CHAPTER I
INTRODUCTION

1.1 Background

Chemistry is a science that studies the structure, composition and properties of substances. Understanding chemistry includes the ability to think on three levels: the macroscopic level, the symbolic level, and the level of particles sub-microscopic level. Students have the most difficulty when trying to understand the sub-microscopic level because it is outside their range of experience (Herga*et al,* 2016). In order to make the better understanding about the sub-microscopic level, students should do experiments in laboratory.

Laboratories are important components of chemistry education. In laboratory applications, students realize practical applications of theoretical knowledge and also they develop their inquiry and scientific processing skills. (Bayrak*et al*, 2009).

Experimental work can be divided into real and virtual. Classical experimental work is the best-known method of practical work and is more commonly used when teaching science and chemistry in primary schools. Pupils train using their manual skills, developing their abilities to describe chemical changes, learn about the physical and chemical properties of matter, developing safety at work abilities within the school laboratory, strengthening and complementing their knowledge, abilities, and skills, and developing an experimental approach as a form of research work (Sokoutis, 2003).

However, at some schools, laboratory applications of chemistry courses are missing because of the following reasons such as absence of chemistry labs, sharing laboratory with physics, chemistry and biology courses, insecurity in labs because of dangerous chemicals, crowded classrooms, lack of time, lack of materials, cost of equipments, incapableness of teachers using labs effectively and their negative attitudes towards laboratory applications (Ekici *et al*, 2002).

Based on preliminary analysis of laboratory activity and virtual chemistry laboratory application in senior high schools in Binjai that was collected by researcher show (1) Almost all of schools have chemistry laboratory but are not separated with physics and biology laboratories, (2) Physically, laboratory building that already exists in school have the minimum standard criteria, but laboratory facilities, do not have a fume hood and a special area for waste disposal, (3) The availability of non-physical laboratory does not have minimum criteria standards of chemical laboratory (4) The availability of laboratory safety does not have minimum standards of a chemical laboratory (5) Some high school chemistry teachers are not familiar with virtual chemistry laboratory or have never used a virtual chemistry laboratory

Based on the description above, the problems in the activity of laboratory experiment can be overcome by using interactive virtual laboratory as the replacer for the real laboratory.

Computer assisted laboratory applications are alternatives for educators to cope with the mentioned limitations of traditional laboratories. A computerized laboratory experiment is an efficient tool to aid understanding of topics developed in the classroom and in the laboratory (Martinez et al., 2003).

Since the real experiment allows teachers and students to reach the desired goals, a virtual experiment could be useful for better understanding of the theoretical information and takes students‘ attention to the techniques used to perform the measurements. Also, simulation experiments give students the opportunity to learn in their own ways. With the help of simulation experiments, students learn the proper usage of the equipments. Moreover, it is possible to organize virtual experiments which cannot usually be done in the laboratory (i. e., with harmful or dangerous chemicals) and the simulation of experiments that would require too many hours or expensive instruments (Belletti *et al*, 2006).

Based on the research was done by Herga *et al* (2015) conclude that the use of a virtual laboratory can affect the formation of mental models at the

submicroscopic level. These dynamic models and animations, which are enabled by a virtual laboratory, when compared with the static sub-micro presentations, proved to be more appropriate for the understanding of chemical concepts.

Research result by Dalgarno *et al* (2009), suggested that the Virtual Laboratory can be an effective tool to help students develop their familiarity with the laboratory environment prior to their laboratory sessions.

One of the chemistry topic that are considered difficult and needed to be explained by doing experiment is solubility and solubility product. In the field, many students present solubility and solubility product only on symbolic level. They are difficult to understand the real concept. This can be proved by the information obtained from chemistry teacher in State Senior High School 1 Binjai that the average of students' achievement grade XI in chemistry subject for the last three years tend to be static and only limited on KKM (Minimum Criterion). Various factors caused by the misconception and student difficulty in understanding concept.It is necessary to look for a proper solution in order to make the better understanding of students about solubility and solubility product in sub-microscopic level.

Based on the description above, researcher conduct research to develop interactive virtual laboratory as innovative learning media in chemistry subject of Senior High School Grade XI to increase student's achievement and also to make better understanding of submicroscopic level in solubility and solubility product.

1.2Problem Identification

1. Chemistry Subject tends to abstract, so to make the better understanding should do experiment in laboratory
2. The activity of laboratory experiment is not going well because the lack of material and equipments.
3. The average value of student's achievement in chemistry topic considerably low

4. Students have the most difficulty when trying to understand the sub-microscopic level of chemistry concept

1.3 Problem Limitation

Given the limitations of researchers, it is necessary to limit the problem as follows:

2. The subject of this research is senior high school students of class XI semester II.
3. The development of virtual chemistry laboratory is limited in grade XI experiment on solubility and solubility product topic.
4. The development of a virtual chemistry laboratory follows the BSNP (National Education Standards Board) standard.
5. The development of virtual chemistry laboratory measures the students achievement, student understanding of submicroscopic level, and student activities

1.4 Problem Statement

Based on the problem identification it can be describe the problem statement as follow :

1. Is the virtual chemistry laboratory media that developed suitable with eligibility standards of BSNP (National Education Standards Board)?
2. Is the student achievement that is learned by using virtual chemistry laboratory media higher than learned without using virtual chemistry laboratory media?
3. Is the student understanding of sub-microscopic level that is learned by using virtual chemistry laboratory media higher than learned without using virtual chemistry laboratory media?

4. How is the student activity that is learned by using virtual chemistry laboratory media and learned without using virtual chemistry laboratory media?
5. Is the student activity has positive correlation with student achievement?
6. Is the student activity has positive correlation with student understanding of submicroscopic level?

1.5Research Objectives

The objectives of this research are :

1. Analyzing the virtual chemistry laboratory media that developed suitable with eligibility standards of BSNP
2. Analyzing the student achievement that is learned by using virtual chemistry laboratory media higher than learned without using virtual chemistry laboratory media
3. Analyzing the student understanding of submicroscopic level that is learned by using virtual chemistry laboratory media higher than learned without using virtual chemistry laboratory media
4. Analyzing student activity that is learned by using virtual chemistry laboratory media and learned without using virtual chemistry laboratory media
5. Analyzing the correlation between student activity and student achievement
6. Analyzing the correlation between student activity and student understanding of submicroscopic level

1.6 Research Benefit

The benefits that expected from this research are :

1.6.1 Theoretic Benefit

This research can be used as chemistry learning media that explain submicroscopic level as representation of chemistry concept in order to make

student become easier to learn chemistry especially in solubility and solubility product.

1.6.2 Practical Benefit

1. For school :
   a) as the learning media alternative to conduct experiment because the lack of materials and equipments
   b) Improving education quality by integrating technology based IT in curriculum in order to increase student understanding of chemistry concept
2. For teacher : as the solution and motivation for chemistry teacher in using learning media innovative for experiment to support learning process.
3. For student :
   a) as learning sources in learning chemistry especially in solubility and solubility product topic
   b) Students be able to do learning activity independently
   c) Improving student enthusiastic in learning process
   d) Improving student skill in operating computer

1.7 Operational Definition

1. Interactive Chemistry Virtual Laboratory

Virtual Laboratory is an interactive environment for creating and conducting simulated experiments: a playground for experimentation. It consists of domain-dependent simulation programs, experimental units called objects that encompass data files, tools that operate on these objects (In this research the virtual laboratory means the experimental chemistry media in the form of virtual animation ((Zhao, 2015).

2. Student Achievement (Normalized gain)

Student achievement that is observed in this research is normalized gain. Normalized gain defined as a rough measure of the effectiveness of a course in

promoting conceptual understanding. This measure is commonly described as "the amount students learned divided by the amount they could have learned (Hake, 1998).

3. Understanding Submicroscopic Level

In understanding submicroscopic level in solubility and solubility products including to analyze the principle of solubility and solubility product by presenting how do the particles and atoms work (Treagust, et al., 2003).

4. Student's Activity

Student's activity is the involvement of students in the form of attitudes, thoughts, attention in learning activities to support the success of the learning process and benefit from these activities (Sardiman, 2011).