CHAPTER I
INTRODUCTION

1.1. Background

Science is a cumulative and endless series of empirical observations which result in the formation of concepts and theories. Concepts and theories being subject to modification in the light of further empirical observation, thus science is both a body of knowledge and a process of acquiring it (Frederic Fitzpatrick in Kumari & Rao, 2008). One branch of science is physics which learns about natural phenomenon systematically and has big roles in knowledge and technology. The structure of physics knowledge also obtains empirically method thus make students to acquire conceptual and procedural knowledge and help them to develop and understand the practical applications of physics to a wide variety of other fields.

Studying physics is not only focusing to the facts, law, theory, principle, models, and mastery the formulas but also focus to understand the basic concepts. Concepts are abstract or psychological constructs that represent ideas or notions that a learner uses in reasoning and thinking. They constitute the general tools of inquiry used in making sense of the world and are the most significant influence in learning. In physics, learner's existing concepts are known to have a profound influence on how phenomena is interpreted, and learners draw on these concepts in making predictions and explaining what they see and experience in the world.

Studying physics also requires more than just learning about the products of science like concept. The culture of science involves very special actions called

science process skill which lay the foundation for scientific inquiry. The science process skills describe the actions or active doing within the culture of science that students can develop through practice and provide benefits to the classroom that extends beyond science learning. Too much content can stifle student interest, whereas paying too much attention to the process skills can distract students from learning the substantive ideas within science. It might imagine the pull in opposite directions, to one side is the attraction of having students actively involved in working with materials while the other side is the desire for students to master essential scientific concepts. Thus, teachers, in terms of supporting their students' science learning are challenged to achieve a balance between science concepts and process skills. Were teacher to teach without developing students' abilities to use the process skills, teacher would be teaching not science but actually some other odd subject that has little relationship to the culture of science (Settlage & Southerland, 2007).

Based on the observation and interview result from Physics teacher at SMA Muhammadiyah 1 Medan obtained students' learning outcomes in cognitive domain is still in low level because they are still less ability to solve the problems related to the physics concept and they are mostly concerned to the formula and calculation. Thus, students felt so difficult to apply what they have known in their daily life situation. This is indicated from physics means grades of students before remedial in academic year 2014/2015 is 69, this average value has not achieved KKM, that is 70.

Moreover, students' science process skill is also in low level which is indicated from the unusual of students to conduct experiments in learning physics,

meant learning physics just theoretically. Learning which familiarized conducts by teacher are direct instruction and cooperative learning where methods are lectured, discussion, investigation and mapping concept. But, all this models have not conducted as the phases of each model. This condition make students have not familiarized to find knowledge by themselves through scientific inquiry, thus students cannot provide explanations based on evidence. Furthermore, students have not trained to observe, infer, ask, interpret, classify, predict, communicate, make a hypothesis, plan, apply concepts and principles and generalize thus students are still less ability in observing, inferring, questioning, interpreting, classifying, predicting, communicating, making hypothesis, planning, applying concepts or principles, and generalizing.

The skills can be enhanced through the preparation of syllabus for physics laboratory courses that include low cost materials instead of laboratory equipment (Hırça, 2013). Furthermore, science process skills will increase students' achievement and scientific creativities (Aktamis & Ergin, 2008). Moreover, the science process skills also can be improved by I-diagram (Karamustafaoğlu, 2011). From this study reported that the skills in which the student teachers are least successful are *hypothesizing*, *identifying and controlling the variables*, and *interpreting data*. *Making experiment* is their most successful skill among the integrated process skills.

Most of student's difficulties in learning physics are not caused by lacking of their understanding because they often come to school with already formed ideas on many topics, including how they view and interpret the world around themselves. Students have ideas about the world that are very different from the

ideas scientists have which delivered in the class. At one point in time, might have dismissed their explanation as simply wrong. This is cause some difficulties and errors in understanding the science concept. It is no surprise that regardless of their content, these views will be highly resistant to change. Change and form students' understanding will be difficult because what their obtained have been as their habit and based on personal experiences.

Teacher needs listening to how learner explain their understanding because that's not possible that their ideas are certain logics, therefore it is inappropriate to dismiss their thinking as errors that simply need to be corrected. As the result, teacher need to develop learning that would move learners away from their initial ideas so they became aligned with accepted scientific explanations. This label suggests that students are using evidence to support their explanation and in that way is consistent with the actions within the culture of science. This kind of learning is called as *conceptual change*.

Conceptual change reflects the desire to have students discard naive concepts about the world in favor of explanations that are more scientifically accurate. A conceptual change guides student to build knowledge after the experiment is over conceptual change requires that students discover improved knowledge that moves them closer to the understanding of scientist. The purpose of *conceptual change* is helping students to change their non-scientific preconceptions. It has been found that by explicitly recognizing the discrepancy between their current beliefs and the scientific ones (experience), students can be motivated to change their current beliefs (Bao et al., 2013). Besides, *conceptual change* learning has significant effect in students' learning outcomes and tolerance attitude (Badlisyah,

2013). Then, *conceptual change* become as an alternative source material for students and science teacher Şahin & Çepni (2011).

The new conception must be sensible and non-contradictory, its meaning must be understood by the learner (intelligible) and it must be believable (plausible) and useful in solving other problems (fruitful). Thus, preconceptions and conceptions introduced through teaching are seen as competing in terms of status in regard to intelligibility, plausibility and fruitfulness, in a process mediated within the learners' epistemological commitments or conceptual ecology (Toulmin in Heywood & Parker, 2019).

One of the common instructional strategies to foster *conceptual change* is to confront students with discrepant events that contradict their existing conceptions. Students have to undergo the process of accepting, using and integrating the new concepts into their lives and even applying them to new conditions. To seek ways to challenge thinking about the awareness of students' ideas is through *scientific inquiry learning model* because this model is the best viewed as a process of *conceptual change*.

Inquiry refers to the activities of students in which they develop knowledge and understanding of scientific ideas, as well as an understanding of how scientists study the natural world. Through this learning, students actively construct their own understanding of the world as a result of their experiences and interactions thus allowed students to function at a much higher level of though (Kalman, 2008).

Scientific Inquiry is one type of inquiry learning which refers to the diverse ways in which scientists study the natural world and propose explanations based

on the evidence derived from their work. Scientific Inquiry designed to teach the research system of a discipline, but also expected to have effects in other domains, sociological methods may be taught in order to increase social understanding and social problem solving (Schwab in Joyce & Weil, 2003).

In *scientific inquiry learning model*, students are guided by teachers to understand physics and to help them become participants within the culture of science. Moreover, *scientific inquiry learning model* will help students to develop critical thinking abilities and enables students to think and construct knowledge like a scientist (Ali & Sencer, 2012; Bao et al., 2013). Thus, understandings of *scientific inquiry* are believed to be critical and essential components of the modern day battle cry of "scientific literacy" (Lederman et al., 2013). The *scientific inquiry* also has significant effect on the student's achievement to apply the concepts of physics in real situations, Dumbrajs et al. (2011) and Hussain et al. (2011). Furthermore, the Inquiry-Based Science Teaching enhance students' science process skills and attitudes toward science where the skills are *observing*, *comparing and classifying*, *inferring*, *predicting*, *measuring*, *recording and interpreting*, *formulating models*, *constructing tables of data and graphs*, *experimenting*, *defining operationally*, *formulating hypotheses*, *identifying and controlling variables* Ergül et al. (2011) and Turpin (2004).

Scientific Inquiry Learning Model Based on Conceptual Change will make learners to really learn the science concepts. The inquiry investigations capture their interest and generate for them evidence about the natural world and conceptual change helps them master the scientific ideas that explain the evidence from their inquiries. So *inquiry* combined with *conceptual change* is better for

science teaching because students actually restructure their knowledge (Settlage & Southerland, 2007).

Based on the explanation described above, the author interested to conduct research which titled is **"The Effect of Scientific Inquiry Learning Model Based on Conceptual Change on Physics Cognitive Competence and Science Process Skill (SPS) of Students at Senior High School".**

1.2. Identification of Problem

Based on problem background presented above, the identifications of problem in this research as follows:

1. The physics cognitive competence and science process skill (SPS) of students is still in low level
2. Student has not trained to observe, infer, ask, interpret, classify, predict, communicate, make hypothesis, plan, apply concepts and principles, and generalize through Scientific Inquiry
3. Physics learning has not given the opportunity to student for using scientific understanding that make student can provide explanations based on evidence
4. Learning physics still focusing to the fact, law, theory, principle, models, and mastery the formulas
5. Students feel so difficult in learning science because of lacking their pre-existing concept which is often different with the ideas of scientists
6. Learning which is applied has not made students finding concepts actively through active doing of science called the science process skills

1.3. Scope of Problem

In accordance with the identifications of problem, the scopes of problem in this research are:

1. This research will study physics cognitive competence of students
2. This research will study science process skill (SPS) of students

1.4. Formulation of Problem

Based on the scopes of problem, the formulations of problem contained in this research are:

1. Is students' physics cognitive competence using Scientific Inquiry Learning Model Based on Conceptual Change better than using Conventional Learning
2. Is students' science process skill (SPS) using Scientific Inquiry Learning Model Based on Conceptual Change better than using Conventional Learning

1.5. Objective of Research

Referring to the formulations of problem, the objective to be achieved in this research are:

1. To analyze is students' physics cognitive competence using Scientific Inquiry Learning Model Based on Conceptual Change better than Conventional Learning

2. To analyze is students' science process skill (SPS) using Scientific Inquiry Learning Model Based on Conceptual Change better than Conventional Learning

1.6. Benefit of Research

The benefits of this research are:

1. For School: can provide good information and donations in order to improve the learning process and school quality through increased students' achievement and professionalism of teachers working
2. For Teachers: for consideration in selecting or integrating a variety of appropriate learning model class, especially in physics learning
3. For Students: students are more motivated and continue to be active during the learning process takes place, so it can improve learning outcomes and provide a fun learning experience
4. Researcher: As an input, and increase knowledge for the researcher as candidate for future in the implementation of Scientific Inquiry Learning Model Based on Conceptual Change.