the data presented, while some other students are still confused about filling in the table to determine the number of anions and cations. Then the teacher guides students to complete the Ksp table from salt or base which is difficult to dissolve. After that, students are given questions about "How is the relationship between Ksp and solubility (s)?".

In the lesson in LKS 3, the teacher presents a discourse about Ca (OH) 2 which is dissolved into 2 beakers each containing water and 0.1 M NaOH solution. After that, the teacher gives problems to the students, namely " Which has the higher solubility, Ca (OH)

2 in water or Ca (OH) 2 in 0.01 M NaOH solution? ". Then the students did experiments on the effect of the dissolution of the namesake ion and wrote the experimental data into the observation table. This experiment aims to arouse students' curiosity and receive information on the problems given. When doing the experiment, the students looked no longer confused about what to do during the experiment, according to the procedure given, and the students were already able to work well with their groups.

In the learning phase in LKS 4, students observed the discourse in the form of Ca (OH) 2 salt dissolved into 3 beakers containing water, HCl solution, and NaOH solution. Most of the students were active in observing the discourse. After that, the students were given a problem, namely "If the Ca (OH) 2 salt is dissolved with 20 mL of distilled water, 20 mL of 0.01 M NaOH solution, and 20 mL of 0.01 M HCl solution in which solution is the amount of Ca (OH) 2 salt dissolved a lot. ? ". At this stage, it provides an opportunity for students to collect information about the effect of pH on solubility.
Furthermore, in the lesson in LKS 5, students observe a discourse about a chemical reaction that can produce sediment. After that, the teacher gave problems to students, namely "In what conditions can a sediment be formed?". At this stage, student activities are more enhanced than previous learning, communication and student cooperation are increasingly well-established, learning is carried out effectively. Thus, at the exploration stage, students have been trained to search for information through providing phenomena and problems at each meeting, so that it will arouse curiosity and motivate students to find solutions to these problems.

The concept discovery stage *(explanation)*

This explanation stage is the second stage of the LC 3E learning model. In this stage, students are asked to relate the information obtained in the previous stage with the questions presented to build concepts on the solubility material and the solubility product.

At the explanation stage of LKS 1, students are asked questions that will help to build concepts about the meaning of Ksp. In the learning process, most students are not active and are still confused about how to answer questions, so the teacher guides and directs students to answer questions based on the results of the experiments that have been carried out, and helps students in connect information that has been obtained previously.

After the students finished working on and answering the questions, then one of the groups presented the results of their answers. It is hoped that other groups can respond and complement if there are incorrect answers. Initially most of the groups seemed inactive in exchanging opinions, so the teacher directed and guided them back so that the discussion ran actively. At this explanatory stage, students are able to explain and conclude the meaning of the constant product of solution (Ksp).

The learning stage in LKS 2, each group discussing to answer the questions provided in the LKS. During the discussion, each group began to appear active in seeking answers and exchanging opinions to find concepts about the relationship between solubility and Ksp. After all the questions were answered, one group explained how the results of the findings of the concept were. The other group who listened also responded to the answers given and the discussion went smoothly.

In the learning phase in LKS 3, LKS 4, and LKS 5, students will find the concept of the effect of the namesake ion on solubility, the effect of pH on solubility, and precipitation reactions. At this stage, students' accuracy and accuracy is needed because there are many concepts that must be understood from previous learning. In the learning process, students begin to get used to connecting the information obtained with the questions given and students can work well with the group and each group looks more active in responding to and exchanging opinions with each other, so that the discussion goes well and is active.

. In addition, students are more courageous and confident in expressing their own opinions from the concepts they find. Thus, students have been trained to relate the information obtained previously with the questions given, so that students can find, build, and master their own concepts.

This is in line with research conducted by Nur (2014) which states that the LC learning model which is applied to the learning process emphasizes student activity to seek, find, and connect information previously obtained through teacher guidance and guidance. Thus, the explanation stage can help students to build their own concepts.

The concept application stage (elaboration)

After obtaining the information, then connecting the information with the problem or question and being able to find and build the concept itself, the next step is to apply the concept to a different problem. In the elaboration in LKS 1, students worked on questions to determine the Ksp formula from AgCl, PbCl2, and Ca3 (PO4) 2 compounds and determined the solubility of Ag2CrO4 compounds. At this stage, the student's answer is correct, it's just that the student's accuracy is still lacking in writing the rank and giving the unit name to the answer.

Furthermore, in the elaboration of LKS 2, students worked on the relationship between the solubility (s) and the solubility product (Ksp) of compounds Hg (CN), Mn (OH) 2, and Ni3 (AsO4) 2 and me¬ determine how much mass of MgC2O4 can dissolve in 250 ml of water. Even though there were students' answers that were not quite right in LKS 2, the teacher again guided the students to be able to correct the incorrect answers.

In the elaboration of LKS 3 students worked on problems comparing and explaining the solubility of AgCl in pure water and 0.1 M NaCl solution. Then, in the elaboration of LKS 4 students worked on questions about how the solubility of Cu (OH) 2 in HCl solution and in NaOH solution and calculate the solubility of Cu (OH) 2. Then, in the elaboration of LKS 5 students worked on questions to predict whether PbCl2 deposits were formed when 1 ml of Pb (NO3) 2 0.01 M solution was added to 1 ml of 0.01 M NaCl solution. , and LKS 5 has answered well.

Based on the activities that have been carried out during the learning process using the LC 3E learning model, it proves that the LC 3E learning model is effective for increasing mastery of the concept of solubility material and the product of solubility. This is in line with Cholistyana's research (2014), which states that the LC 5E learning model provides opportunities for students to improve learning activities and also provides pleasant learning conditions so that it affects their learning outcomes.

▪ CONCLUSION

Then the two mean equality test was carried out using a parametric statistical test, namely the t test using the Independent sample t-test. Based on the results of the SPSS 23.0 output, it shows that sig. (2-tailed) obtained is 0.704, so that it is greater than 0.05 then accept H0, which means the average score of the concept mastery pretest in the experimental class that uses LC 3E learning is the same as the average score-a mean mastery of concepts in control class with conventional learning.

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