DEVELOPMENT OF LEARNING MATERIAL OF STATIC ELECTRICITY BASED ON SCIENTIFIC LEARNING TO ENHANCE STUDENT'S CONCEPT UNDERSTANDING IN NGUYEN TAT THANH SENIOR HIGH SCHOOL HANOI VIETNAM

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Study Program: Physics Education

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Bachelor thesis with the title **Development of Learning Material of Static Electricity based on Scientific Learning to Enhance Student's Concept Understanding in Nguyen Tat Thanh Senior High School Hanoi Vietnam** has been approved by the advisor to be served to the committee of bachelor thesis examination in Physics Department of Mathematics and Natural Sciences Faculty of Semarang State University INDONESIA.

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STATEMENT LETTER

I confirmed that this bachelor thesis is free from plagiarism. If in the future time has found a sign of plagiarism within this bachelor thesis, I am ready to receive punishment according to the laws.

Semarang, 20 April 2017

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RATIFICATION LETTER

Bachelor thesis entitled,

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MOTTO AND DEDICATION

Motto

- Being outstanding person is not about how many achievements they have, but how many contributions they can do.
- There is no luck in this world. The good thing we receive is a gift which is paid due to what we have done in the previous.
- Become an eminent is not about life aimlessly, but struggle and being acquainted within any circumstances.
- Elevating the knowledge by binding the circle of conference, while overcoming the obstacle by binding the circle of discussion.
- The only thing you'll put love on is based on your heart.
- When the relationship/friendship touches the highest, then the distance means nothing.

||Moto of Aan Priyanto

This bachelor thesis is dedicated for:

- My beloved Mother, Mrs. Mburyati and my beloved Father, Mr. Edi Bawan who always being my side with entire compassions through prays and motivations.
- My greatest brother Mr. Iwan, My lovely family Mrs. Okti, Mr. Indra, and Mrs. Rati.
- My beloved *Almamater* Semarang State University.

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The writer realizes that this bachelor thesis isn't completely perfect thus it still require any feedback for the next research. Hopefully, this bachelor thesis can be useful for the reader, teacher, and students.

Semarang, 13 February 2017

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Keywords: learning material, scientific learning, conceptual undestanding.

Nguyen Tat Thanh High School (NTT) school is a school that under the Hanoi National University of Education. NTT School has missions to educate and train students to be future citizens with strength, understanding, rich spirit, life skills, self-study, sense of responsibility and endless efforts for creativity; Train students of Hanoi National University of Education teaching methods, pedagogy and develop their competence and professional skills; Its core values are responsibility, honesty, solidarity, creativity, and devotion. In order to achieve the aims of school curriculum, it is very important to create an effective learning including in scope of learning material development. According to the observation, physics learning material of grade 11 in NTT remains consist of reading paragraph and has no specified into scientific learning material which is easier to understand by the students and explain by the teacher. Thus, scientific learning material is required to enhance the students' concept understanding according to the NTT's mission.

Scientific approach plays an important role as an approach to make learning materials in order to enhance student concept understanding as a cognitive skill. This educational research is aimed to develop learning material based on scientific approach to enhance the conceptual understanding or cognitive ability of students in learning an abstract physics of static electricity. This research was conducted in Nguyen Tat Thanh High School, Hanoi Vietnam. This research consists of several stages such as initial stage, planning stage, development stage, and trial stage as well. The average score of learning material eligibility which are given by validators is 83,4%. It means that the learning material is proper to use in a real field. The readability testing score of learning material is 98,7%. This indicates that the learning material is easy to read by the students. *Normalized gain (g)* testing was conducted to determine the enhancement of student's concept understanding after they receive study with scientific learning material. Students' normalized gain obtained after the treatment is 0,717 then the enhancement of student concept understanding can be classified as excellent. This research is also shown that learning material based on scientific approach can improve the high order thinking of the students. It proved by the enhancement of several student' cognitive aspects such as the ability of *applying* which is improved 32,94%, the ability of *analyzing* and *evaluating* which are improved 21,74%. Therefore, static electricity learning material based on scientific learning can enhance the student' concept understanding and in particular it enhances the high order thinking of the students.

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CHAPTER 1

INTRODUCTION

1.1 Research Background

Nguyen Tat Thanh School (NTT), established on July 4th 1998, located in Cau Giay district, Hanoi, which is about 6 km from the Old Quarters, Vietnam. Nguyen Tat Thanh High School has 51 classes and 2132 students. This school is under the Hanoi National University of Education. Nguyen Tat Thanh High School has missions to educate and train students to be future citizens with strength, understanding, rich spirit, life skills, self-study, sense of responsibility and endless efforts for creativity; Train students of Hanoi National University of Education teaching methods, pedagogy and develop their competence and professional skills; Its core values are responsibility, honesty, solidarity, creativity, and devotion. In order to achieve the aims of school curriculum, it is very important to create an effective learning including in scope of learning material development. According to the observation, physics learning material of grade 11 in NTT remains consist of reading paragraph and has no specified into scientific learning material which is easier to understand by the students and explain by the teacher. Thus, scientific learning material is required to enhance the students' concept understanding according to the NTT's mission.

Educators or teachers is one of the basic component in learning process. Teachers requires capable skills in order to create an effective learning. Teachers need to make connections between ideas, in addition to adding new ideas about subject-area concepts, instructional approaches, students' likely ideas, or teaching

principles (Elizabeth A *et al*, 2005). Therefore, in this case teachers (like any learners or students) must also integrate their knowledge (Davis, 2004; Linn, Eylon, & Davis, 2004). Professional teachers are those who have ability to manage their teaching duties properly. Teachers have been challenged to use creativity in making interesting, innovative and variant learning material needed by the students. Skills of teachers for creating learning material is vitally important.

Learning material is any material which is required to support the instructors or teachers in class (Depdiknas, 2008). Learning material plays an important role in order to enahnce the quality of education in all countries. Knowledge of educators for creating learning material is one from many aspects that reflects country's quality of education level. Therefore, learning quality decreased while the quality of learning material is decreasing as well. Systematic learning material will be easier to use by the students through learning process. Learning process is an effort attempt to engage and use professional knowledge provided by teachers to achieve the aims of the curriculum. Thus, learning is an activity to modify various conditions that are geared to achieve curriculum goals (Hardini, 2012: 10). Learning process is applied in particular approach in order to reach the aim of learning.

The learning approach that able to empower student's competencies is needed to develop teaching materials according to the needs and character of students as well as the applicable curriculum. Hence, learning materials should be developed using the appropriate scientific approach according to the curriculum as an anvil. The scientific approach is a way or mechanism for collecting knowledge

by procedures based on a scientific method. Scientific method was first introduced in the science of American education in 19th century, as the emphasis on the process of learning knowledge that leads to scientific facts. Scientific learning method has characteristics that are student-centered, science process skills involved in constructing the concept, law or principle, involves the cognitive processes of potential in stimulating intellectual development, especially high-level thinking skills of students, and also develops student's character.

Scientific approach is intended to provide students in recognizing and understanding the material. In this process, students use the scientific approach so that information can be derived from everything and not just sourced from the teacher. Therefore, the expected learning circumstances created to encourage students to seek out a variety of sources through observation (Daryanto, 2014:51). However, the role of teachers remains literally important in class. Teachers were highly valued and it was thought that "without a teacher, you can do nothing" (Pham & Fry, 2004). Therefore, in terms of scientific learning teacher is placed as facilitator in class. As a facilitator, teachers should be able to develop approaches that make science learning more practical and action-oriented (McFarlane, 2013).

Physics is part of the science that will be easier learned through the study using scientific approach. Students should understand the basic concepts in physics to be able to thoroughly understand physics. Knowledge and understanding of the basic concepts of each material in physics becomes a vital thing to consider in the process of learning physics. Understanding the basic concepts also train students to develop problem solving skills. Understanding of the basic concepts of physics is one form of student learning outcomes.

Understanding the concept of physics belongs to cognitive skill which is literally necessary gained by the students.

Systematic learning materials is still needed by students at Nguyen Tat Thanh High School (NTT), Hanoi Vietnam in order to enhance the cognitive skill of the students. According Bodewig *et al* (2014) reported that that the early years of childhood are particularly important in setting of the cognitive skill. In this case, it can be concluded that the job specific-skill (such as social skill) can be formed later. Cognitive skill formation is intertwined and evidence from Vietnam shows that academic confidence helps with learning. Learning success fosters academic confidence and good cognitive facilitates the formation of job-specific skill. Vietnam is successfully expanding access to full-day school for student in secondary school either senior high school as well. This due to the government has intention to develop the cognitive and non-cognitive skill of the student.

Based on the interview, students need instructional materials sciences are written using the international language in order to improve the cognitive skill and English Language literacy. Students at NTT find the difficulties when studying the material of static electricity as part of the abstract physics. Most of students still consider that physics static electricity is an abstract lesson and difficult to understand conceptually. Correspondingly, Purwanto et al (2015: 78-79) states that the material of static electricity at the high school level is an abstract physics and it requires specialized learning. Squire et al (2013: 514) argues that the electrostatic material and the electric field is a matter of abstract, thus making it's difficult for students to understand. The appropriate solution in overcoming the problem is by compiling suitable teaching materials for the students. Scientific

approach plays an important role as an approach to make learning materials in order to enhance student concept understanding as a cognitive skill.

Based on the description above, it is necessary to study: Development of Learning Material of Static Electricity Based on Scientific Learning to Enhance Student's Concept Understanding in Nguyen Tat Thanh Senior High School. The enhancement of student's concept understanding can be determined through the academic achievement or test result. This due to the academic achievement is the other name of cognitive skills (Van D. F., *et al,* 2014)

1.2 Research Questions

According to the background of the research number 1.1, question formulas of this research are:

1. How is the quality of learning material of static electricity based on scientific learning to enhance student's concept understanding in Nguyen Tat Thanh Senior High School?
2. How is the result of learning material of static electricity based on scientific learning in order to enhance student's concept understanding as a cognitive skill in Nguyen Tat Thanh Senior High School?

1.3 Research Objectives

The aims of this research as following:

1. Explain the quality of learning material of static electricity based on scientific learning to enhance student's concept understanding in Nguyen Tat Thanh Senior High School.

2. Explain the result of learning material of static electricity based on scientific learning in order to enhance student's concept understanding as a cognitive skill in Nguyen Tat Thanh Senior High School.

1.4 Research Benefits

Benefits of this research as following:

1. For students: providing scientific-based teaching materials to enhance students' concept understanding of static electricity. In the meaning of students' concept understanding refers to the cognitive skill of the student.
2. For teachers: This research could be an alternative learning and teaching reference materials that can be used in study of static electricity in Nguyen Tat Thanh Senior High School either to the other school too.
3. For researcher: to train personal competence in making learning material physics. In addition, this research is served to complete the task in obtaining of physics education bachelor degree.

1.5 Terms Affirmation

In order to make clear understanding and avoid misinterpretations, here is served some terms affirmation:

1. Learning Material: any material which is required to support the instructors or teachers in class (Depdiknas, 2008). In this research learning materials refers to printed material as guidebook for students and teachers. This learning material is written English language.

2. Static Electricity: Static electricity is an imbalance of electric charges within or on the surface of a material. The charge remains until it is able to move away by means of an electric current or electrical discharge. Static electricity is named in contrast with current electricity, which flows through wires or other conductors and transmits energy. The scope of static electricity is provided in this learning material consists of: properties of electric charges, Coulomb's Law and the electric field.
3. Students' Concept Understanding: this can be obtained from the result of students' examination of static electricity. Student concept can be mentioned as cognitive skills. Cognitive skills are understood as the mental actions or pro-cesses of acquiring knowledge and understanding through thought,experience, and the senses (Van D. F., *et al,* 2014).

1.6 Systematics of Bachelor Thesis

The introductory part of the bachelor thesis consists of a cover pages, summary (abstract), sheet of validations, motto and dedication, preface, table of contents, list of figures, list of tables, and a list of attachments. The body section of this bachelor thesis consists of five chapters arranged by systematic chapter 1 that includes an introduction, containing background, problems, research objectives, the benefits of research, terms affirmation and systematics of thesis. Chapter 2 provides the theoretical reviews that are supporting theories research. Chapter 3 provides a method of research, shows the place of research, tools and materials of the research, as well as the steps in the research. Chapter 4 provides the results of research and discussion. Chapter 5 is the end-part of bachelor thesis

that contains the conclusion of the study and suggestions related to the results of research. The final part of the thesis contains a list of libraries used as a reference of the thesis.

CHAPTER 2

LITERATURE REVIEW

2.1 Theoretical Review

2.1.1 Physics Learning

Physics is a branch of natural sciences. Physics is about studying natural behavior and cause of various forms of phenomena that appear in nature. Like all other sciences, physics is based on experimental observations and quantitative measurements. The main objective of physics is to find the limited number of fundamental laws that govern natural phenomena and to use them to develop theories that can predict the results of future experiments. The fundamental laws used in developing theories are expressed in the language of mathematics, the tool that provides a bridge between theory and experiment (Serway, 2004: 3; Haliday, 2008: 3). Recently in fact, some students thought that physics is difficult.

In teaching and learning physics, it is always difficult to make students interested in the subject or to realize connections between physics and phenomenon in everyday lives. Recently research in education field suggests that traditional instruction hardly improve students' concept understanding and appreciation in physics even if the instruction includes physics demonstrations, simulations or computer-aided instructions. All these techniques are not effective because students are not engaged or participating actively in the learning process. Therefore with supports from UNESCO, physics experts and sciences education researcher from developing and developed countries and Asean Physics Education Network have developed a new effective approach in teaching physics called an

active learning method, which is actively engaging students in learning physics (Paosawatyanyong, 2010).

Characteristics of physics learning should involve students actively to interact with real objects that exist in nature around or circumstances experienced by students in everyday life. This kind of learning process that will provide a pleasant atmosphere, out of the routine heard and recorded, and activates all the senses of students. The more senses that are involved in the learning process, the longer the memory stored. Based on the description above can be concluded that physics learning is more focused on the process of granting direct experience to students by applying fun learning, so students can save the knowledge gained. Therefore to support students in learning physics actively, they need to be provided by learning material which is based on scientific method. In this case students are trained to be active in thinking, questioning, observing, arguing, concluding and communicating.

2.1.2 Learning Material

Learning material is any material which is required to support the instructors or teachers in class (Depdiknas, 2008). Learning material plays an important role in order to enahnce the quality of education in all countries. Knowledge of educators for creating learning material is one from many aspects that reflects country's quality of education level. Therefore, learning quality decreased while the quality of learning material is decreasing as well. Systematic learning material will be easier to use by the students through learning process. Learning process is an effort attempt to engage and use professional knowledge provided by teachers to achieve the aims of the curriculum. Thus, learning is an

activity to modify various conditions that are geared to achieve curriculum goals (Hardini, 2012: 10).

Learning material is devided into textual learning material and non-textual learning material. Learning material must be able to provide an object systematically and trigger the students to develop their cognitive abilities and either their psychomotor as well. Textual learning material can be classified into some forms such as: handout, books, students' worksheet, brochure, leaflet, wall-chart, photograph, picture, and prototype. Non-textual learning material can be classified as audio-learning material and audio-visual learning material.

The following are the function of learning material for teacher and students as well (Prastowo, 2013: 24-27):

(1) Functions of learning material for teacher as following:

a. Make time-efficiency in learning process;
b. Changing the role of educator becomes a facilitator in class;
c. Enhancing the learning process to be more effective and interactive;
d. Become an anvil for teachers in learning process;
e. Become a tool to evaluate students' understanding.

(2) Functions of learning material for students as following:

a. Students can learn the material even though the teacher is not present;
b. Students can learn anywhere and anytime;
c. Students can learn according to their own ability in learning quickly;
d. Students can learn by their own curious in turns of the material;
e. Helps the students to develop their independence as a higher students;

f. Becomes an anvil for the student to obtain their competences from the material.

Basically learning material at least consists of several parts such as: (a) learning directions, (b) aimed competences, (c) content, (d) additional information, (e) exercises, (f) students worksheet, and (g) evaluations (Prastowo, 2013: 28-30).

2.1.3 Static Electricity

Electricity is becoming vitally important in our life. The law of electricity has a central role in the operation of such devices as radios, televitions, electric motors, computers, mobiles, and others electronic devices. Discussing about electricity is also discussing about magnetism due to both of them are connected. The ancient Greeks observed electric and magnetic phenomena possibly as early as 700 B.C. They found that a piece of amber, when rubbed, becomes electrified and attracts pieces of straw or feathers. In 1600, the Englishman William Gilbert discovered that electrification is not limited to amber but rather is a general phenomenon. In the years following this discovery, scientists electrified a variety of objects.

Static electricity is an imbalance of electric charges within or on the surface of a material. The charge remains until it is able to move away by means of an electric current or electrical discharge. Static electricity is named in contrast with current electricity, which flows through wires or other conductors and transmits energy.

A static electric charge can be created whenever two surfaces contact and separate, and at least one of the surfaces has a high resistance to electric current (and is therefore an electrical insulator). The effects of static electricity are

familiar to most people because people can feel, hear, and even see the spark as the excess charge is neutralized when brought close to a large electrical conductor (for example, a path to ground), or a region with an excess charge of the opposite polarity (positive or negative). The familiar phenomenon of a static shock–more specifically, an electrostatic discharge–is caused by the neutralization of charge.

2.1.3.1 Properties of Electric Charges

A number of simple experiments demonstrate the existence of electric forces and charges. For example, after running a comb through your hair on a dry day, you will find that the comb attracts bits of paper. The attractive force is often strong enough to suspend the paper. The same effect occurs when certain materials are rubbed together, such as glass rubbed with silk or rubber with fur.

Another simple experiment is to rub an inflated balloon with wool. The balloon then adheres to a wall, often for hours. When materials behave in this way, they are said to be *electrified*, or to have become electrically charged. You can easily electrify your body by vigorously rubbing your shoes on a wool rug. Evidence of the electric charge on your body can be detected by lightly touching (and startling) a friend. Under the right conditions, you will see a spark when you touch, and both of you will feel a slight tingle. (Experiments such as these work best on a dry day because an excessive amount of moisture in the air can cause any charge you build up to "leak" from your body to the Earth.)

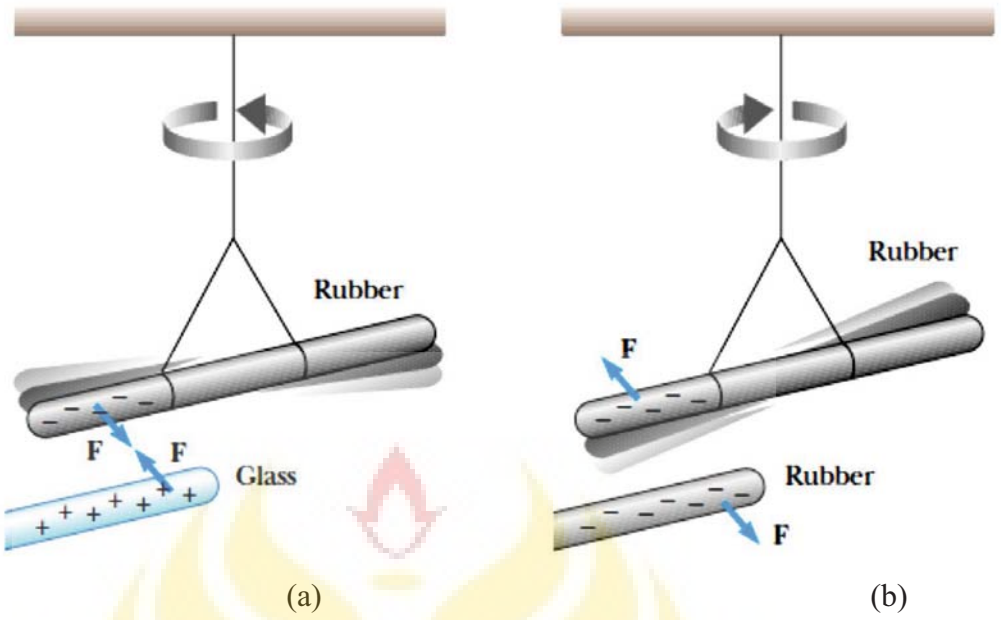


Figure 2.1 (a) A negatively charged rubber rod suspended by a thread is attracted to a positively charged glass rod. (b) A negatively charged rubber rod is repelled by another negatively charged rubber rod.

In a series of simple experiments, it was found that there are two kinds of electric charges, which were given the names positive and negative by Benjamin Franklin (1706–1790). We identify negative charge as that type possessed by electrons and positive charge as that possessed by protons. To verify that there are two types of charge, suppose a hard rubber rod that has been rubbed with fur is suspended by a sewing thread, as shown in **Figure 2.1** When a glass rod that has been rubbed with silk is brought near the rubber rod, the two attract each other (**Figure 2.1 a**). On the other hand, if two charged rubber rods (or two charged glass rods) are brought near each other, as shown in **Figure 2.1 b**, the two repel each other. This observation shows that the rubber and glass have two different types of charge on them. On the basis of these observations, we conclude that charges of the same sign repel one another and charges with opposite signs attract

one another. Using the convention suggested by Franklin, the electric charge on the glass rod is called positive and that on the rubber rod is called negative. Therefore, any charged object attracted to a charged rubber rod (or repelled by a charged glass rod) must have a positive charge, and any charged object repelled by a charged rubber rod (or attracted to a charged glass rod) must have a negative charge.

Attractive electric forces are responsible for the behavior of a wide variety of commercial products. For example, the plastic in many contact lenses, *etafilcon*, is made up of molecules that electrically attract the protein molecules in human tears. These protein molecules are absorbed and held by the plastic so that the lens ends up being primarily composed of the wearer's tears. Because of this, the lens does not behave as a foreign object to the wearer's eye, and it can be worn comfortably. Many cosmetics also take advantage of electric forces by incorporating materials that are electrically attracted to skin or hair, causing the pigments or other chemicals to stay put once they are applied.

Another important aspect of electricity that arises from experimental observations is that electric charge is always conserved in an isolated system. That is, when one object is rubbed against another, charge is not created in the process. The electrified state is due to a *transfer* of charge from one object to the other. One object gains some amount of negative charge while the other gains an equal amount of positive charge.

From our discussion thus far, we conclude that electric charge has the following important properties:

1. There are two kinds of charges in nature; charges of opposite sign attract one properties of electric charge another and charges of the same sign repel one another.
2. Total charge in an isolated system is conserved.
3. Charge is quantized.

(Serway, 2004)

2.1.3.2 Coulombs' Law

Charles Coulomb (1736–1806) measured the magnitudes of the electric forces between charged objects using the torsion balance, which he invented (**Figure 2.2**).

Figure 2.2 Coulomb's torsion balance, used to establish the inverse-square law for the electric force between two charges.

From Coulomb's experiments, we can generalize the following properties of the electric force between two stationary charged particles. The electric force

- is inversely proportional to the square of the separation r between the particles and directed along the line joining them;
- is proportional to the product of the charges q_1 and q_2 on the two particles;
- is attractive if the charges are of opposite sign and repulsive if the charges have the same sign;
- is a conservative force.

We will use the term point charge to mean a particle of zero size that carries an electric charge. The electrical behavior of electrons and protons is very well described by modeling them as point charges. From experimental observations on the electric force, we can express Coulomb's law as an equation giving the magnitude of the electric force (sometimes called the *Coulomb force*) between two point charges:

$$\overrightarrow{F_e} = k_e \frac{|q_1||q_2|}{r^2} \hat{r}$$

(equation 1)

where k_e is a constant called the Coulomb constant. In his experiments, Coulomb was able to show that the value of the exponent of r was 2 to within an uncertainty of a few percent. Modern experiments have shown that the exponent is 2 to within an uncertainty of a few parts in 10^{16}.

The value of the Coulomb constant depends on the choice of units. The SI unit of charge is the coulomb (C). The Coulomb constant k_e in SI units has the value

$$k_e = 8.987\ 5\ x\ 10^9\ N.m^2/C^2$$

When dealing with Coulomb's law, you must remember that force is a vector quantity and must be treated accordingly. The law expressed in vector form for the electric force exerted by a charge q_1 on a second charge q_2, written $\vec{\mathbf{F}}_{12}$, is

$$\vec{\mathbf{F}}_{12} = k_e \frac{q_1 q_2}{r^2} \vec{\boldsymbol{r}}$$

(equation 2)

where $\vec{\boldsymbol{r}}$ is a unit vector directed from q_1 toward q_2, as shown in **Figure 2.3 a**. Because the electric force obeys Newton's third law, the electric force exerted by q_2 on q_1 is equal in magnitude to the force exerted by q_1 on q_2 and in the opposite direction; that is, $\vec{\mathbf{F}}_{12} = -\vec{\mathbf{F}}_{21}$. Finally, we see that if q_1 and q_2 have the same sign, as in **Figure 2.3 a**, the product $q_1 q_2$ is positive. If q_1 and q_2 are of opposite sign, as shown in **Figure 2.3 b**, the product $q_1 q_2$ is negative. These signs describe the *relative* direction of the force but not the *absolute* direction. A negative product indicates an attractive force, so that the charges each experience a force toward the other—thus, the force on one charge is in a direction *relative* to the other. A positive product indicates a repulsive force such that each charge experiences a force away from the other. The *absolute* direction of the force in space is not determined solely by the sign of $q_1 q_2$ —whether the force on an individual charge is in the positive or negative direction on a coordinate axis depends on the location of the other charge. For example, if an x axis lies along

the two charges in **Figure 2.3 a**, the product $q_1 q_2$ is positive, but $\vec{\mathbf{F}}_{12}$ points in the $+x$ direction and $\vec{\mathbf{F}}_{21}$ points in the $-x$ direction.

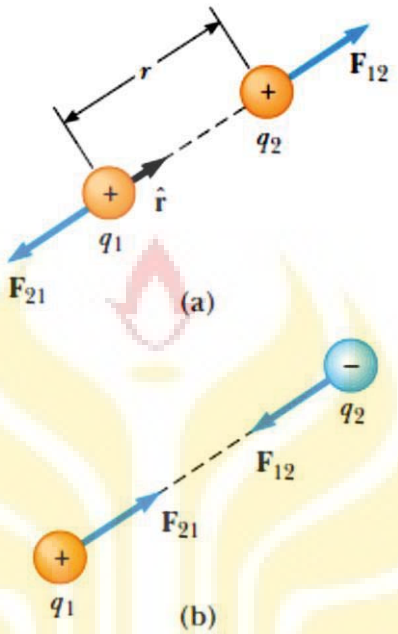


Figure 2.3 Two point charges separated by a distance r exert a force on each other that is given by Coulomb's law. The force $\vec{\mathbf{F}}_{21}$ exerted by q_2 on q_1 is equal in magnitude and opposite in direction to the force $\vec{\mathbf{F}}_{12}$ exerted by q_1 on q_2. (a) When the charges are of the same sign, the force is repulsive. (b) When the charges are of opposite signs, the force is attractive.

When more than two charges are present, the force between any pair of them is given by equation 2. Therefore, the resultant force on any one of them equals the vector sum of the forces exerted by the various individual charges. For example, if four charges are present, then the resultant force exerted by particles 2, 3, and 4 on particle 1 is

$$\vec{\mathbf{F}}_1 = \vec{\mathbf{F}}_{21} + \vec{\mathbf{F}}_{31} + \vec{\mathbf{F}}_{41}$$

2.1.3.3 The Electric Field

The electric force exerted by one charge on another is an example of an actionat a-distance force, similar to the gravitational force exerted by one mass on another. The idea of action at a distance presents a difficult conceptual problem. What is the mechanism by which one particle can exert a force on another across the empty space between the particles? Suppose that a charged particle at some point is suddenly moved. Does the force exerted on the second particle some distance r away change instantaneously? To avoid the problem of action at a distance, the concept of the electric field is introduced. One charge produces an electric field $\boldsymbol{E}$ everywhere in space, and this field exerts the force on the second charge. Thus, it is the field $\boldsymbol{E}$ at the position of the second charge that exerts the force on it, not the first charge itself which is some distance away. Changes in the field propagate through space at the speed of light, c. Thus, if a charge is suddenly moved, the force it exerts on a second charge a distance r away does not change until a time r/c later.

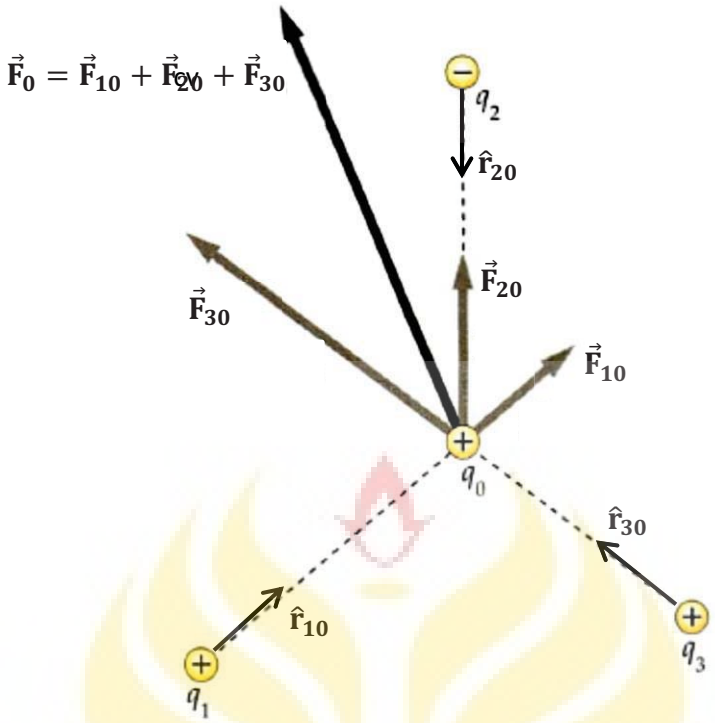


Figure 2.4. A small test charge q_0 in the vicinity of a system of charges q_1 q_2 q_3 .experiences a force $\vec{F}$ that is proportional to q_0- The ratio $\vec{F}/q_0$ is the electric field at that point.

Figure 2.4 shows a set of point charges, q_1 q_2 and q_3 arbitrarily arranged in space. These charges produce an electric field $\vec{E}$ everywhere in space. If we place a small positive test charge q_0 at some point near the three charges, there will be a force exerted on q_0 due to the other charges.t The net force on q_0 is the vector sum of the individual forces exerted on q_0 by each of the other charges in the system. Because each of these forces is proportional to q_0, the net force will be proportional to q_0. The electric field $\vec{E}$ at a point is this force divided by q_0.

$$\vec{E} = \frac{\vec{F}}{q_0}$$

(q_0 small)

The S1 unit of the electric field is the newton per coulomb (N/C). **Table 2.1**. lists the magnitudes of some of the electric fields found in nature.

Table 2.1 Some Electric Fields in Nature

Kind of Electric Field in nature	$\vec{E}\ (N/C)$
In household wires	10^{-2}
In radio waves	10^{-1}
In the atmosphere	10^{2}
In sunlight	10^{3}
Under a thundercloud	10^{4}
In a lighting bolt	10^{4}
In an X-ray tube	10^{6}
At the electron in a hydrogen atom	$6\ x\ 10^{11}$
At the surface of a uranium nucleus	$2\ x\ 10^{21}$

The electric field describes the condition in space set up by the system of point charges. By moving a test charge q_0 from point to point, we can find $\vec{E}$ at all points in space (except at any point occupied by a charge q). The electric field $\vec{E}$ is thus a vector function of position. The force exerted on a test charge q_0 at any point is related to the electric field at that point by

$$\vec{F} = q_0\vec{E}$$

(Tippler, 2004)

2.1.4 Learning with Scientific Approach

The scientific approach is an approach in learning activity that promotes creativity and the students' inventions (Kosasih, 2014:72). The implementation of

scientific approaches in learning process must involves skills such as observing, classifying, measuring, predicting, explaining, and concluding. In carrying out these processes of scientific approach learning, the teachers' role must be decreased while the students' activities are increasing in class (Daryanto, 2014 : 51). However, the role of teachers remains literally important in class. Teachers were highly valued and it was thought that "without a teacher, you can do nothing" (Pham & Fry, 2004). Therefore, in terms of scientific learning teacher is placed as facilitator in class. As a facilitator, teachers should be able to develop approaches that make science learning more practical and action-oriented (McFarlane, 2013). In Indonesian education curriculum 2013, learning process for all levels has implemented using scientific approach (scientific).

Basically scientific approach consists of five main activities including observing, questioning, experimenting/collecting some data, associating and communicating. The following are those explanations in detail:

2.1.4.1 Observing

Observing is a deliberate and systematic study of the particular phenomenon through of observation and recording. Observation is conducted in order to understand the characteristics and significant correlation of elements on a social phenomenon or other particular phenomenon. Within learning activities, students perform observation through the investigation activity (Hosnan, 2014:40). The observing method have priors to create meaningful of learning.

The observing method is very useful provide the curiosity of learners or students. Through observation, students found relationship between among of objects have been analyzed with learning materials used by teachers (Kurinasih

and Sani, 2014:142). According to Permendikbud No. 81A, explained that teachers should be able to open widely up the opportunities of learners to make observations through: look, listen, hear, and read. Teachers have to facilitate the learners to observe, train them to pay attention (see, read, hear) things that are important from an object. Students are expected to gain competencies such as seriousness, rigor and skill for looking any information.

2.1.4.2 Questioning

Questioning is aimed to develop the curiosity of students. As getting trained in asking the curiosity as more the students can be developed. Questioning becomes an anvil for seeking further information and a variety of sources. An effective teacher can inspire students to improve and develop the realm of attitudes, skills and knowledge. By the time the teacher asked, at the same time he guided or guide their students to learn well. When the teacher answered questions from learners, unconsciously he pushed her care to be good listeners and learners (Kurniasih and Sani, 2014: 146).

"Questioning" in learning activities, as presented in Permendikbud No. 81A in 2013, is asking questions about information that is not understood from observations to collect additional information about what is observed (starting from factual questions either hypothetical questions as well). The competencies are expected from this activity are to develop creativity, curiosity, the ability to formulate questions, critical thinking which is very necessary. In this learning activity, students undertake a study to ask (Hosnan. 2014: 49).

2.1.4.3 Experimenting/Collecting Some Data

Experimenting or collecting information is the follow up activity of questioning. This activity is done by digging and collecting information from various sources through a variety of ways. In this case, students can read books more, attention to the phenomenon or object that is more studied, or even conduct experiments. This activity accumulates amount of information. Permendikbud No. 81A in 2013 explained that the activity of collecting information can be done through experimentation, reading sources other than textbooks, observing the objects/events/activities informant interviews, and etc. From this activity students are expected to develop an attitude conscientious, honest, polite, respect the opinions of others, the ability to communicate, implement the ability to collect information through a variety of ways to learn and develop the habit of learning (Hosnan, 2014: 57).

2.1.4.3 Associating

The term "associating" within the framework of the learning process with a scientific approach adopted in curriculum 2013, is to develop that teachers and learners are active participants. The emphasis is certainly that students must be more active rather than teachers. Associating is a process of thinking logically and systematically on empirical facts that can be observed to obtain a conclusion (Hosnan, 2014: 67).

Associating is completely different with reasoning even though both of them have similar meaning. The term “associating” in the context of curriculum 2013 refers to learning theories association or associative learning. The term association in learning refers to the ability to group diverse ideas and diverse

associate events to then put it into a fragment of memory. During the process of transferring special events to the brain, it is stored in a reference to the experience of other events. The experiences that have been stored in the memory of the brain relate and interact with prior experience are already available. That process is known as associating.

In perspective of psychology, the associating refers to the connection between the conceptual entities or mentally as a result of the similarity between the mind or the proximity in time and space (Kurniasih and Sani, 2013: 147-148). The "associating/process information/ reasoning" in learning activities, as presented in Permendikbud No. 81A in 2013, is processing the information already collected either limited from the activities of collecting/experiment and the results of the activity observed and information collecting activities. Processing information is collected from nature to add breadth and depth to the information processing that are looking for solutions from a variety of sources that have a different opinion to the contrary. This activity is conducted to find the relationship of the information with other information, found a pattern of linkages such information. From this activity students are expected to develop their attitude of honest, conscientious, disciplined, law-abiding, hard work, ability to apply the procedures and the ability to think inductively and deductively in concluding.

2.1.4.4 Communicating

In the scientific approach, teachers are expected to provide an opportunity for learners to communicate what they have learned. In this case, students have to communicate and explain the results of the work that has been prepared well

together in groups or individually. In this activity students have to try to deliver the conclusions to the class. Communication provides activities of clarification by the teacher so that learners will know the true whether the answer is correct or still need correction. It can be focused on the following confirmation as to the standard process. This can be done through a write or tell what is found in the activities of finding information, to associate and find the patterns. The findings were presented in class and graded by the teacher as learning outcomes of students or groups.

The activity of "communicating" in learning activities, as presented in Permendikbud No. 81A in 2013, is to convey the observations, conclusions based on the analysis of oral, written, or other media. From this activity students are expected to develop their attitude, fair, thorough, tolerance, the ability to think systematically, express opinions succinctly and clearly, and language development as well. In communicating the activities of learners expected to be able to present its findings to be displayed in front of the crowd so bold flavors leave comments, suggestions or improvements on what was presented by his mates in class (Hosnan, 2014: 76).

2.1.5 Student's Concept Understanding as Cognitive Skill

Student concept can be mentioned as cognitive skills. Cognitive skills are understood as the mental actions or pro-cesses of acquiring knowledge and understanding through thought,experience, and the senses (Van D. F., *et al,* 2014). Cognitive skills has a lots of name such as cognitive performance or cognitive function or cognitive abilities or cognitive behavior or cognitive control or

cognitive processes or cognition or intelligence or IQ or academic achievement or kindergarten achievement or language development or executive functions or memory or working memory or attention (Van D. F., *et al,* 2014).

Jean Piaget defines that intellect is intellect based on aspects of cognitive, particularly the higher thinking processes. While intelligence or intelligent synonymous with intelligence that the entire abilities to think and act adaptively, including complex mental abilities such as thinking, considering, analyzing, synthesizing, evaluating and solving the problem. Jean Piaget said that intelligence is the whole possibility of coordination that give structure to the behavior of an organism as a mental adaptation to the new situations.

According to the Bloom's Taxonomy, education is classified into three domains including cognitive domain, Affective domain, and psychomotor domain. Cognitive domain contains attitudes which are concern to the intellectual aspects. Intellectual aspect is an attitude which is consisted of knowledge, description and thinking pattern. Within cognitive domain there are six sub domains including knowledge, comprehension, application, analysis, synthesis and evaluation. Sub domain knowledge contains ability to recognize and recall the term, definitions, pattern, facts, ideas, theory, methodology, basic concept, etc. Comprehension contains ability to demonstrate the facts and ideas, and classifying by organizing, comparing, interpreting, analyzing, and etc. Application contains ability to apply the theory, ideas, procedure, laws, formula, and etc. Analysis contains ability to analyze the information and understand the pattern and the structure of the information. Synthesis contains ability to explain the invisible structure and pattern of scenario or information, and the ability to recognize the

data and information should be obtained to provide the solution. Evaluation contains the ability to examine the solution, ideas, methodology, and etc.

From these definitions it can be concluded that student's concept understanding can be determined by the result of academic achievement or test result of the students itself. Measurement of such knowledge/cognitive and skills is essential to tracking students' development and assessing the effectiveness of educational policies and practices (Finn *et al,* 2014).Cognitive ability has multiple facets. Psychologists distinguish between fluid intelligence (the rate atwhich people learn) and crystallized intelligence (acquired knowledge). Achievement tests are designed to capture crystallized intelligence. (Kautz *et al*, 2014).

According to the revised Bloom's Taxonomy by Taksonomi Bloom by Karthwohl, D. R., (2002: 215), here the points of structure of the cognitive process dimension of the revised taxonomy

1. **Remember** - Retrieving relevant knowledge from long-term memory.

1.1 Recognizing

1.2 Recalling

2. Understand - Determining the meaning of instructional messages, including oral, written, and graphic communication.

2.1 Interpreting

2.2 Exemplifying

2.3 Classifying

2.4 Summarizing

2.5 Inferring

2.6 Comparing

2.7 Explaining

3. Apply - Carrying out or using a procedure in a given situation.

3.1 Executing

3.2 Implementing

4. Analyze - Breaking material into its constituent parts and detecting how the parts relate to one another and to an overall structure or purpose.

4.1 Differentiating

4.2 Organizing

4.3 Attributing

5. Evaluate - Making judgments based on criteria and standards.

5.1 Checking

5.2 Critiquing

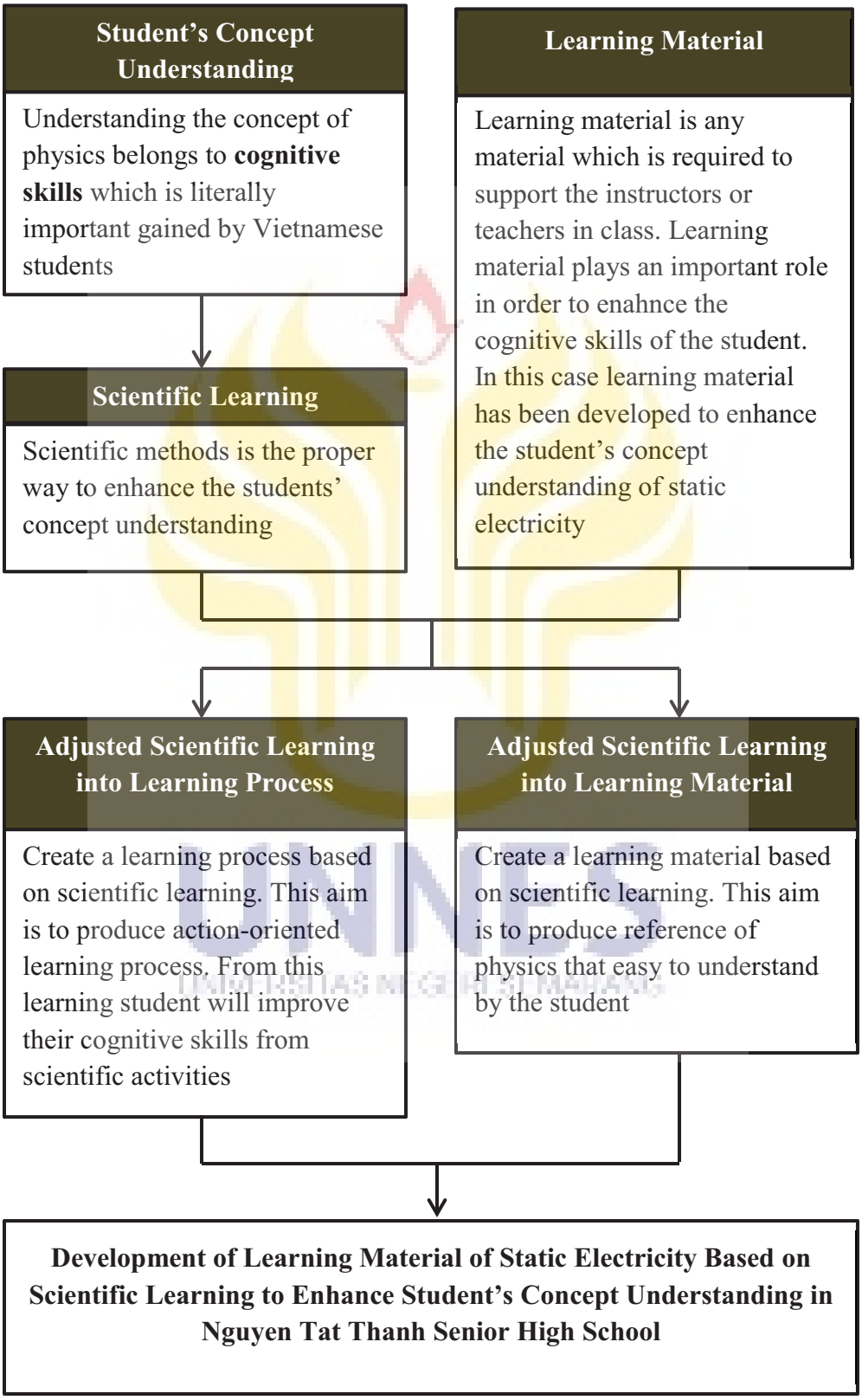
6. Create - Putting elements together to form a novel, coherent whole or make an original product.

6.1 Generating

6.2 Planning

6.3 Producing

2.2 Framework of Thinking



CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1 Conclusion

Based on the results of research and analysis, it can be concluded as follows:

5.1.1 Learning materials of static electricity based on scientific approach can be made by applying scientific learning methods. Static electricity learning materials based on scientific approach is eligible to be used in learning process. This is confirmed by the average score of the eligibility provided by validator is equal to 83.4%. Furthermore the readability of static electricity learning material is classified as easy and readable learning material with the average percentage score readability testing of learning material is 98.7%.

5.1.2 Static electricity learning material based on scientific learning is able to improve students' concept understanding. This is indicated by the value of the normalized gain at pretest-posttest of the experimental class of 0.72 and it's classified as excellent enhancement. In addition *t* test also showed significant difference between the posttest results experiment class and control class. The enhancement of student comprehension ability is also demonstrated by the average enhancement in percentage cognitive aspects of experimental class students that higher than average enhancement in cognitive control class. The average enhancement of cognitive experimental class is 17.59%. Therefore, it can be concluded that the learning material static electricity can improve students' concept understanding as cognitive aspects of the students.

5.1.3 The cognitive ability of students after receiving learning material based on scientific learning is dominant on the level of C3, C4, and C5. Therefore it can be concluded that with the implementation of static electricity learning materials based on scientific learning can improve students' in high order thinking.

5.2 Recommendation

Based on the results of research and analysis, the suggestion or recommendation is that for further research can be suggested that for the accuracy of research, it can be sure that all students do and finish all step of scientific approach that have been adjusted in learning material.

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