THE LEVEL OF SCIENTIFIC SKILL AMONG CHEMISTRY STUDENTS

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DEDICATION

This project report is respectfully devoted to my beloved father and mother who give me words of encouragement, taught me that the best kind of knowledge to have is that which is learned for its own sake and supported me throughout the study process.

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My sincere gratitude extends to all the respondents who had provided assistance and cooperation on data collection to complete this study. I wish to express sincere appreciation to my family members and all my friends who had provided me help, encouragement and support to make this study successfully.

ABSTRACT

Our nation intend to equip each individual with scientific literacy that has scientific skills and pursue their future career in science area. The scientific skills are covering the basic science process skills, integrated science process skills and manipulative skills. This study purpose to investigate the level of scientific skill among chemistry students in Form Four level. A total of 270 respondents from Johor secondary school students are participated in this study. This study applies quantitative methods with survey research design. The data collected by adapted and compilation of several instruments which come from Miles, Burns, Okey, Wise, Padilla and Mohd Fazil. The data collected were analysed via Statistical Package for Social Science (SPSS) version 20 and consist of percentage, frequency and mean of data. Based on the finding, students' level in scientific skills consider moderate level same goes with basic science process skills, integrated science process skills and manipulative skills. The moderate level in basic science process skill is due to each of skills has different score such as predicting is highest level because students able to predict their answer with prior knowledge, while the lowest score is observing skill because students unable to differentiate question and lack of imagination. While for integrated science process skill in moderate level also same goes with each skill have different score such as controlling and identify is the highest score due to students learning this skill from their primary level and they familiar with variables. Manipulative skills also same with moderate level due to students weak in draw out specimen skill. In this study, the implication of study is concern on the teaching and learning, curriculum and science literacy that related with scientific skill.

ABSTRAK

Negara berhasrat untuk melengkapkan setiap individu dengan literasi saintifik yang menguasai kemahiran saintifik dan meneruskan kerjaya masa depan mereka dalam bidang sains. Kemahiran saintifik merangkumi kemahiran proses sains asas, kemahiran proses sains bersepadu dan kemahiran manipulatif. Kajian ini bertujuan untuk mengetahui tahap kemahiran saintifik dalam kalangan pelajar kimia Tingkatan Empat. Seramai 270 responden dari pelajar Sekolah Menengah Kebangsaan Johor telah mengambil bahagian dalam kajian ini. Kajian ini menggunakan kaedah kuantitatif dengan reka bentuk tinjauan. Data yang dikumpulkan melalui beberapa instrument yang diadaptasi dan disusun berdasarkan instumen yang berasal dari Miles, Burns, Okey, Wise, Padilla dan Mohd Fazil. Data yang dikumpulkan dianalisis melalui Statistical Package for Social Science (SPSS) versi 20 dan terdiri daripada peratusan, frekuensi dan min data. Berdasarkan penemuan tersebut, tahap kemahiran saintifik pelajar berada pada tahap sederhana sama dengan kemahiran proses sains asas, kemahiran proses sains bersepadu dan kemahiran manipulatif. Tahap sederhana dalam kemahiran proses sains asas adalah kerana setiap kemahiran mempunyai skor yang berbeza seperti meramalkan tahap tertinggi kerana pelajar dapat meramalkan jawapan mereka dengan pengetahuan dahulu, sementara skor terendah adalah kemahiran memerhatikan kerana pelahar tidak dapat membezakan soalan dan kekurangan khayalan. Manakala untuk kemahiran sains bersepadu dalam tahap sederhana juga berlaku dengan setiap kemahiran mempunyai skor yang berbeza seperti mengawal dan mengenal pasti pemboleh ubah yang paling tinggi kerana pelajar mempelajari kemahiran ini dari sekolah rendah. Kemahiran manipulatif juga sama dengan tahap sederhana kerana pelajar lemah dalam kemahiran melakar spesimen, Kajian ini memberikan implikasi terhadap pengajaran dan pembelajaran, kurikulum dan literasi sains yang berkaitan dengkan kemahiran saintifik.

TABLE OF CONTENT

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

UTM	-	Universiti Teknologi Malaysia
KR-20	-	Kuder-Richerson

LIST OF SYMBOLS

%	-	percentage
N	-	number of respondents
s	-	sample size
X^2	-	Table value for chi-square
P	-	Population proportion
d	-	Degree proportion
N	-	Population size
σ^2	-	Variance

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

1.1 Introduction

In this modernization and technology era, Malaysia intends to become a developing county in the globalization. Tun Mahathir Mohamad had declared the implementation of Vision 2020 (known as year 2020) in which Malaysia would become an advanced country or turn Malaysia from a consumer country into an industrialised country. In Vision 2020, it is hoped that Malaysia can be a united country with well-built moral and ethical values, living in a society which is democratic, free, tolerant, caring, equal economic, continuous and has competitive, robust, dynamic and resilient economy (Prime Minister's Office of Malaysia, 2020). *Transformasi Nasional 2050* and *Wawasan Kemakmuran Bersama* which is the continuation of Vision 2020 (Official Portal, Ministry of Housing and Local Government). Therefore, in order to achieve this goal or target, Malaysia government must educate the next generation in the scientific method to confirm that all the residents are fully equipped with the scientific knowledge. To reach the scientific knowledge society among all residents, Malaysia is facing challenges in achieving the goal.

Based on the sixth challenge that Malaysia needs to overcome, Malaysia needs to exhibit a scientific and progressive society which is innovative and looking forward to give contribution to scientific and technological civilization in the future not only consumer of technology. In order to become a developed, creative and progressive country, Malaysia is required to have a scientific society environment which means that citizens should have science literacy, and higher order thinking skills in science

and technology. Therefore, Malaysia education puts more effort in nurturing or constructing individuals who are scientific oriented, well-performed, knowledgeable and responsible in science and technology with balanced in both emotional and physical in daily life (Hassan *et al.* 2009).

Today, science and technology are developing rapidly in the global and this affects our lives in the future. Hence, government must enhance the quality of the science and technology in the educational system (Aydoğdu, 2006).

Based on FEYZİOĞLU (2009), science and technology play a vital role in a developed countries and act as a gold key for the future education. Furthermore, when science is implemented in the education curriculum, it enables students to understand the worth of science and technology in the society and lead them aware of scientific knowledge in their daily life (Abungu *et al.*, 2014). Whereas Akani (2015) stated that the application of science and technology can be used to define the level of development of a country, this means that country development should stress on scientific education.

In the Malaysia Education Blueprint, all Malaysian citizens must learn science and technology at schools. According to Ministry of Education (2006), Malaysia Education system has been vigorously implementing Science and Technology Culture to nurture individuals to have the capability, competence and mastery in their science and technology subjects in school life. Whereas, Malaysia education has also enrolled STEM (Science, Technology, Engineering, Mathematics) in education. STEM is integrated in teaching and learning in the year of 2017 and documented in Malaysia Education Blueprint 2013-2015 (Ministry of Education, 2013).

Based on Bahrum, Wahid and Ibrahim (2017), STEM is represented as "pedagogical applicants based on design and engineering technology for teaching and practice in the science and mathematics education simultaneously". STEM brings benefits such as increase students' interest through new learning approach that include higher order thinking skill, improve teachers' competency skill and awareness of STEM fields in future life (Khairani, 2017 and Ramli and Talib, 2017).

Other than that, Malaysia also focuses on nurturing students to be equipped with accessing information skills instead of just being delivered with information (FEYZİOĞLU, 2009). Hence, students can learn problem solving skills when facing with new situations and this can prevent students in rote learning (Gedik *et al.*, 2002).

Therefore, through nurturing in these processes, students can gain scientific knowledge, scientific attitude and scientific skill. This research study focuses on studying the scientific skills among chemistry students.

1.2 Background of the Study

Since this research study is to study the scientific skills among chemistry students. Chemistry is seemed to be important to create awareness on students about environment of chemistry and student must master the syllabus before examination (Yunus and Ali, 2013). Furthermore, chemistry can be referred as a life, occur in any place of modern science (Opara and Waswa, 2013). Therefore, this means that chemistry represents as a core science that will form a simple foundation to discipline in order to enhance the quality of life and performance.

Based on Omiko (2007), scientific skill is a core concept of science and students should pay more attention rather than facts, skills and theories. Learning science should be clarifying with the scientific skill and applied in the daily life. Scientific skill include science process skills (BSPS and ISPS) and manipulative skills. Acording to Abungu *et al.*, (2014), science process skills is determined as an activity which allows students to hands-on the scientific investigation to obtain the scientific knowledge and skills. Also, this is supported by Opara (2011), students can learn how to describe an object or events, ask questions, provide structure explanation, test the explanation with scientific knowledge and transfer their idea to other through learning science process skill.

Özgelen (2012) stated that science process skill refers to scientists' thinking skill intent to build up knowledge to solve problems. When students build up their scientific skill knowledge, this can assist them to have more science literacy in the future. While Akani (2015) and Özgelen (2012) conclude that science process skill consists of basic science process skills and integrated science process skill. Both of these process skills can be classified as below in Table 1.1:

Table 1.1: Classification of Science Process Skill

Science Process Skill	
Basic Science Process Skill	Integrated Science Process Skill
• Observing • Measuring • Inferring • Classifying • Predicting • Communication	• Formulating hypotheses • Identify variables • Define variables • Interpret data • Experimenting • Formulate model

Whereas according to Ango (1992), science process skill can be sorted into two groups, which are basic science process skill and integrated science process skill. The basic science process skill can be known as a simpler process skill that offers a foundation for learning and importance for learning science and all the basic concept information at primary school level. On the other hand, the integrated science process skill can be known as a more complex skill and difficult in the formation of models, experiment at the secondary school level or tertiary level.

Apart from that, other researchers such as Kahar and Sani (2018) also explained scientific skills are separated into two categories which are science process skill and manipulative skills. The science process skill can be defined as the skill that students need to find out comprehensive answer with information processing, while the manipulative skills can be referred to student's capability in handling science experiment. (Osman and Vebrianto, 2013). This statement is also be supported by Ten (2004) who stated that science process skills is which students are able to handle the equipment and material of science.

Furthermore, in Malaysia, science subject is required to be taught for five times a week to reach the equivalent about 200 minutes (3.5 hours) per week which is set by MOE (Ministry of Education, 2014). With this implementation, it can be clearly known that Malaysia Education has put effort and emphasis on the science subject and scientific skills to be learned by students. Science classroom usually consists of practical works (experiments) and science theories and facts from scientists (Lilia, 2013). Besides that, MOE has highlighted 12 science process skills which are observing, categorizing, making hypotheses, measuring and use of numbers, making inferences, predicting, communicating, interpreting data, controlling variables, defining operation and experiments with uses of time and space. Ergül *et al.*, (2011) stated that science process skill can help student's persistence of their learning in science and this can enable them to solve problems, improve critical thinking, make correct decisions and find out answers by their own. These skills are classified into 4 levels based on Bahagian Pembangunan Kurikulum (2012) in Table 1.2.

Table 1.2: Level of Science Process Skills

Level	Types of Science Process Skills
Level 1	Observing, categorizing
Level 2	Estimating, formulating hypothesis, controlling variables, experimenting
Level 3	Comparing, inferring, measuring and use of numbers, use of times and spaces
Level 4	Interpreting data, making decision

Refer: Kahar & Sani (2018)

Even though science process skills assist learners to develop and retain in science study, students still often face some problems in learning science.

1.2.1 Student's Difficulty Mastering in Basic Science Process Skills

The basic science process skill consists of the basic knowledge skills that students should master in depth such as through an observation, students can understand what the nature of science is and visualize the causes happening in daily life; through measuring to measure the objects; through inference to understand what kind of reactant produce what type of chemical product; through classification to classify the matters or non-matters; through prediction to predict the reaction of chemical substance when doing experiments and can communicate with either teacher or peers to improve own weakness in a particular theory (Settlage & Southerland, 2012).

Since the basic skills are related to daily life concern, but there are still some of the students who cannot master the basic science process skills. For example, student's failure to calculate chemical reaction. This can be supported by Irwanto *et al.*, (2017) who stated that students tend to have difficulties in calculating the process. Besides, when students are unable to understand the basic science process skill, this will affect their motivation in their future learning desire. Based on Sevilay (2011), it is learnt that students face difficulties in predicting the result of experiments and some of the students face problems in the space-time relationship.

Whereas according to Rauf *et al.*, (2013), students will face failure when they are required to make inferences and predictions, this makes students feel uneasy in the classroom due to the fact that skills are not easy to be understood. MANDASARI PUTRI (2016) mentioned that students usually have failure in observation because they are unable to understand the picture provided. Also, students fail to apply the basic algebraic skill in the chemistry classroom (Idleman, 2016).

As a conclusion, basic science process skills are important to produce the scientific community and scientific social. However, problems do occur among students in mastering the basic science process skills. Therefore, this study will focus on identifying the mastery of science process skills among students.

1.2.2 Student's Difficulty in Mastering Integrated Science Process Skills

The integrated science process skills are to offer students' a learning experience and these allow them to develop their scientific literacy and help them to be more active in future learning. In addition, the integrated science process skills

known as the fundamental offer by basic science process skills which is able to improve students' critical thinking, logical thinking and higher order thinking skills. Hence, integrated science process skill is comprised of formulating hypotheses, identifying the variables, defining the variables, interpreting the data collection, experimenting and formulating the model (Settlage & Southerland, 2012).

The most common problem in integrated science process skills usually is that they are unable to clearly understand or utilize the skills completely. For example, students normally face difficulties in doing hypotheses, identifying and controlling the experiment variables, and interpreting data collection. All of these difficulties or problems will make students' learning desire to become lower and their skill cannot reach the literacy goal set by their teacher or their own. This can be supported by Sevilay (2011), in the result of pre-test and post-test of the study which has showed that students fail to find out clearly and employ the necessary skills fully in their learning. Through this researcher's study, this can be proven that students still do not comprehend in the integrated science process skill.

Rauf *et al.,* (2013) stated that students also feel uncomfortable in learning the skills such as forming hypothesis, defining operational when they get in touch in the integrated science process skill for the first time due to unknown knowledge. As a conclusion, integrated science process skills are important to nurture the scientific social. However, it has been proven that students face problems to master the integrated science process skills. Therefore, this study will focus on identifying the mastery of science process skills among students.

1.2.3 Student's Difficulty in Mastering Manipulative Skills

Manipulative skill is an approach for teaching and learning to nurture inquiry and manipulative experiment skills among students and avoid students to involve in a rote learning situation (Akinbobola & Afolabi, 2010). Besides that, manipulating skill also can be referred as the higher order thinking skill in integrated science process skill. Hart *et al* (2000) have proven that experiment can be seen as vital part to science education and this must be a part of curriculum at schools.

On the other hand, students usually receive huge information and knowledge transfer from school, this will cause the students to be very mentally fatigue. Hence, students also learn the experiments process before conducting the real experiment, this will cause them not to have curiosity about the reaction of the product. Whereas, some of the students only concern on completing the experiment task rather than the learning, this focus completion of task will reduce the learning chance (Hart *et al*. 2000). Hodson (1990) has proven that experiment work usually insipid and more teacher-centred, this is the sign to indicate that the students failed in the experiment work and other related aspects of learning. Furthermore, when teachers do not possess sufficient science process skill and they are unable to use the laboratory skill efficiently, this will affect teachers to allow students to perform any experimental activities (Şahin-Pekmez, 2001).

Fadzil and Saat (2013) said that the students are lack of manipulative skills due to the fact that they rarely do hands-on experiments and this lack of practice will be carried from the primary school level to the secondary school level. For example, if students are instructed to read the volume of graduated cylinder, they do not know the correct way of reading it and this will cause the measurement of reading to be wrong. Fadzil and Saat (2014) mentioned that students' incompetency in manipulative skill is because of lack of hands-on practical work (experiment activities) at schools. As a conclusion, manipulative skills are important to nurture students with competency

hands-on skills in the laboratory and produce scientific social. However, it has been proven that students face problems to master the manipulative skills. Therefore, this study will focus on identifying the mastery of manipulative skills among students.

1.3 Problem Statement

Akinbobola and Afolabi (2010) mentioned that science process skills are psychomotor and cognitive skills applied in the problem solving. Therefore, this can assist students in identifying objective, inquiring, gathering data, making transformation, making communication and interpreting the knowledge of chemistry. Previous studies have mentioned that students face with the difficulties in the basic science process skill, integrated science process skill and the manipulative science process skill. Generally, when students face difficulties with these science process skills, it will affect their performance in the hands-on experiment such as wrong measuring and unable to perform in a correct way of the activity experiments.

Nevertheless, Ministry of Education Malaysia has implemented a lot of the strategies in order to improve or grow the quality of students' in science process skill. The strategies that Ministry of Education Malaysia has implemented in education are such as STEM, the basic of technology, PPPM (*Pelan Pembangunn Pendidikan Malaysia*) also known as the Blueprint of Malaysia, science carnival and the others to improve the science literacy. According to Curriculum Development Division (2006), it is stated that STEM programme is able to help or manage students' point of view to align perfectly with scientists' view and this will increase students' science literacy in the future job related to STEM. Furthermore, STEM is an approach that is far away from typical instruction and held by the professional development under well planned and transfer to students (Herschbach, 2011; Labov, Reid and Yamamotor, 2010).

Whereas for PPPM, it is stated that priority is focused on enhancing STEM education at schools and continuing district transformation program in order to provide a good and well-planned education to the students. Through PPPM, students' knowledge can be increased and able to master the core subjects such as science and mathematics, and they are also encouraged to learn arts too. In this blueprint of Malaysia, it clearly shows that government is nurturing citizens to master their cognitive skills such as critical thinking skill, reasoning thinking skill, creativity and innovative. Therefore, students will be able to catch up with the globalization level of scientific skill and able to compete in the global.

Besides that, government has also announced PEKA (*Pentaksiran Kerja Amali*) also known as Science Practical Work Assessment which implemented into secondary school level science subjects mainly in chemistry, physics and biology intend to enable the students to have scientific attitude (Lian & Yew, 2013). This assessment is implemented into the teaching and learning process mentioned in Science Curriculum Specification to nurture individuals with scientific skills, scientific attitude and intellectual. According to Shahali and Halim (2010), PEKA assessment requires students' hands-on activities with the proper procedure to judge student's science process skill.

This shows that the Malaysia government has revised various policies to address the problems that inherent students' mastery of scientific skills. Nevertheless, from the previous research study, most of the researcher studies emphasise more on the topics such as effect of the science process skills, the analysis of science process skills, the developing of science process skills, the improving and enhance of the science process skills in the education sector. However, these studies are limited research on identify the students' level of scientific skills among the students. The information of the level of scientific skills among students is limited. Therefore, this research study is to find out the level of scientific skill among the chemistry students to fill this gap.

1.4 Research Objective

This research study is to identify the level of science process skills among the chemistry students and they are Form 4 students from a few secondary schools. Hence, there are three main objectives for this study which are stated as below:

1) To identify the level of mastery in basic science process skills among students.
2) To identify the level of mastery in integrated science process skills among students.
3) To identify the level of mastery in manipulative science process skills among students.

1.5 Research Questions

According to the research objectives mentioned in the previous section. The following are the research questions for this study aims to answer:

1) What is the level of students' mastery in basic science process skills?
2) What is the level of students' mastery in integrated science process skills?
3) What is the level of students' mastery in manipulative science process skills?

1.6 Importance of the study

The importance of the study puts its concern on the level of science process skill among the chemistry students. In this study, chemistry as a core science subject represents as an important need to be learned by students. Science can help to reduce the stereotype occurs by the culture differences (Terracciano, 2005). Malaysia intends to equip each individual with scientific literacy that is full of scientific knowledge and they can pursue their future career in the science area. This way can improve our nation's name in the global and compete within the global.

While in order to pursue this scientific literacy society, there are three perspectives that are very crucial and need to be considered before implementing the science process skill among students. The three keys that need to be considered are students, teachers and the Ministry of Education. Also, based on Settlage and Southerland (2012), science literacy includes:

- Familiarise with nature
- Understanding the key concept and principle of science
- Using scientific thinking
- Knowing that science is a human being enterprise
- Employing scientific knowledge to think and make decision

Akinbobola and Afolabi (2010) mentioned that science process skills can be represented as cognitive skill and psychomotor skill that are adopted in problem solving. Therefore, applying science process skill is a crucial indicator to transfer the knowledge that is necessary to be applied in the problem-solving and practical life.

Abungu *et al.,* (2014) stated that the significance of teaching science process skill allows students to describe an object or events, ask question and build an explanation and this explanation can allow communication among each other.

1.6.1 Teachers' Perspective

Based on the finding result, teacher can identify students' level on basic science process skills, integrated science process skills and manipulative skill. Nevertheless, teacher also can find out students' difficulties or weak in mastery which scientific skills. Hence, teacher will understand students' learning progress and emphasis on their learning in scientific skills and this can help to improve students' scientific skills.

In the science process skill, teachers play a vital role in implementing this to students. Role of teachers are needed to help students to gain scientific process skill. Therefore, in order to achieve this target, teachers need to gain science skills so as to cultivate the same comprehension of those skills towards their students (Elvan *et al.,* 2010). Ango (2002) stated that there is a need to select the appropriate skill to be taught by teachers and learned by students.

In addition, Erkol and Uğulu (2014) mentioned that teacher must be well prepared and trained in order to transfer the science process skills to the students. Hence, when teachers are knowledgeable and intellectual in those skills, they can present the skills well to students and students' knowledge will be improved and this leads the students to have the noble value and scientific attitudes in their life. For example, a professional teacher with ample knowledge of these skills, he or she knows how to teach some weak students about those skills and able to construct and modify the correct knowledge to their students' mind concept of this skills.

Also, teacher as a guidance and they need to understand deeply in the science process skill then only can transfer the knowledge and guide the students in the correct path. If teachers also have some misconceptions about the science process skill, this will directly affect students to have the same misconceptions on the science process

skill too. Therefore, teacher should have a clear picture on science process skill before guiding the students.

1.6.2 Ministry of Education

Based on the finding result, Ministry of Education is able to identify the students' level of scientific skills and able to produce the new policy intend to improve students' scientific skills in the learning.

Ministry of Education acts as an important role in the education system because the ministry can implement the required policies in order to improve the students' science process skill. Ministry of education also can focus on the problem such as students' weakness or difficulties in the science process skill, and can plan to solve this issue among the chemistry students. For example, Ministry of Education can demand each secondary school to implement some activities that are able to increase the students' science process skill like STEM carnival, STEM programme and others.

While for the teachers' perspective, ministry of education is required to implement some of the approach that can assist teacher in their teaching practice such as broadening the horizon of sight in the science process skill. For example, when ministry of education implements a new approach at schools, this intends to increase the skills of teacher and students in the science process skills. Furthermore, students and teacher can follow the steps of the skills to explore and expand their new knowledge on that particular skill. Besides that, ministry of education also can set a target for schools and plan a progress on how to achieve the goal.

1.7 Theoretical Framework

This study is based on the theory of constructivism that can be explained that through active learning, students can build up a meaningful learning from their experience as (Jean Piaget's Theory of Constructivist learning; Vygotsky Social Constructivism). Based on Bada and Olusegun (2015), constructivism can be represented as one of the big ideas in an education and known as approach to teaching and learning based on the premise which cognition leads to result of mental construction. In other words, students learn the new knowledge fit together with the prior knowledge.

The Piaget's constructivist learning theory has broad impact on learning theory with teaching methods in the education, this is one of the many education reform movements. While for the DeVries (2000), the Vygotsky and Piaget consist of the similarities theoretical social factors act as vital role in child development. It can be developed through the process of investigation as known as inquiry learning by Bruner. Hence, Piaget, Vygotsky and Bruner known as the foundation of constructivism and inquiry.

Inquiry learning is also known as discovery learning, is a constructivist learning theory in the problem solving and students need to discover the relationships and fact related with their prior knowledge. Hence, based on the MANDASARI PUTRI (2016), inquiry learning is the best model to teach science process skill in order to make students to be more active and creative in classroom. Whereas, Bilgin (2009) explains that guided inquiry learning activity enables students and teachers to ask questions to develop the cognitive, responsibility, problem solving and understanding skill and this is further supported by Sevilay (2011) that inquiry-based activity must be applied in science classroom in all education levels.

Udo (2010) stated that inquiry learning can engage the students in basic experimental activity either in structured or unstructured that consist the students-centre approach. Therefore, students can use their inquiry approach to discover facts and the principles of science (Gbamanja, 1991). Li and Arshad (2015) also prove that inquiry learning is the suggested teaching approach because it can promote satisfactory learning and instil the students with higher order thinking skill.

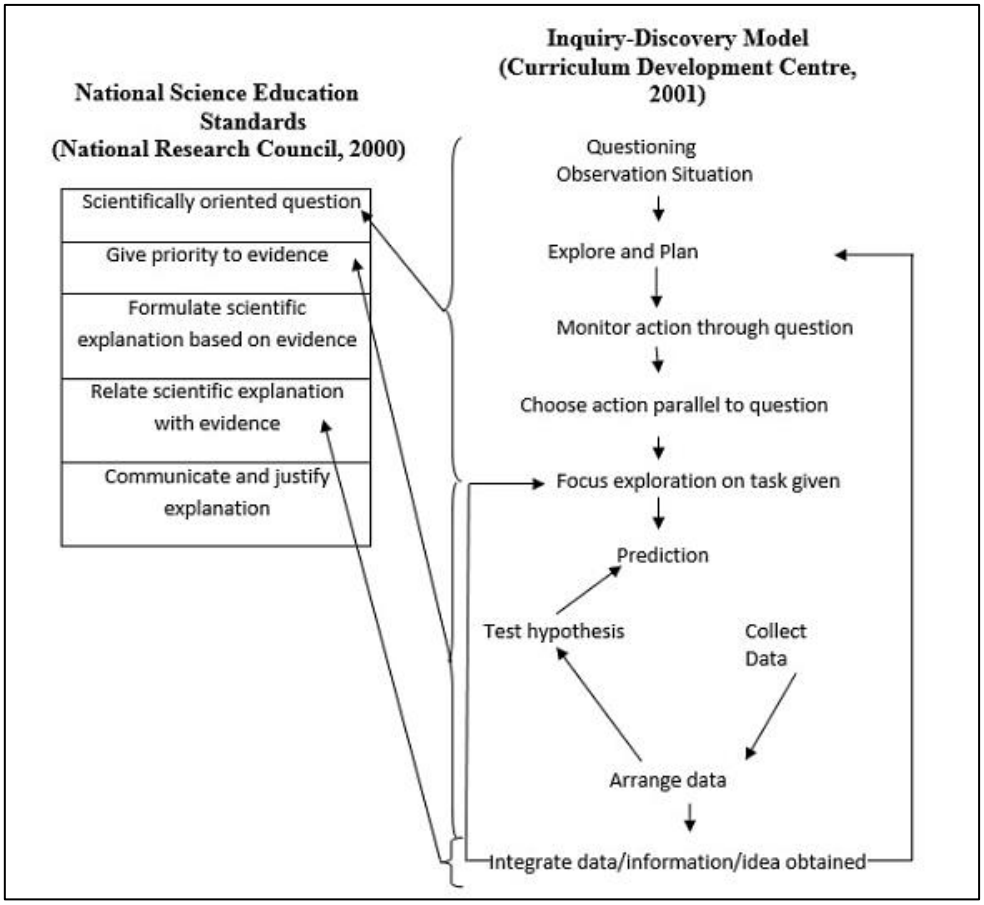

Figure 1.1 Comparison between the Inquiry classroom and Inquiry-Discovery Model

Settlage and Southerland (2012) clarified that the inquiry learning involves the cycle between explanation and the evidence as a challenge to understand the fact beyond science. Through this cycle process, students can apply the basic science process skill in the evidence and use the integrated and manipulative skills to make an

explanation on the evidence. Therefore, the inquiry or discover learning is the most suitable method to implement the science process skills onto the students' academic learning progress. Scientific skill involves science process skills and the manipulative skill. The science process skills consist of the basic science process skills and the integrated science process skills. Science process skills and manipulative skills are able to promote students to think critically, creatively, analytical and systematic manner. Therefore, this study is to find out the level of science process skills and manipulative skills among the chemistry students.

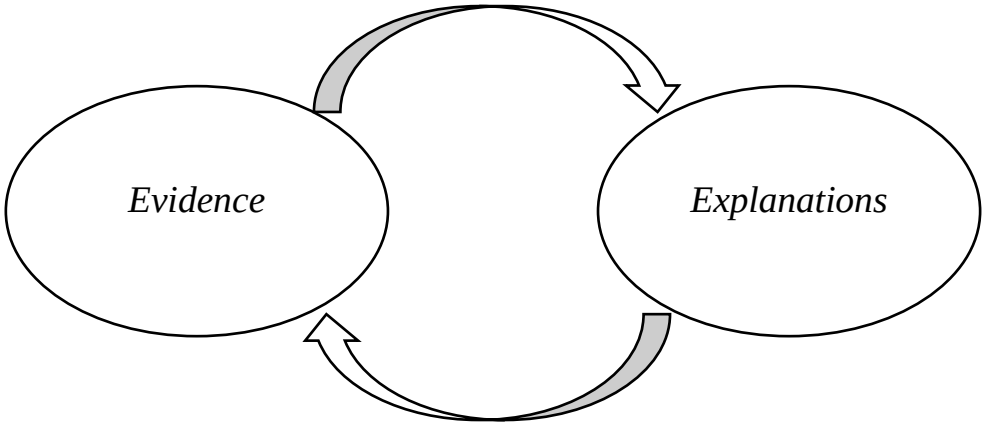

Figure 1.2 Evidence and Explanation Cycle

Idleman (2016) also supported that the inquiry-based learning promotes the active learning approach and guides students to learn through previous knowledge or experience, observation and minimum instruction made by the teachers. Same with Settlage and Southerland (2012), the scientific inquiry can be represented as the action made by the scientists in pursue of knowledge and find the explanations of natural phenomena. From the previous research study, this can be determined that inquiry learning is suitable to teach chemistry in the classroom to advance their skills and intellectual.

1.8 Conceptual Framework

Conceptual framework helps to organise the research ideas into proper manner. Hence, conceptual framework is important in this research study. In this study, the conceptual framework focuses on the students and how the science process skills are effective in the students' actual skill. Therefore, students can improve their skill through this conceptual framework.

The nature of science is assumed to guide the scientists' action (Settlage and Southerland, 2012). Hence, learning science is about including the knowledge, method and the social enterprise. Knowledge is known as the theory of science and need to memorise the facts, principles and theory. While for the method, it is known as a skill that needs to be focused on how the students prepare experiments, hands-on experiments and how to use the basic skills in doing experiments. Therefore, learning science or chemistry subject does not only involve rote learning, an interactive learning also appears in the students learning progress.

The scientific skill is separated into two parts which are science process skill and manipulative skill, whereas the science process skill can be categorised into basic science process skill and integrated science process skill.

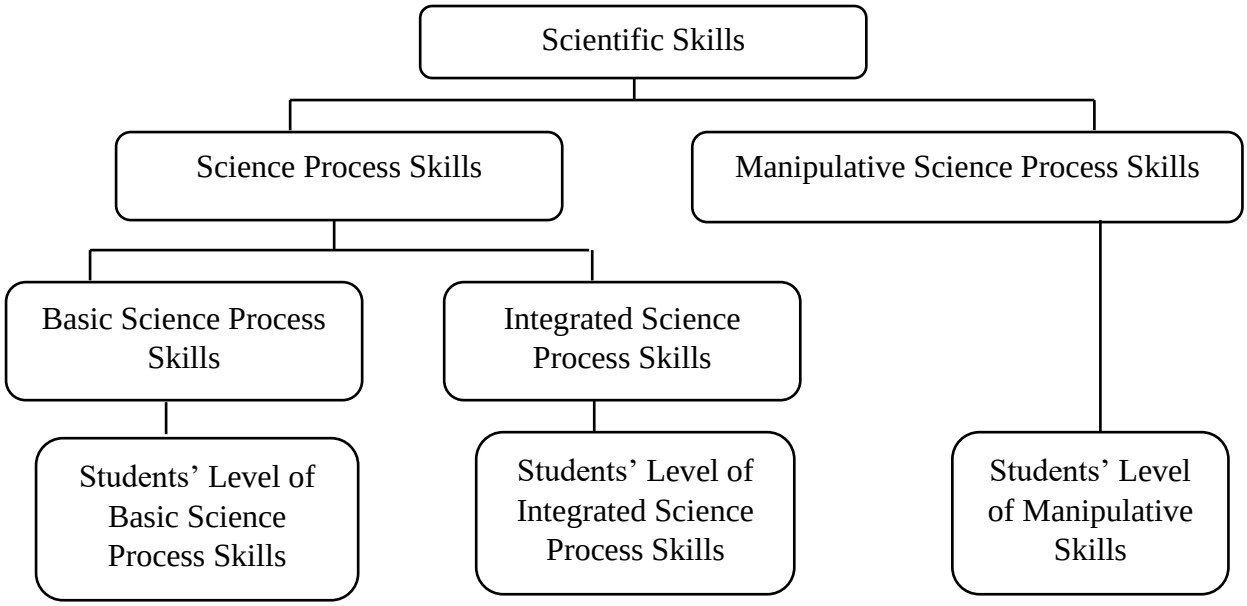

Figure 1.3 Conceptual Framework

Based on Figure 1.3 above, this is a clear picture to show that the science process skills include the basic science process skill, integrated science process skill and manipulative science process skill. This concept is outlined and must be determined on how it affects students in the chemistry through these science process skills.

1.9 Operational Definition

The main objective for this part is to offer an operational definition in this research study that includes the science process skill, basic science process skill, integrated science process skill and the manipulative science process skill. Jack (2018) mentioned that scientific process skills are key to gain scientific knowledge that is very useful for solving problems in our current environment. Hence, this study applies Jack

(2018) research study which is "*Chemistry Students' Science Process Skills Acquisition: Influence of Gender and Class size*".

1.9.1 Science Process Skills

Science process skills (SPS) can be known as scientist's skill and it is used to adapt for the knowledge, thinking skills and problem solving with the conclusion (Farsakoğlu *et al.*, 2008). In this research study, science process skills encompass Basic Science Process Skills and Integrated Science Process Skills.

1.9.2 Basic Science Process Skills

Ongowo (2018) stated that the basic science process skill is the fundamental process for building new knowledge among students. In this research study, basic science process skills consist of the observing, measuring, classification, inferring, predicting and communication.

1.9.3 Integrated Science Process Skills

Ongowo (2018) also stated that the integrated science process skill is more scientific literate and students have the capability to understand the science concept. In this research study, integrated science process skills consist of the controlling and identifying the variables, defining operational, formulate hypotheses, interpreting data, experimenting.

1.9.4 Manipulative Science Process Skills

Manipulative science process skill can be refer as the students' technical skill and their understanding through their hands-on experiment by their own (Fadzil and Saat, 2017). In this research study, manipulative skills consist of using and handling apparatus and substances correctly, handling specimens properly and carefully, drawing specimens, apparatus and substances accurately, cleaning apparatus in a correct way and storing apparatus and substances in a correct and safe place (Curriculum Development Centre, 2006).

1.10 Closing Chapter

This chapter is divided into nine parts which involve Introduction, Background of the Study, Problem Statement, Research Objective of Study, Research Question of Study, Importance of Study, Theoretical Framework, Conceptual Framework of the Study, and Operational Definition of the terms.

As a summary, this chapter emphasises on the introduction of the science process skills, and outlines the background of this study, the problem statement of this study, research objectives and questions for this study, the importance of this study based on the science process skills and manipulative skills among chemistry students. Besides that, the theoretical framework employed in this research study is the inquiry learning or discovery learning proposed by Jerome Bruner or Okey which encourages students to construct their past experience or prior knowledge to discover the new information. This inquiry or discovery learning is form of active learning that helps students to become proactive learners in the classroom. While for conceptual framework, it is applied to compose research ideas into this study based on level of scientific process skill among chemistry students.

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