The Effect of Scientific Inquiry Learning Model and Scientific Argumentation on The Students’ Science Process Skill

N P Nababan1*, D Nasution2, R D Jayanti1
1 Postgraduate University Medan, Indonesia
*nestinababan@gmail.com

Abstract. This study aim to analyze if the result of students science process skill with using scientific inquiry learning model better than conventional learning, to analyze if the result of science process skill of students who have high average of scientific argumentation better than students who have low average of scientific argumentation, to find out interaction between scientific inquiry learning model and scientific argumentation of physics students science process skill. This research is a quasi-experimental design with two group pretest-posttest design. The result of the data analyzed by using two ways Analysis of Variance. The results showed that the science process skill of students using scientific inquiry learning model better than conventional learning. The science process skill of students who have high average of scientific argumentation better than students who have the low average of scientific argumentation, and there was interaction between the scientific inquiry learning model and conventional learning with scientific argumentation to improve physics students science process skill.

1. Introduction

Science basically deals with ways to find out and understand about nature. Learning science studies problems through a series of processes known as scientific processes that are built on the basis of scientific attitudes and the results are realized as scientific products that are composed of three components in the form of concepts, principles, and theories that apply universally [1]. Physics is one of the subjects in the science family that studies natural phenomena and symptoms empirically, logically, systematically, and rationally involving scientific processes and attitudes that can develop students’ inductive and deductive thinking skills in solving problems related to natural events, and develop knowledge, skills and attitudes of confidence to enter higher education and develop science and technology [2].

Learning physics is basically a product, process and scientific attitude. Physics as a product includes facts, concepts, principles, theories, and laws. As a process, physics perform scientific activities. Physicists determine the variables under study, by observing, asking, making hypotheses, predicting, finding patterns and relationships, communicating, designing and making, planning and conducting investigations and measuring and calculating. These activities are part of science process skills [3].

Science process skills as mental and a stools need ed for the effective study of science and well as problem-solving, individual and societal development. The American Association for the Advancement of Science (AAAS) classified the science process These are: observing , measuring, classifying, communicating, predicting, inferring, using number, using space/ time, relationship, questioning, controlling variables.

Hypothesis is the operationally, formula ing models, designing experiment and interpreting data [4], what happens in the field is not appropriate as expected, because learning in schools does not show the learning process of physics that equips students to develop science process skills. Based on the results of preliminary observations conducted by researchers at SMAN 1 Pasaman, information was obtained that in the learning process at school, physics teachers tend to emphasize mathematical equations in solving physics problems. Students tend to only hear and record the material, so the learning process like this has a negative impact on student science process skills because the learning process
activities do not train students in terms of observing, asking questions, making hypotheses, predicting, finding patterns and relationships, communicating, designing and making, planning and conduct investigations, and measure and count.

Based on the results of interviews with researchers, some students were randomly assigned to the school, the students said they rarely practiced in the laboratory, even though there were laboratories at school. This has an impact on student Science process skills that do not develop because students rarely do lab work and are less trained in science process skills. This is reinforced when students do lab work, students look confused in following the steps in the student worksheet given by the teacher. Students are less able to observe phenomena that occur during practicum, are less able to communicate with group friends, are less serious, unable to make correct conclusions and tend to ask the teacher each time they will conduct an experiment. Responding to the problem there needs to be a model that involves active learning of students to improve science process skill and student learning outcomes, one of which is the scientific inquiry learning model. The scientific inquiry learning model is designed to involve students in truly original inquiry problems by exposing students to investigations, helping students identify conceptual or methodological problems in the field, and inviting students to be able to design ways to overcome these problems.

The scientific inquiry model is very suitable to be used to increase science process skill because in scientific inquiry activities students are faced with a scientific activity or investigating activities through experiments. Students are trained to be skilled in obtaining and processing information through thinking activities by following scientific procedures (methods) such as skilled observation and measurement, making hypotheses, predicting, finding patterns and relationships and communicating findings. Students are directed to develop their own science process skill process and find out the knowledge yourself. Along with the ability of students to carry out investigations, it is not only the science process skill that develops, but the student learning outcomes will increase because students have learned physics more meaningfully, have understood the process, not just results.

Application of the scientific learning model. This inquiry has been investigated by several previous researchers, such as [7] who concluded that scientific inquiry was able to increase science process skill. Further more concluded that learning Biology concepts to students through inquiry scientific learning models was more effective than conventional learning. This shows that the learning model of scientific inquiry has implications for learning in the classroom and also makes the learning process interactive and interesting. Students play a role in finding their own core from the subject matter in the learning process scientific inquiry, while the teacher trains and giving freedom of thought in the process of learning physics and also giving students the freedom to act in understanding knowledge and solving problems, including freedom students to argue in learning. Students argue scientifically as a process to find out for yourself the core subject matter in the learning process. Scientific argumentation stimulates students to submit hypothetical data which they must then prove to produce the truth of evidence data supported by accurate theory.

Defines that scientific argumentation as a statement accompanied for reasons whose components include claims (conclusions, propositions, or statements), data (evidence which supports claims), evidence (explanation of the relationship between claims and data), support (basic assumptions that support evidence), qualifications (conditions that claim is true), and refutation (conditions that abort claims). Based on this definition, evidence and support do not always provide the information needed to draw conclusions. The correct argument is if data and conclusions are mutually supportive and appropriate [8].

Component data and evidence in argumentation scientific must be obtained from an investigation to prove whether the claim and data submitted can be used as evidence, then look for evidence to state that the claim submitted is correct, and give conclusions whether the data (theory) is in accordance with the results of the investigation. The stages in scientific argumentation have an important role to play in developing and increasing student science process skills. This is in line with the research by [9-10] that there are significant differences in student science process skills between who were treated with arguments based on the concept of cartoon activity with conventionally treated students. All stages of scientific argumentation can train and increase student PPP, but based on the results of interviews with one of the Physics teachers in school, scientific arguments have never been explored or trained in the learning process.
2. Research Method

Research including the type of research is quasi-experiment. The study sample consisted of 2 classes randomly selected by cluster random sampling technique and selected two classes as a class experiment with the scientific inquiry model and control class with conventional learning. Design this research was in the form of two groups pretest-posttest design. The design of this study is shown in Table 1.

| Table 1 Design of Research Design |
|-----------------------------------|
| Class   | Pre-test | Treatment | Postes |
|-----------------|---------|----------|--------|
| Experiment      | T1      | X        | T2     |
| Control         | T1      | Y        | T2     |

Information:
T1 = Initial ability test (pre-test)
T2 = Final ability test (post-test)
X = Treatment in the experimental class, namely the application of the scientific inquiry learning model
Y = The treatment in the control class is the application of conventional learning

The instrument used is a test of scientific arguments and tests of science process skills. The scientific argumentation test consists of 10 questions and the science process skills test is 10 questions. Observations made are direct and carried out by observers.

3. Result and Discussion

The beginning of the study in both classes was given a pretest which aims to determine the ability of students’ initial learning in each class. Based on the data obtained from the average value of the pretest of the experimental class and the control class before being given treatment, the t-test was carried out by two parties and it was concluded that the two classes had the same initial ability. The results of the pretest and posttest experimental class and control class in detail can be seen in Table 1. After the sample applied different learning models, posttest results were obtained in both classes. The results of the study by applying the scientific inquiry learning model (experimental class) and conventional learning (control class) are as follows:

| Table 2 Pretest and Posttest |
|-----------------------------|
| Sample     | N  | Average |
| Pretest Control          | 32 | 37.22   |
| Pre-test Experiment      | 36 | 42.67   |
| Post-test Control        | 32 | 68.47   |
| Post-test Experiment     | 36 | 75.39   |

The explanation for scientific arguments can be seen in Table 3 below.

| Table 3 Average Second Class Scientific Arguments |
|-----------------------------------------------|
| Control Class | Experiment Class | Both of Class |
|----------------|------------------|---------------|
| 56.66          | 61.69            | 59.32         |

| Table 4 Science Process Skills based on Scientific Arguments |
|-------------------------------------------------------------|
| Class                      | Control class | Experimental class |
| Scientific arguments below the average value | 67.52 | 70.21 |
| Scientific arguments above the average value      | 68.16 | 78.68 |

Based on Table 3 and Table 4 it can be seen that the average scientific argumentation value in the experimental class is higher than the control class. Based on the average value of the overall scientific arguments obtained, students are grouped into two categories, namely groups of students who have
scientific arguments above the average value and groups of students who have scientific arguments below average values.

Hypothesis testing is done with using Analysis of Variance to see whether or not there is an interaction between the variables studied, namely the scientific inquiry model, scientific argumentation and students' science process skills. The two-way ANOVA technique uses SPSS 17 with the test criteria used is $f_{\text{count}} > f_{\text{table}}$ at the level $= 0.05$, then the hypothesis proposed $\alpha$ significant be accepted. After the data feasibility test, and the data is declared homogeneous then it is then carried out by two-way ANOVA testing with the Univariate General Linear Model (GLM) by using ANOVA test with SPSS 17 assistance. The test results can be seen on 5

|        | Number of Square | Degrees of Freedom | Average Squares | F       | Sig.  |
|--------|------------------|--------------------|----------------|---------|-------|
|Corrected Model | 1429.230* | 3 | 476.410 | 8.563 | .000 |
|Intercept      | 331860.197 | 1 | 331860.197 | 5965.055 | .000 |
|Learning Model | 566.461 | 1 | 566.461 | 10.182 | .002 |
|Scientific Argument | 345.901 | 1 | 345.901 | 6.217 | .015 |
|Learning Model * Scientific Argument | 240.735 | 1 | 240.735 | 4.327 | .042 |
|Error           | 3560.579 | 64 | 55.634 |
|Total           | 358799.000 | 68 |
|Corrected Total | 4989.809 | 67 |

Based on Table 4, the results of the calculation of two-way ANOVA are obtained significance in the 0.00 learning model where this value is smaller than the significant level of 0.05. This shows the learning model in the experimental class, that is, the scientific inquiry model is better than conventional learning in the control class. The scientific argumentation section obtained a significance value of 0.002 where this value is smaller from a significant level of 0.05. This shows that the science process skills of students who have scientific arguments above average are better than scientific arguments below average. The learning model section * scientific argumentation obtained a significance value of 0.015 where this value is smaller than the significant value of 0.042. This shows there is an interaction between the learning model of scientific inquiry and scientific argumentation on students' science process skills. This can be seen in Figure 1.

![Figure 1](image)

**Figure 1** The interaction between Learning Models and Scientific Arguments on Science Process Skills

Based on the results of the study show that there are significant differences in science process skills of students between students who are taught by using the scientific inquiry learning model with students who are taught using conventional learning.

Application of the scientific inquiry model facilitate researchers in conveying information to students so that the teaching and learning process becomes innovative and not boring for students. This learning pattern is more varied than conventional learning because in research students in the scientific class inquiry holds joint discussions and share in solving problems (with groups). Learning activities such as
observing, asking, making hypotheses, predicting, finding patterns and relationships, communicating, designing and making, planning and carrying out investigations and measuring and counting are done by students when learning takes place.

The results of the study were supported by [4] who stated that the essence of the scientific inquiry learning model is to involve students in problem investigation and scientific activities to find and find their own answers to a questionable problem. Students are trained to be skilled in obtaining and processing information through thinking activities by following scientific procedures (methods) such as skilled observation and measurement, making hypotheses, predicting, finding patterns and relationships and communicating findings. All student activities directed to find and find their own answers can lead to student confidence and scientific attitudes. Teachers do not act as learning resources but as facilitators and motivators for students in learning. Students develop and discover the knowledge itself.

Students who are taught by the scientific inquiry learning model are better than students who are taught by conventional learning in this study. The findings in this study prove that the calculated average in the inquiry scientific class is 75.39, which shows the difference in the conventional learning outcomes of the class is 68.47.

Based on science process skills students each indicator obtained that science process skills with indicators observing, asking questions (asking), finding patterns and relationships, planning experiments, and measuring and counting in the experimental class was better than the control class. Based on the average value of the overall science process skills students obtained by the experimental class students were also higher than the control class. This is because students in the experimental class are more trained for three meetings to ask questions based on the observed problems. already accustomed to identifying the relationship between one variable with another variable, making conclusions, conducting experiments, using a temperature measuring device (thermometer) and can already read the measurement results properly. Unlike the control class that has never done an experiment and uses a thermometer so that some students are still confused reading the measurements shown by the thermometer.

Conventional learning in the control class focus training on students. Students only listen to the teacher's explanation, memorize the knowledge given by the teacher, write and do the exercises. A series of activities carried out instructional without giving the opportunity for students to find their own knowledge. Monotonous learning makes absorption of weak material impact on unsatisfactory results. The scientific inquiry learning model can be recommended for students who have scientific arguments above average or below average to obtain high science process skills, and science process skills yield higher results in groups of students who have scientific arguments above the average-rate. Based on the tests conducted by groups of students who learned the scientific inquiry model suitable for students who have scientific arguments above or below the average.

The findings of this study are in line with research conducted by [9] concluded that scientific inquiry was able to increase science process skills. Science process skills that can be improved in the scientific inquiry model are: asking questions, grouping, formulating hypotheses, interpreting, predicting, planning experiments, applying concepts or principles, communicating. Scientific argumentation stimulates students to submit hypothesis data which they must prove to produce the correctness of the evidence data supported by accurate theory. The data they have to prove is based on investigative activities (such as observing, asking, formulating hypotheses, predicting, finding patterns and relationships, planning and experimenting, communicating, measuring and calculating). The data obtained will produce evidence and conclusions that can be used as claims. Appropriate claims certainly have proof of reason (warrant) and support (backing) that is in accordance with the results of the investigation and the existing theory. Science process skills of course students are trained if they often argue scientifically. Students will get used to observing, finding patterns and relationships, predicting, asking questions, and hypothesizing existing problems. Then students are asked to provide qualifications how confident they are with the answer and this trains students' skills to communicate effectively. Finally, if students are not sure about the evidence or data available, students can do rebuttal (disclaimer). Disclaimers were given by students in addition to training students to communicate also requires students to conduct investigations again.

All indicators on scientific argument scan train and improve students' science process skills. So from that, it is proven that students who have scientific arguments above the average have better science
process skills than students who have arguments below average. This study shows an interaction between the scientific inquiry learning model and scientific argumentation on science process skills which means that the scientific inquiry model has an effect on improving science process skills. Learning the scientific inquiry model makes students tend to actively find out through the investigation process which ultimately reaches the content of knowledge itself so that either directly or indirectly students will have learning outcomes in the form of good science process skills. The scientific inquiry learning model as a learning model that involves scientific arguments of students to conduct investigations and prove whether claims and submitted data can be used as evidence and provide conclusions. The investigation activity itself contains thinking activities by following scientific procedures (methods) such as skill ful conduct observation and measurement, making hypotheses, predicting, finding patterns and relationships and communicating findings. These activities are indicators of science process skills. Based on the conclusions above, it can be concluded that the learning model of scientific inquiry and scientific argumentation influence each other in creating better science process skills for students.

4. Conclusion
Based on the results of research obtained from the results of data analysis and hypothesis testing the no obtained that students’ science process skills are taught with scientific inquiry learning models better than students' science process skills taught with conventional learning. These results indicate that there is the influence of the scientific inquiry learning model on students’ science process skills. Science process skills students in the scientific argumentation group are above average better than science process skills students in the scientific argumentation group are below average. These results indicate there is an influence of scientific argumentation on students 'science process skills and there is an interaction between learning models and scientific arguments in influencing students' science process skills. These results indicate an interaction that the learning model of scientific inquiry with scientific arguments above and below average has science process skills better than conventional learning. This means that the scientific inquiry learning model with scientific arguments influences science process skills while learning with conventional learning with scientific arguments do not influence science process skills.

5. References
[1] Trianto 2007 Model pembelajaran terpadu dalam teori dan praktek 212
[2] Hinduan, A., Setiawan,W.,Siahaan, P & Suyan,I Ilmu dan Aplikasi Pendidikan Fisika Handbook TimPengembang Ilmu Pendidikan UPI. Bandung: PT Imperial Bhakti Utama
[3] T. Dalgleish et al., / No Title / 136 1
[4] F. Akin bobola, Akin yemi Olufunmimiyi Afolabi 2010 Analysis of Science Process Skills in West African Senior Secondar [1] F. Akinbobola, Akinyemi Olufumimiyi Afolabi Analysis of Science Process Skills in West African Senior Secondary School Certificate Physics Practical Examinations in Nigeria,’ Am. J Am. J. Sci. Res. 5 4 234-240
[5] S. E. Toulmin 2003 The uses of argument (Updated edition, first published in 1958)
[6] Dhaaka.A 2012 Biological Science Inquiry Model and Biology Teaching,” Bookman International Journal of Account Economics & Business Management. 1
[7] Muslim, K & Tapilouw, F.S 2015 Pengaruh Model Inkuiri Ilmiah Terhadap Peningkatan Keterampilan Proses Sains Siswa Pada Materi Kalor Jurnal EDUSAINS. 7 1 88-96
[8] Y. P. Pateliya An Introduction to Modern Models of Teaching,” Int. J. Res. Educ., vol. 2, no. 2, 2013, 125-129
[9] S. Türkoguz and M. İnlı 2014 Effects of argumentation based concept cartoon activities on students’ scientific process skills Mersin Üniversitesi Eğitim Fakültesi Derg. 10 214, 142-156
[10] Nashikah, M 2016 Peranan Soft Skill Dalam Menumbuhkan Karakter Anak TPA Tadris: Jurnal Keguruan Dan Ilmu Tarbiyah, 1 33–39