Student’s learning outcomes through the application of guided inquiry learning model based on scientific approach in fundamental chemical laws

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Abstract. The discovery learning model is a learning model which can be implemented in the Curriculum 2013 in Indonesia. However, the student’s learning outcomes of chemistry subject at SMAN 7 Palu using this learning model are not satisfactory because the students’ scores have not passed the passing grade. Therefore, it is needed other learning model that has the characteristics of the scientific approach to be implemented. The purpose of this study is to see whether the application of the guided inquiry learning model based on the scientific approach in Fundamental Chemical Law topic can provide better learning outcomes for students in class X of SMA Negeri 7 Palu compared to the discovery learning model. The research method was a quasi-experimental study by conducting the experimental group and control groups. The results obtained by this study, to be precise the learning achievement data reached 92.1% to 96.05% in the experimental class 1 and 91.35% - 94.75% in the experimental class 2. While student’s learning outcomes obtained an average of 56.48 and 46.25 with a standard deviation of 11.07 and 11.98. These values prove that the guided inquiry learning model to provide better learning outcomes compared to discovery learning. Furthermore, based on the two samples t-test results obtained, it was found that - t<sub>table</sub> < t<sub>count</sub> + t<sub>table</sub> (<-1.68 < 2.99 > +1.68) with a significant level (∝ = 0.05) and degrees of freedom 41. Consequently, it can be inferred that the implementation of the guided inquiry learning model based on the scientific approach in the Fundamental Chemistry Law topic can provide better learning outcomes for class X students of SMA Negeri 7 Palu.

1. Introduction
At present, the curriculum used by schools in Indonesia is the Curriculum 2013 (K-13) which is a refinement of the previous curriculum, namely the Curriculum 2006 or Kurikulum Tingkat Satuan Pendidikan (KTSP) [1][2]. The K-13 aims to create productive, imaginative, innovative and effective Indonesian people through reinforcing perceptions, awareness, and skills [3]. The learning design that characterizes K-13 is a scientific approach whose application procedures have stages of observing, questioning, reasoning, trying, then communicating what is expected to produce students who have good attitudes, knowledge, and skills [4].
SMA Negeri 7 Palu is the state senior high schools in the Palu city, Central Sulawesi. This school has already implemented K-13 where the learning process prioritizes the active role of students (students cantered learning) and teachers only as facilitators [5][6]. Therefore, the learning models that are applied in the learning process in this school are models of learning that conform to characteristics of K-13. For chemistry subjects, the learning model used is the discovery learning model.

Discovery learning refers to learning that occurs when students are involved in experiences and experiments, where they get their own knowledge and concepts [7][8]. According to [9], the discovery learning model emphasizes the importance of understanding a concept through active student involvement in the process of learning. This learning model emphasizes the formation of student knowledge from experience during learning. Learning activities by means of this discovery can increase student interest in learning including chemistry in a more fun way [10]. However, based on interviews with teachers in SMA Negeri 7 Palu, there was a problem in the chemistry subject, especially in the Fundamental Chemical Law topic. The scores obtained by students on the average learning outcomes obtained by students were 71.65 that value still does not reach the passing grade which is 75.00. Although, the learning process already has used the discovery learning model. Teachers predicted the problem was for some reason. Some of the reason was this model is still new for the teachers, the model was still not known to the students, and students lack understanding between concept and calculation.

Based on the description previously, it is needed another learning model that can trigger the achievement of learning outcomes to meet the passing grade. One of them is by applying a scientific learning models such as the guided inquiry learning model. The guided inquiry learning model is a learning model that has steps to solve issues, plan experiments, conduct experiments, collect and analyse data, and draw conclusions [11][12]. The use of guided inquiry learning models on teaching process, students can be invited to observe phenomena in daily life will gain experience of the discovery of concepts through teacher guidance. In learning with a scientific approach, students can observe, ask, reason, try, and present their own experiments that occur and can measure, and analyse data directly. Guided inquiry based on scientific approach will lead students to be active in the teaching-learning process and be able to apply the scientific method so that learning is no longer teacher-cantered. In addition, the scientific approach can improve the ability of students to observe, have a positive impact on their soft skills.

The objective of this research is to understand what learning model can give a better learning outcome of students’ class X in SMA Negeri 7 Palu on Fundamental Chemical Law topic, the guided inquiry learning model the discovery learning model.

2. Method
This research was a quasi-experimental study by conducting two groups, namely an experimental group that was taught with a guided inquiry learning model and a control group with a discovery learning model. It was conducted in SMA Negeri 7 Palu. The population was students of class X that registered in academic year 2018/2019. Sampling technique was purposive sampling, where class X MIA 1 as the experiment group and class X MIA 2 as the control group. Therefore, the study design used was pretest-posttest control group design as can be seen in Table. 1.

| Group | Pre-test | Model | Post-test |
|-------|----------|-------|-----------|
| A     | O₁       | X₁    | O₂        |
| B     | O₁       | X₂    | O₂        |

Information:
A : Experiment Group
B : Control Group
O₁ : Pre-test of Fundamental Chemistry Law
X₁ : Guided inquiry learning model based on scientific approach
X₂ : Discovery learning model
O₂ : Post-test of Fundamental Chemistry Law

The instruments compiled to obtain research data were the Learning Implementation Plan (RPP), Student Worksheet (LKPD), Implementation of the RPP’s sheets, and Learning Outcomes Test that used in pre- and post-tests. The research data were analysed using a descriptive statistical analysis method and an inferential statistical analysis.

The descriptive statistical analysis techniques are used to describe the achievement of each variable. The relationship between the pre-test and post-test in the experimental group and the control group, including the highest score, lowest score, range, average, standard deviation and the N-gain test, is determined by the description of the achievement of each variable.

Meanwhile, the inferential statistical analysis is used to test the hypothesis and then draw conclusions. Before testing the hypothesis, the prerequisite test is carried out including the normality test and the homogeneity test.

3. Result and Discussion
The results of this study cover the implementation of learning process by the teacher and student activities during the learning process, also the students’ learning outcomes. These results were observation during the teaching and learning process in both classes, class X MIA 1 using the guided inquiry learning model (the experimental group) and X MIA 2 using the discovery learning model (control group).

Observation of the implementation of learning model was done to determine the effectiveness of the learning process with guided inquiry learning models in the experimental group and discovery learning models in the control group. By knowing the effectiveness can be useful, because it can describe the improvement of teacher and student activities, even the student’s critical thinking skills [13]. The obtained data, in the first meeting was 96.05%, in the second meeting was 90.78% and in the third meetings was 92.10%. While in the control group at the first meeting was 92.50%, the second meeting was 94.75% and 91.35% at the third meeting. These results show that there was no significant difference in the implementation of learning model. The data can be seen clearly in Table 2.

| Group | 1st Meeting | 2nd Meeting | 3rd Meeting |
|-------|-------------|-------------|-------------|
| A     | 96.05%      | 90.78%      | 92.10%      |
| B     | 92.50%      | 94.75%      | 91.35%      |

Based on Table 2, the implementation of guided inquiry learning model for every meeting was started 90.78% to 96.05% while for discovery learning model was started 91.35% to 94.75%. These values showed that both of models are representative for scientific approach in learning process that requirement of the curriculum 2013 in Indonesia [14].

Student learning outcomes are one aspect of the achievement of the implementation of the learning process. Because student learning outcomes are essentially change in behaviour as a result of learning that covering the cognitive, affective and psychomotor aspects. Student learning outcomes in this study are obtained from multiple-choice tests that are given after the overall teaching and learning activities for the Basic Chemistry Law topic. However, before the teaching and learning process, a pre-test for every group was conducted. The obtained data on student learning outcomes in the experimental group and the control group is described in Table 3.
Table 3. Observation results during implementation of learning model.

| Description | Experiment Group | Control Group |
|-------------|------------------|---------------|
|             | Pre-test | Post-test | Pre-test | Post-test |
| Sample      | 21       | 21       | 22       | 22       |
| Min Score   | 20       | 65       | 15       | 60       |
| Max Score   | 45       | 90       | 40       | 85       |
| Average Score | 30.24   | 56.48    | 25.23    | 46.25    |

Based on Table 3 above, it can be seen that there is a tendency that the learning outcomes of students in the experimental group is greater than in the control group. This shows that guided inquiry learning model can be more activated student in learning compared to discovery learning model.

To obtain information on the increasing of score before and after implementation learning model, normalized-Gain (n-Gain) was determined on both groups. N-Gain was calculated based on equation 1 [15].

\[ n - Gain = \frac{\text{Score}_{\text{post-test}} - \text{Score}_{\text{pre-test}}}{\text{Score}_{\text{max}} - \text{Score}_{\text{pre-test}}} \]  

(1)

Category:
- g-height = value \((<g>) \geq 0.70\)
- g-moderate = value of \(0.30 \leq (<g>) < 0.70\)
- g-low = value \((<g>) < 0.30\)

The results of the N-Gain based on the data’s above with Eq. 1, in the experimental group obtained, was in moderate category (9 students) and in height category (12 students). Similar to in the experimental group, the control group was also in medium category and height category, however the different just in the number of students where 12 students in medium category and 10 students in height category. It means there is an increasing score of students before and after when both models were implemented in classes.

In this study, the data were analysed by the normality and the homogeneity tests before applied the statistical test [12]. The normality test aims to determine whether the data is normally distributed or not. The data are normally distributed if it meets \(\chi^2_{\text{count}} \leq \chi^2_{\text{table}}\). The normality test used the Chi-Square formula [16] (equation 2).

\[ \chi^2 = \sum_{i=1}^{k} \frac{(O_i - E_i)^2}{E_i} \]  

(2)

Explanation:
- \(O_i\) = the observation frequency
- \(E_i\) = the expected frequency
- \(k\) = the number of class interval

Based on the calculation by using equation 2, the data of Group A and B were normally category. The value of \(\chi^2_{\text{count}}\) for Group A was 3.97 and \(\chi^2_{\text{table}}\) was 5.99. Moreover, the value of \(\chi^2_{\text{count}}\) for Group B was 5.21 and \(\chi^2_{\text{table}}\) was 5.99.

The homogeneity testing is intended to determine the similarity of two variances, homogeneous or non-homogeneous. For this purpose, the F test was conducted. Two variances are called homogeneous if they meet the criterion if \(F_{\text{count}} < F_{\text{table}}\). The homogeneity test [17] used the equation 3.

\[ F = \frac{\text{largest variance}}{\text{smallest variance}} \]  

(3)

The calculation results obtained based on equation 3, that the largest variance was 9.21 while the smallest variance was 7.93 so that \(F_{\text{count}}\) was 1.16 and \(F_{\text{table}}\) was 2.94. These values fulfil the criteria.
Thus, the two variances were homogeneous. Therefore, the hypothesis test by two samples t-test [18] can be applied (equation 4).

\[ t = \frac{\bar{X}_1 - \bar{X}_2}{\sqrt{\frac{(n_1-1)S_1^2 + (n_2-1)S_2^2}{n_1 + n_2 - 2} \left( \frac{1}{n_1} + \frac{1}{n_2} \right)}} \]  

(4)

Explanation:
\( \bar{X}_1 \) = the average score of the experimental group
\( \bar{X}_2 \) = the average score of the control group
\( S_1^2 \) = the variance of the experimental group
\( S_2^2 \) = the variance of the control group
\( n_1 \) = the number of samples in the experiment group
\( n_2 \) = the number of samples in the control group

The outcomes of the inferential analysis using the two samples t-test (equation 4), obtained \( -t_{\text{table}} \leq t_{\text{count}} \leq t_{\text{table}} \) (\( t_{\text{count}} = 2.99 \) and \( t_{\text{table}} = 1.68 \)), this value is in the rejection area \( H_0 \). Therefore, \( H_0 \) was rejected and \( H_1 \) was accepted, then it can be said that the guided inquiry learning model provide better student learning outcomes on the Fundamental Chemistry Law topic.

Based on the data obtained in both descriptive statistical tests and inferential statistics, the inquiry guided learning model with the scientific approach gives better student learning outcomes compared to discovery learning. This is because students have the opportunity to gain experience in finding concepts for themselves in observing, asking questions, reasoning, trying, and presenting various results obtained during learning both in class and in the laboratory. The teaching and learning process with the guided inquiry model, students are given instructions as needed. These instructions are very useful for guiding and directing students in formulating problems and finding concepts through demonstration or experiment activities, direction questions, or instructions for conducting experiments listed in Student Activity Sheets (LKPD). The main targets of inquiry learning activities are (1) maximum involvement of students in the learning process; (2) the logical and systematic direction of activities on learning objectives, and develop students’ confidence about what is found in the inquiry process. In contrast to discovery learning, students are given the opportunity to freely exploit their potential without having to get more guidance so that when students experience difficulties do not get much time to communicate with the teacher. The findings of this research are inline or in line with the findings of previous studies conducted by [19] concluding that the application of guided inquiry learning can provide effective learning outcomes. The same thing was obtained by [20] who concluded that the implementation of the guided inquiry learning model increased more than the other learning model on the subject matter of the Electrolyte And Non Electrolyte Solution.

4. Conclusions
Based on the results of data analysis and discussion of the results of this study, it can be concluded that the application of the guided inquiry learning model based on the scientific approach to the Basic Chemical Law material can provide better learning outcomes for students in class X of SMA Negeri 7 Palu compared to the discovery learning model. This can be seen from the increase in the pre-test and the post-test scores. Furthermore, it is also reinforced by the average student activity and the N-Gain result.

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