Guided inquiry-based on practicum to improve critical thinking skills on the subject of Newton's law

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Abstract. This study aims to determine the effectiveness of guided inquiry-based on practicum to improve critical thinking skills on Newton’s law concept. The method used in this study is a quasi-experimental method through a non-equivalent control group design. This research was conducted by applying guided inquiry-based on practicum in the experimental class and conventional practicum in the control class. The type of approach used is a quantitative approach. The population in this study were all students of grade ten Senior High School 1 Bireuen, in which two classes of each class consisting of 30 students were used as research samples selected using a purposive sampling technique. Data collection was obtained using a test instrument of critical thinking skills in the form of description questions given at the initial and final tests. The results of data analysis with the t-test show the use of guided inquiry-based on practicum on Newton's law concepts can significantly improve students' critical thinking skills compared to the use of verification-based practicum. This can be seen from N-gain critical thinking skills for the experimental class which is equal to 0.71, higher than the control class with N-gain of 0.53.

1. Introduction
Education is a very important aspect of human life. Along with the rapid progress of the era, excelled humans are needed who can compete in various sectors of life. This can be realized through quality and relevant learning process that in accordance with the development of the era. Learning quality is a process that is built by the teacher to improve students' thinking skills to understand the lesson taught in school [1]. Thinking ability is defined as a process for using the ability of judgment, concepts, and conclusions. One of the most important thinking skills that need to be owned by students is the ability to think critically. Critical thinking ability is the ability to think rationally and reflective that focuses on the ability to decide what is believed and done. Critical thinking characters involve the ability to think, deduce and induce based on current research and practice findings [2].

According to initial studies at Senior High School 1 Bireuen and interviews with teachers of physics subject, it found that there was still a lack of effort to develop critical thinking skills for students. This can be seen from the teacher's function which still dominates the teaching and learning activities. The dominant function of the teacher can be seen from the way of the presentation of the lessons that are less creative and varied, the role of the teacher who has more control throughout learning activities makes the less involvement of students. This condition causes students to be accustomed to accepting rather than finding the knowledge themselves. Teacher-centered teaching in
learning activities makes students more silent and less active both in asking questions and giving answers so that students' critical thinking skills become less developed [3].

Critical thinking skill, especially in the process of learning physics is a very important attribute. Critical thinking skills play an important role in preparing students to be able to solve problems reliably and quickly. Teachers play a significant role in building critical thinking skills, so teachers need to make appropriate teaching materials to apply. [4] It revealed that in learning, teachers should make teaching materials or learning tools that provide opportunities for students to develop the ability to develop concepts and theorems based on the experience and knowledge they already have, high-level thinking skills (such as the ability to think critically and creatively) through questions and problem-solving, the ability to communicate and interact (respect and understand different opinions and contribute ideas) through group work and ethics of hard work, tenacity, discipline, and honesty.

The selection of suitable learning models is very influential in efforts to build critical thinking skills and science process skills for students. Various kinds of learning models can be used to build critical thinking skills, one of which is guided inquiry-based practical learning. Practical learning is a learning model that can facilitate students to understand a concept by developing critical thinking skills. In practical learning, students experiment with something, observe the process, write down the results of the experiment, then draw conclusions. Practical learning aims to enable students to find their problems by allowing students to experience and solve a problem independently [5].

The inquiry-based practice has stages that can condition students in such a way as to develop critical thinking skills [6]. Students can improve their critical thinking skills if the curriculum is designed explicitly to improve critical thinking skills through sequences of inquiry learning from a concept that is understood and can be observed towards a concept that is not understood and abstract [7].

Guided inquiry-based on practicum has been carried out by researchers in science subjects, especially physics. The application of guided inquiry learning models can improve students' critical thinking skills [8]. The next research aims at investigating the scientific attitudes of students using guided inquiry-based on practicum learning, the results obtained were the positive impact of the use of guided inquiry learning models on students' scientific attitudes which affected the science process skills [9]. Then another research states that guided inquiry-based on practicum can significantly improve the critical thinking skills and science process skills of students with high N-gain categories, namely 66%, and 70% [10].

Based on the results of the above studies, it is very possible if guided inquiry-based on practicum is implemented to improve students' critical thinking skills and science process skills. Newton's law concepts is one of the lesson which is suitable for the practicum application directly by students using simple tools and available in school laboratories.

2. Method
The method used in this research is the quasi-experimental design method through nonequivalent control group design, which is a research design that begins with the pre-test, then continues with treatment and the post-test is given at the end. This research was conducted by applying a guided inquiry-based on practicum in the experimental class and conventional practicum in the control class.

The population in this study was the students of grade ten of Senior High School 1 Bireuen, the academic year of 2018/2019, which is divided into nine classes. The sample in this study was determined by purposive sampling technique so that the class grade ten-C and grade ten-D was selected as the study sample.

Data collection is done by using a critical thinking skills test instrument in the form of description questions given at the initial test and final test. Before the instrument is used, it is first validated by an expert. The results of the validation were then tested on a class that had studied Newton's law concepts.

The data analysis technique in this study is a prerequisite test consisting of a normality test. Hypothesis testing using the independent t-test.
3. Result and Discussion

The result of normality tests the students’ critical thinking skills before and after learning in the experimental class control class can be seen in Table 1.

| Class            | Kolmogorov-Smirnov | Shapiro-Wilk |
|------------------|---------------------|--------------|
|                  | Statistic | df | Sig. | Statistic | df | Sig. |
| Experimental     | 0.122     | 30 | 0.200* | 0.964     | 30 | 0.385 |
| Control class    | 0.155     | 30 | 0.063 | 0.975     | 30 | 0.688 |

* This is a lower bound of the true significance

The table above shows that the value of df for the experimental class and the control class is 30, so that means the number of data samples for each group is less than 50 so that the use of Shapiro Wilk parametric statistics for the normality test can be said to be already right. In the Table 1, it can be seen that the significance value for the experimental class is 0.385 and the significance value for the control class is 0.688. The significance value of the two classes is > 0.05, so as the decision making in Shapiro Wilk normality test parametric Statistics can be concluded that the research data is normally distributed.

The difference in the increase in critical thinking skills was viewed from the results of the t-test pretest, posttest, and N-gain experimental class and control class. The results of the full t-test are presented in Table 2.

| Class   | Pretest Average | T-test | Posttest Average | T-test | N-gain Average | T-test |
|---------|-----------------|--------|------------------|--------|----------------|--------|
| Experiment | 44.16        | 0.89   | 84.06            | 4.42   | 0.71           | 4.26   |
| Control  | 43.03          | 73.43  |                  |        | 0.53           |        |

The table above shows that the results of the t-test analysis on pretest data obtained $t_{\text{count}} < t_{\text{table}}$ (0.89 <2.001, $p = 0.05$), so it was concluded that there were no significant differences in the critical thinking skills of the experimental class and control class, which means both classes are homogeneous before the treatment. The results of the t-test analysis on posttest data obtained $t_{\text{count}} > t_{\text{table}}$ (4.42 > 2.001, $p = 0.05$), and the N-gain obtained $t_{\text{count}} > t_{\text{table}}$ (4.26 > 2.001, $p = 0.05$), which means there are significant differences in critical thinking skills between the experimental class and the control class. This shows that the improvement of students’ critical thinking skills is significantly better in the experimental class using inquiry-based practicum compared to the control class that using the verification practicum. This is because in the guided inquiry-based on practicum students are given the opportunity to discover their own concepts through investigation using the stages of guided inquiry. The advantage of inquiry is that it is able to train students independently to design, develop and carry out experiments and collect experimental data so that students’ critical thinking skills can develop properly. Guided inquiry approach was more effective than the traditional learning approach in improving conceptualization [11].

In detail, each indicator of critical thinking skills provides a simple explanation, builds basic skills, concludes, makes further explanations, strategies and tactics in the experimental class and the control class are presented in Figure 1.
Figure 1. Comparison of N-gain critical thinking skills

The figure above shows that the difference in N-gain of high critical thinking skills between the experimental class and the control class students on the indicator giving a simple explanation that is equal to 0.35. This is due to the experimental class students are trained to formulate problems and determine the steps taken to solve these problems. Overall the critical thinking skills of students in the experimental class are better than the critical thinking skills of students in the control class on each indicator.

The results of this study are in line with the research others research which state that inquiry-based on practicum can increase students’ critical thinking in science process better than conventional learning [10-12].

4. Conclusion
Based on the results of research and data analysis shows that guided inquiry-based on practicum can increase the students’ critical thinking especially in Newton’s law concepts because inquiry-based learning is able to train students to design, develop and carry out experiments independently.

References
[1] Sagala S 2010 Konsep dan Makna Pembelajaran (Bandung: Alfabeta)
[2] Abdi A 2012 A study on the relationship of thinking styles of students and their critical thinking skills Journal Procedia Social and Behavioral Sciences 47 1719
[3] Zulyadaini Z 2017 Perbandingan hasil belajar matematika model pembelajaran kooperatif tipe coop-coop dengan konvensional Jurnal Ilmiah Universitas Batanghari Jambi 16(1) 153-158
[4] Mulyana T 2008 Pembelajaran Analitik Sintetik untuk Meningkatkan Kemampuan Berpikir Kritis dan Kreatif matematika Siswa Sekolah Menengah Atas Disertasi (Bandung: Universitas Pendidikan Indonesia)
[5] Roestiyah 2012 Strategi Belajar Mengajar (Jakarta: Rineka Cipta)
[6] Lipman M 2003 Thinking In Education (Cambridge: University Press)
[7] Sudarmini Y 2015 Pembelajaran fisika berbasis inkuiri terbimbing dengan menggunakan lks untuk meningkatkan keterampilan berpikir kritis ditinjau dari sikap ilmiah siswa madrasah aliyah qamarul huda dagu lombok tengah Jurnal Penelitian Pendidikan IPA 1 35

[8] Hilmi M, Sunarno W and Saputro S 2015 Pembelajaran kimia menggunakan pendekatan inkuiri dengan metodeeksperimen dan proyek ditinjau dari kreativitas dan kemampuan berpikir kritis peserta didik Jurnal Inkuiri ISSN 1 92

[9] Sayekti I C 2015 Science learning by using guided inquiry approach through experiment and demonstration method viewed from students’ scientific attitudes Proceeding of International Conference On Research, Implementation And Education (Yogyakarta: Yogyakarta State University) p 39-46

[10] Sarlivanti S, Adlim A and Djailani D 2014 Pembelajaran praktikum berbasis inkuiri terbimbing untuk meningkatkan keterampilan berpikir kritis dan keterampilan proses sains pada pokok bahasan larutan penyanga Jurnal pendidikan Sains Indonesia 2 75-86

[11] Ningsyih 2016 Pengaruh pembelajaran inkuiri terbimbing terhadap kemampuan berpikir kritis dan hasil belajar kimia siswa Jurnal Pijar MIPA 2

[12] Blanchard M R, Southerland S A, Osborne J W, Sampson V D, Annetta L A and Granger E M 2010 Is inquiry possible in light of accountability?: A quantitative comparison of the relative effectiveness of guided inquiry and verification laboratory instruction Science Education 94 577-616

[12] Nisa E K, Koestiari T, Habibulloh M and Jatmiko B 2017 Effectiveness of guided inquiry learning model to improve students' critical thinking skills at senior high school Journal of Physics: Conf. Series 997 012049