A COMPARATIVE STUDY OF GRADE 6 SCIENCE STUDENTS' ACADEMIC ACHIEVEMENT UNDER TEACHER-CENTERED LEARNING METHOD AND INQUIRY-BASED LEARNING METHOD AT PANCHASAP SCHOOL, BANGKOK, THAILAND

Shriya Gorowara

A Thesis Submitted in Partial Fulfillment of the Requirements for the Degree of MASTER OF EDUCATION in Curriculum and Instruction Graduate School of Human Sciences ASSUMPTION UNIVERSITY OF THAILAND 2017
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ABSTRACT

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Key Words: TEACHER-CENTERED LEARNING METHOD, INQUIRY-BASED LEARNING METHOD, COMPARATIVE STUDY, PRE-TEST, POST-TEST
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Thesis Advisor: ASST. PROF. DR. RICHARD LYNCH

The purpose of this study was to compare students' academic achievement under two different teaching methods which were teacher-centered learning method and inquiry-based learning method. The research included five objectives. Objective one was to determine students' academic achievement under teacher-centered learning method in pre-test and post-test. Objective two was to determine the significant difference between pre-test and post-test under teacher-centered method. Objective three was to determine students' academic achievement under inquiry-based learning method in pre-test and post-test. Objective four was to determine the significant difference between pre-test and post-test under inquiry-based learning method. Objective five was to determine the result between teacher-centered learning method and inquiry-based learning method in order to determine which learning
method was better and more efficient in terms of academic achievement. Two groups of Grade 6 students at Panchasap School, Bangkok, Thailand were used for this research study. This research study was conducted from December 2017 to February 2018 in science class. The topic was about electric circuit which emphasized on electricity, electric component symbols, types of electric circuit, electric current flow, electromagnets and the famous scientists involved in the discovery. The lessons were for 10 weeks with one class per week lasting for 50 minutes. The sample size of this study was 83 students where 42 students were under the teacher-centered learning method and 41 students were under the inquiry-based learning method. The data were collected by using pre-post test. The pre-post test scores were analyzed by means, standard deviations, paired samples t-test and an independent samples t-test (two-tailed). The findings of the study indicated a significant difference between teacher-centered learning method and inquiry-based learning method at a significance level of .05. Students achieved higher when exposed to inquiry-based learning method. Teachers and the school should be made aware of the inquiry-based learning method as it can really help our students.
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CHAPTER I

INTRODUCTION

This chapter presents the background of the study, statement of the problem, research questions, research objectives, research hypothesis, theoretical framework, conceptual framework, scope of study, definition of terms, and significance of the study.

Background of the study

Science as a subject is an important part of a curriculum in Thai education as well as in international education. According to the National Education Act 1999, science is one of the core subject taught in the school (Ministry of Education Thailand, 2001). The role of science in modern society is very different to that of a generation ago (Susman, 2013). It provides solution to many ongoing problems such as climate change, ageing population, environmental degradation, science and innovation also aid the enhancement of economic productivity. Science and technology are essentials in developing a suitable solution for the challenges faced by the society today, in fact, according to Gluckman (2011), this is no solution without association of science and technology. Therefore, in schools the focus on practicing science that leads to a greater understanding of scientific knowledge is required for this ever-changing world.

STEM education is based on the idea of educating students in four specific related disciplines - science, technology, engineering and mathematics - in an interdisciplinary and applied approach (Hom, 2014). This infers that science as a subject is an important element of STEM education. At present, inventing an innovation or technology is becoming very crucial for this scientific world where it can face both benefits and challenges. To succeed in this highly technological society, students need to develop their capabilities in STEM to
levels much beyond what was considered acceptable in the past (Hunt, 2016). Not only internationally, but Thailand is also on the verge of incorporating STEM education in the curriculum. STEM must be the approach brought to the classroom from primary to high school, university and professionals so that Thailand can achieve what we expect to develop the country (Boonruang, 2015). Therefore, providing students with strong science background is significant.

Ordinary National Education Test (O-NET) is a standardized test which is conducted by the Thai Ministry of Education where students of Grade 6, 9 and 12 have to take part in it (NIETS, 2014). According to the results of O-NET exam in 2017, the average score achieved in general science of Grade 6 students was below that of the previous year. In order to help Thai students learn science, it is important to create appealing, motivating, and student-centered teaching model (Fredrickson, 2017). For instance, the implementation of inquiry-based learning method will improve students' responsibility in learning and exploring the knowledge by themselves, connecting it to the previous knowledge and present it (Misra & Auken, 2000).

Statement of the Problem

Panchasap School is a private catholic school located in Bangkok, Thailand. The school includes the Intensive English Program (IEP) for students to learn English in which mathematics and science are taught using English as the medium of instruction for four periods a week. Otherwise, the medium of instruction is Thai.

The learning method in Panchasap School is primarily a traditional way where the teacher is the prime focus where students listen and take notes. In other words, it is a teacher-centered approach. The difficulties involved in teaching in English also arise as students are non-native speakers. According to the researcher’s own experience, the overall motivation
displayed towards the subject is also relatively poor. The knowledge gap between high
achievers and low achievers are also relatively high as according to the Thailand's No Fail
Policy, students are not allowed to be failed (Iverson, 2016).

In this 21st century of Internet and technology, it is very easy to retrieve
information with just a few clicks. But if students do not learn how to access and process
information as well as filtering the useful ones, they will be at an incredible disadvantage.
Learning facts alone is not enough anymore as they are continuously changing. Students need
to learn how to ask and answer new questions that arise. This can be done by filtering the
resources and information needed, evaluate, process and apply it (Collier, Johnson, Nyberg &
Lockwood, n.d.). Unfortunately, Thai students lag behind in learning science (Ramsoot,
2016). This was also observed in Grade 6 of Panchasap School by the teacher. Given the no
fail policy in Thailand, all students are promoted every year from kindergarten without
having any external assessments given until Grade 6. Students in Grade 6 must take the O-
NET standardized test in order to be promoted to the secondary level. Therefore, this makes it
more difficult for some of the students who perform below average in their studies.
Panchasap School has been using teacher-centered learning method all this while. High
achiever students will somehow perform well as they will be able to adapt to different
teaching methods but what about the low achievers? The researcher believed that a different
learning method applied in the school may make a difference to these students learning.
Therefore, the researcher decided to conduct a research study on Grade 6 students to compare
the academic achievement level under two learning methods: traditional learning method
(teacher-centered approach) and inquiry-based learning method (student-centered approach).
Research Questions

The following research questions were used in this study.

1. What is Grade 6 science students’ academic achievement level under teacher-centered learning method in pre-test and post-test at Panchasap School, Bangkok, Thailand?

2. Is there a significant difference in Grade 6 science students’ academic achievement level between pre-test and post-test under teacher-centered learning method at Panchasap School, Bangkok, Thailand?

3. What is Grade 6 science students’ academic achievement level under inquiry-based learning method in pre-test and post-test at Panchasap School, Bangkok, Thailand?

4. Is there a significant difference in Grade 6 science students’ academic achievement level between pre-test and post-test under inquiry-based learning method at Panchasap School, Bangkok, Thailand?

5. Is there a significant difference in Grade 6 science students’ achievement level between teacher-centered learning method and inquiry-based learning method at Panchasap School, Bangkok, Thailand?

Research Objectives

The following research objectives were used in this study.

1. To determine Grade 6 science students’ academic achievement level under teacher-centered learning method in pre-test and post-test at Panchasap School, Bangkok, Thailand.
2. To determine if there is a significant difference in Grade 6 science students’ academic achievement level under teacher-centered learning method between pre-test and post-test at Panchasap School, Bangkok, Thailand.

3. To determine Grade 6 science students’ academic achievement level under inquiry-based learning method at Panchasap School, Bangkok, Thailand.

4. To determine if there is a significant difference in Grade 6 science students’ academic achievement level under inquiry-based learning method between pre-test and post-test at Panchasap School, Bangkok, Thailand.

5. To determine if there is a significant difference in Grade 6 science students’ academic achievement level under teacher-centered learning method and inquiry-based learning method at Panchasap School, Bangkok, Thailand.

**Research Hypotheses**

The following research hypotheses were used in this study.

1. There is a significant difference in Grade 6 science students’ academic achievement level between pre-test and post-test under teacher-centered method in Panchasap School, Bangkok, Thailand at the level of .05.

2. There is a significant difference in Grade 6 science students’ academic achievement level between pre-test and post-test under inquiry-based learning method in Panchasap School, Bangkok, Thailand at the level of .05.

3. There is a significant difference in Grade 6 science students’ academic achievement level under teacher-centered method and inquiry-based learning method in Panchasap School, Bangkok, Thailand at the level of .05.
Theoretical Framework

First, Skinner’s operant conditioning theory which is also known as one of the behaviorism theory of learning is based on the idea that all human and animal behavior is determined by learning and reinforcement (McLeod, 2015). Learning occurs when new behaviors or change in behaviors are acquired between stimuli and responses. The reinforcement used could be positive or negative, where positive reinforcement in classrooms could be compliments or rewards while negative reinforcement could be punishments (Hartley, 2013). In this type of classrooms, teachers are the ones who are directly responsible for their students. The entire learning and teaching process in teacher-centered approach (Tompkins, Campbell, Green & Smith, 2015) is based on the effectiveness of the method used by the teacher as they give out directions and feedbacks.

Second, Bruner’s constructivist theory of development which is also known as one of the constructivist learning theory (McLeod, 2008). It insists on giving the opportunities for learners to connect new information, new concepts and ideas to what they already know. The learners are the active creators of their own knowledge (Ultanir, 2012). For this to happen, learners should ask questions, explore and assess what they already know. This can be done by the Biological Sciences Curriculum Study (BSCS) 5E Instructional Model which focuses on engaging, exploring, explaining, elaborating and evaluating. It emphasizes on how students can develop their scientific concepts and models through the sequence of the inquiry process (Bybee, 1997).

Conceptual Framework

The purpose of this study was to determine the students’ achievement towards teacher-centered learning method and inquiry-based method as the teaching instruction. With the use of scores from pretest and posttest, to investigate whether there is any significant difference between the two teaching methods or not. The study was conducted on two classes.
of Grade 6 where Grade 6/5 was through teacher-centered learning method and Grade 6/4 was through inquiry-based learning method.

**Figure 1.** Conceptual framework of science class in Panchasap School.

**Scope of the Study**

The study was focused on Grade 6 students of Panchasap School, Bangkok. The population consisted of 250 Thai students and the research sample which were used for the test was 83 students which consisted of Grade 6/4 and Grade 6/5. The sampling method used were based on the convenience sampling. The research was only limited to science class, which was the researcher class teaching in the school. Science class was limited to only one period per week and therefore the research study lasted for 10 weeks including the pretest and posttest. The contents of the test were from Chapter 5 “Electric Circuit” of the Science Book.

The study was focused on three learning models which include skinners operant conditioning theory, bruner’s constructivist theory of development theory and the learning cycle which is also known as inquiry-based learning method emphasizing on the BSCS 5E instructional model.
Definitions of Terms

**Biological Sciences Curriculum Study (BSCS) 5E Instructional Model.** Is based on the inquiry learning cycle emphasizing on five phases which includes engaging, exploring, explaining, elaborating and evaluating.

**Comparative study.** Is a study in which students are randomly assigned to different treatment groups for purposes of comparing the effects of the treatments.

**Inquiry-based learning.** Is based on asking a question, finding out the answers and reflecting it.

**Panchasap school.** Is a Catholic-based Thai school located in Din-Daeng, Bangkok with around 700 students ranging from kindergarten to Grade 9. The school has two campuses; Din Daeng and Minburi. The research study was for Din Daeng campus. Panchasap School is a co-educational private school. The school follows the Thai National Education Act 1999 under the Ministry of Education of Thailand.

**Pre-test.** Is a test given before the instruction period of Grade 6 science class at Panchasap School.

**Post-test.** Is a test given after the instruction period of Grade 6 science class at Panchasap School.

**Student academic achievement.** Is the development of students’ knowledge in electric circuit as taught in the “Electric circuit” unit of Grade 6 science class measured by the difference in their pre-test and post-test means.
**Student-centered method.** Is based on allowing students to share in their ideas and decisions in their own learning. Teachers are the facilitators in student’s learning.

**Teacher–centered method.** Is based on teacher being the controller in the class and students following the instruction given.

**Significance of the Study**

This research can help other science teachers at Panchasap School, Bangkok in exploring and utilizing different methods to improve their teaching in the classrooms. Moreover, it can also help the administrators of the school to plan professional development seminars for the teachers to gain more knowledge about the different instruction methods and its benefits. Furthermore, it can help the future researchers who are interested in the use of inquiry-based learning method to teach science subject.
CHAPTER II

REVIEW OF RELATED LITERATURE

This chapter includes a detailed literature review relevant to this study. It comprises details on the Thailand’s education system, its National Education Act 1999, National Curriculum as well as STEM Education internationally and in Thailand. It also discusses the importance of science education and the different learning theories which are behaviorism, constructivism as well as the learning cycle. This chapter also includes a detailed information on the two types of teaching approaches which as the teacher-centered approach and the student-centered approach. Moreover, the instructional methods used for this research study are also included in this chapter. The two learning methods are teacher-centered learning method and inquiry-based learning method. Furthermore, a brief history of Panchasap School, Bangkok, is given as well.

Thailand’s Education System

Thailand’s education system is provided by the Ministry of Education under the Thai government. It covers from pre-school to senior high school where twelve years of free basic education is provided by the government, and a minimum of nine years’ school attendance is mandatory (Ministry of Education Thailand, 2008). The education system is divided into six years of primary education and six years of secondary education. Six years of secondary education is further divided into three years of lower secondary and three years of upper secondary. Kindergarten levels of pre-primary education are also part of the basic
education level. The school structure is divided into four key stages: the first three years in elementary school, Prathom (Primary) 1-3, are for age groups 6 to 8, the second level, Prathom (Primary) 4-6 are for age groups 9 to 11, the third level, Matthayom (Secondary) 1-3, is for age groups 12 to 14. The upper secondary level of schooling consists of Matthayom (Secondary) 4-6, for age groups 15 to 17. Secondary 4-6 are divided into two streams where students can choose to pursue their education. It can be either academic stream or vocational stream. Academic stream is for the students who want to pursue their education by attending a university. On the other hand, vocational stream prepares students for employment without the need of attending further education in university. There are also academic upper secondary schools, vocational upper secondary schools and comprehensive schools offering both academic and vocational track (World Education News and Reviews, 2014).

National Education Act B.E. 2542 (1999)

Current education policy is guided by the National Education Act of 1999 and the 15-year National Education Plan (UNESCO, 2011). Under the National Education Act, 12 years of free public schooling is guaranteed to all Thai citizens, with a 2002 amendment also guaranteeing two years of free preschool. Currently, the first nine years of primary and secondary education are compulsory, consisting of six years of primary education and three years of lower secondary. Students continuing beyond compulsory education complete a further three years of upper secondary education before entering the labor market or undertaking higher studies (The Ministry of Education Thailand, 2008).

National Core Curriculum

Eight core subjects form the National Curriculum: Thai language, mathematics, science, social studies, religion and culture, health and physical education, arts, careers and
technology, and foreign languages. Flexibility is built into the curriculum to integrate local wisdom and culture, so that it is consistent with set learning standards in each of the core subject groups. The promotion of thinking skills, self-learning strategies and moral development is at the heart of teaching and learning in the Thai National Curriculum. The objectives of the primary curriculum are to provide: basic education for all; experiences useful for daily living; and education for national unity with common purposes (The Ministry Education Thailand, 2008).

In this context, local authorities are given the opportunity to develop part of the curriculum—rendering it suitable for local conditions and needs.

The curriculum experiences provided for learners comprise five areas:

1. tool subjects: Thai language and mathematics;
2. life experiences: the process of solving social and daily life problems (with an emphasis on scientific process skills for better living);
3. character development: activities necessary for developing desirable habits, values, attitudes and behaviours leading to an acceptable character;
4. work-oriented experiences: general and practical work experiences and basic knowledge for career preparation;
5. special experiences: activities based on learners' interests (The Ministry of Education Thailand, 2008).

**Science Education**

Science has always been an importance part in a human life. It involves technological devices, instruments and products which help our lives and works to be better. The benefits from scientific knowledge combined with other disciplines enable students to develop thinking skills in various respects (The Ministry of Education Thailand, 2008). Science
literacy develops analysis, discussions and critical thinking skills (UNESCO, 2010).

Unfortunately, the Thai education system fails to prepare students with the ability to think for themselves (Tangkitvanich, 2013). The results of Grade 6 O - Net exam in 2017 results, the average score in general science was 40.47% which was even below the last year results, in order to help Thai children, learn science, it is important to create an appealing, motivating, and student-centered teaching model (Fredrickson, 2017).

Science is a universal subject taught in most school in the world (Jaussen, 2008). Science education emphasizes the involvement of students for them to develop scientific knowledge, outlook, approach and skills. According to the National Foundation for Educational Research (2011), students tend to prefer a practical approach to science which they believe makes the subject more interesting and more understandable. Science requires engaging students with enthusiasm to catch the interest of the many different groups present in a classroom.

**STEM Education**

STEM education is a learning innovation in which science, technology, engineering and mathematics are integrated. This will engage learners in applying knowledge to problems in daily life as well as finding, applying and solving problems to benefit their lives and occupations through project-based and problem-based learning activities. It is a pedagogical approach that integrates science, mathematics, technology and engineering processes for solving problems in one’s daily life. One of its key features is the combination of engineering design with learning in science, mathematics and technology (U.S. Department of Education, Office of Innovation and Improvement, 2016). Students develop their knowledge and skills in science, mathematics and technology through activities, which provide them with the opportunity to apply new knowledge via the engineering process to solve real life problems, and finally achieve solutions or develop technology as a result (Boonruang, 2015).
Recently, Thailand is one of the countries that has been introduced to STEM education by The Institute for the Promotion of Teaching Science and Technology (IPST, 2013). The institute believed that learners with experience in STEM activities or projects are more equipped for the workforce in the country and therefore it can increase the economic potential of the country. The approach will be implemented from primary education level to high school education level. STEM education will not be implemented only in science subjects but also to other subjects to develop skills in analytical thinking, solving problems and creating innovations (Boonruang, 2015).

The implementation of STEM education is only at the beginning stage and therefore according to Manosuttirit (2016), due to lack of sufficient information and knowledge about STEM education, not all schools in Thailand can discover and implement the methods and format of STEM instruction. Manosuttirit (2016) argued that STEM education needs time for teachers and others to understand and use this new approach towards teaching. activities in STEM education should be open, flexible, challenging and emphasize problem-solving ideas and methods. STEM education should be used along with the 21st century skills and critical thinking. This will bring enhancement and help to increase the economic status of Thailand to a higher level.

**Skinner's Operant Conditioning Theory of Learning**

A teacher – centered theory approach known as behaviorism focuses only on the observable and measurable aspects of human behavior (McLeod, 2017). They believe that behavior can be learned or unlearned, and that could be the result of stimulus and response actions (O'Donohue & Kitchener, 1998). Behaviorism stems from the work of B.F. Skinner where it is believed that knowledge exists independently and outside of people (Kelly, 2012). It is also believed that learning occurs when new behaviors or change in behaviors are
acquired between stimuli and responses. The theory of learning begins with a stimulus from the environment and the learner reacts to the stimulus (David, 2007).

The change in behavior of learner signifies that learning has occurred. The history of behaviorism in educational technology can be found in a teaching machine constructed by Skinner in 1958. Skinner’s teaching machine was a rote-and-drill machine where individual instruction was presented in the form of a book; the machine housed, displayed, and presented programmed instruction. This teaching machine can be viewed as a form of early technology which can be compared to today’s basic educational software (Pacis & Weegar, 2011). Behaviorist identify conditioning as a universal learning process and one of the types is called as the operant conditioning. In operant condition, the organism behave to gain an award or tops behaving to avoid a punishment. This theory is described as teacher-centered because it focuses on the teacher’s knowledge more than of a student (McLeod, 2015).

Teachers are the one to instruct the lesson and for the student to master the lesson, the student should go through practice activities. Examples of behaviorist learning theory includes drill work, practices, bonus points, participation points. Behaviorism instruction does not prepare the learners to solve problems and use creative thinking. They do what they are told to do and are only responsible for recalling the facts, automatic responses and performing task (Tompkins, Campbell, Green & Smith, 2015).

**Teacher-Centered Learning Method**

Teacher-centered instruction is also known as the direct instruction model, highly teacher oriented. The method focuses on lectures, oral recitations, rote learning, and memorization; thus, leaving no place for students to think, feel or like (Beck, 2009). It focuses only on the knowledge as the content to be transferred and the learning as the
assimilation. (Thamraksa, 2011). Learning not only occurs between the teachers and students, but between students and their environment, and the students themselves (Johnson, Johnson & Smith, 1991). But quite often, teachers often view themselves as the main cause for learning to occur (Novak & Gowin, 1984). Furthermore, the constantly increasing amount of material to memorize becomes quickly overwhelming. Students lose interest as the subject appears stressful, crushing, boring, and no longer enjoyable (Phungphol, 2005). But this does not mean that all students will not be able to achieve success academically. For this method to be really efficient, students must demonstrate a high level of individual motivation towards academic activities (Andersen, 2011).

**Bruner's Constructivist Theory of Development**

One of the student-centered approach is the Jerome bruner constructivist theory of development. It is one of the constructivism learning theories where a learner must actively construct knowledge and skills. The knowledge constructed will be mainly based on connecting the dots. Learners will produce a meaningful information by linking the new knowledge with the previous knowledge gained.

It is a nature of an individual when experiences something new, they will filters the information through mental structures (schemata) which incorporates prior knowledge, beliefs and presumptions to make sense of the information (Prince & Felder, 2006).

According to Bruner (1966), the theory of instruction should address four major elements:

1. predisposition towards learning,
2. the structures of knowledge; so that it can be most readily grasped by the learner
3. effective sequences used to present the material, and
4. the nature and pacing of rewards and punishments.
Cognitive constructivism draws mainly on Piaget’s (1972) theory of cognitive development. Cognitive Constructivism is divided into two sorts; assimilation and accommodation. Assimilation happens when new knowledge is linked to the existing knowledge where it broadens the total body of a human’s mind. On the other hand, accommodation is when the new knowledge in in conflict with the existing knowledge and therefore resulting in a remodeling of the existing schema in order to incorporate new information (Swan, 2005). According to Piaget (1972), knowledge is built through experience and individual must construct their own knowledge. These experiences promote creation of schemas or mental models and thus lead to learning. Schemas and mental models are cognitive structure that connect the concepts and represent relationships amongst them.

**Student-Centered Method**

Student-centered approach is an approach that focuses on the student rather than of a teacher. It is a way of teaching where truly engages a student in education where they take responsibility for their own learning and teachers are the facilitator to help the student achieve it. Students are given the responsibilities to actively participate in making their educational process a meaningful one. Students are involved in the planning, implementation and assessments through course work, projects or hands on experiences. Students tends to be more motivated when they are engaged in their own learning process. The students centered approach an include active learning, cooperative learning, inquiry-based learning, project-based learning, problem-based learning and discovery learning. The four main principles of student-centered approach are creativity, mobility, dynamics and cognitively agitating. There are many reasons why this approach should be adopted; firstly, it is a very enjoyable method for learners and secondly research has strongly indicated that this approach tends to improve
student learning. It is not a way to cut out teacher roles, but an approach to bring a change in teaching techniques which improves learning and knowledge of the learners (Froyd & Simpson, 2008). According to NFER (2011), students prefer a practical approach to science as it makes the subject more interesting.

Student-centered method focuses on activities where students solve problems, make questions on their own, discuss debate and brainstorm during the lesson rather than the teacher-centered approach in which team work is not encouraged and most of the time is spent on teacher lecturing.

Schwab's Inquiry-Based Learning

The Schwab's Inquiry-based instructional approach is a set of a process where learners ask questions and explore for the answers by themselves under the guidance of the teachers. The teachers are facilitators to help their students solve the issues. It is more of a constructivist approach where students have to collect the information, analyze it and link it to their previous knowledge. Students need to be familiarize with the concept of connecting the dots from previous knowledge to the found information. The main concept of this approach is to let the students make the information found a meaningful one where they can apply it (Inquiry Based Learning, 2017). In this 21st century, learning is no more about memorizing the information or in another word “rote learning”. This type of learning lasts only for a short period time. World is changing and so are the facts, therefore striving on the knowledge gained years ago is inefficient in today’s time. Nowadays students need to be more engaged in learning so that they can develop the skills needed to function in today’s world. They need to be able to seek the information, understand, analyze, apply and solve the problems in the outside world. This can be achieved by making students more thoughtful, more motivated and more engaged in their own inquiries. In an Inquiry-based learning
classroom, the learning involves the participation of both teachers and students. The lesson usually starts with an open-ended question which allows students to engage in brainstorming by asking more questions to seek for answers, collect the information and filter out what is needed, reasonable answers with provided evidence, solving problem creatively and reflect on their own answers. On the other hand, teachers are the one to guide the students along the process where they are responsible to the students’ learning needs. They play the role of the provocateur and finds creative ways to introduce ideas for them to move forward in their inquiry (Ministry of Education Ontario, 2013).

The first step in this process is that the teacher must create a question which catches student attention and interest. The second step is that teachers must guide students towards the objective of the lesson(s). An inquiry requires the ability for students to pursue questions, evaluate solutions, and gather information to seek out answers. Inquiry-based learning develops and validates habits of mind to become lifelong learners. It gives opportunities for students to take ownership in their learning (Towns, 2008).

**Inquiry-Based Learning in Science Classroom**

This approach has shifted the traditional focus of science education from facts memorization and concepts to inquiry-based learning, where students seek answers to their own questions. This can be due to the lack of understanding of scientific concepts and the inability to apply it in the outside world. According to Furtado (2010), Varma et al. (2009), and Buxton et al. (2008), to increase students’ engagement in science class, develop high order thinking skills and achievement scores, students must be instructed using the Inquiry-based learning approach. Science subject usually focuses on facts and concepts where which were developed after a lot of research and findings. The use of inquiry-based learning approach will help the students to understand these concepts better as they will have to
investigate, analyze and incorporate the new knowledge into their understanding (Maxwell, Lambeth & Cox, 2015). Chang and Mao (1998), found out inquiry-based science instruction for middle and high school students had positive effects on students’ science achievement, intellectual development, laboratory skills, science process skills, and understanding of science knowledge as compared to students taught using a traditional approach (Chang & Mao, 1998).

**Karplus Inquiry-Based Learning Cycle Model**

Karplus inquiry-based learning cycle model was established during the 1950’s by a science teacher at an elementary school. The purpose of creating this learning cycle was to help the educators to plan, design and implement the inquiry-based learning approach to their instructions (Duran, 2004).

A learning cycle model divides instruction into various phases based upon an established planning method, and is consistent with contemporary theories about how individuals learn, constructivist ideas of the nature of science, and the developmental theory of Jean Piaget (Piaget, 1970). For science education, which emphasizes how students can develop their scientific concepts and models through the sequence of the inquiry process. It consists of five steps:

1) asking a well-formed, investigable research question,
2) generating a set of competing hypotheses to predict relevant phenomena,
3) carrying out experiments to test hypotheses,
4) constructing scientific models based on their findings, and
5) applying their models to various situations (White & Frederiksen, 1998).
This learning cycle can result in better retention of science concepts, higher achievement in science, superior process skills, improved attitudes toward science and science learning, and improved reasoning abilities. Though, there are variations of learning cycles, 5E Instructional Model will be highlighted here as a method to support inquiry-based teaching (Bybee & Landes, 1990).

**BSCS 5E Instructional Model**

The BSCS 5E Instructional Model (Bybee & Landes, 1990) also known as Biological Science Curriculum Study 5E instructional model can be used to design a science lesson, and is based upon cognitive psychology, constructivist-learning theory, and best practices in science teaching. The BSCS 5E Instructional Model consists of five phases that a learner goes through. Bybee (1997) declares that “using this approach, students redefine, reorganize, elaborate, and change their initial concepts through self-reflection and interaction with their peers and their environment. Learners interpret objects and phenomena and internalize those interpretations in terms of their current conceptual understanding.” It includes engage, explore, explain, elaborate and evaluate.

*Engage.* It is the first phase where it captures the learner’s attention and providing them an opportunity to ask questions or express themselves. This can be through an activity or posing an open-ended question. Learners here will try to make a connection between the new information and the previous knowledge gained. (5Es Teaching and Learning Model, 2017). In this phase, teachers will also get an opportunity to learn about the student’s existing knowledge (Duran, 2004).

*Explore.* The learner will explore the understanding of the new concept by carrying out a hands-on activity. Once the student explored the concept, an explanation of that exploration will be developed.
**Explain.** With that explanation, students will be given an opportunity to elaborate their understanding of the concepts with each other.

**Evaluate.** This final phase is the evaluating phase where the student will reflect on their own learning and new understanding.

This learning model provides an opportunity for student to process their prior information and develop an understanding of a new concept through hands-on activities (5E’s Teaching and Learning Model, 2017).

In BSCS 5E instructional model, the traditional roles of the teacher and student are virtually reversed. Students take on more responsibility in learning as the knowledge is constructed through discovery, whereas in traditional models the teacher is responsible for providing information to the students. The teacher acts as a guide by raising questions, providing opportunities for exploration, asking for evidence to support student explanations, referring students to existing explanations, correcting misconceptions, and coaching students as they apply new concepts (Ansberry & Morgan, 2007).

**Previous Research on Primary Level Teaching in Thailand**

Zuber and Lynch (2016) noted that in Thailand traditional teacher-centered approaches fail to grasp the interest of students. They found that statistically there was a difference in the level of academic achievement between students who study under traditional learning instruction and students who study using cooperative learning instruction. From the pre-test and post-test students under traditional learning instruction improved by a score of 54% and students under cooperative learning instruction improved by a score of 68%.

Cooperative learning instruction is one of the ways to create appealing, motivating and
student-centered teaching models. It is also encouraged by the Thai Ministry of Education as an effective teaching method (Zuber & Lynch, 2016).

Upadhya and Lynch (2017) found that there was no statistical difference in the level of academic achievement between students who study under teacher-centered learning method and student-centered method. Both the groups scored better in their post-test but it was not significant. However, students’ motivation was higher in student-centered method than in teacher-centered learning method. This could have been due to the student-centered model’s more appealing nature. The researchers believed that with more time for students to adapt to this new learning method there would have been a significant positive effect on their achievement scores (Upadhya & Lynch, 2017).

**Panchasap School**

Panchasap School is a private Roman Catholic Thai school with two branches in Bangkok. One of them is in Minburi and the other is in Din-Daeng. Panchasap Din-Daeng was founded on 13th July 1968. At present, the school has classes from Kindergarten 1 to Grade 9 with more than 1700 students in total. There are five sections in each grade where one of the section consists of only high achiever students. The section is called as the “King Classroom”. Students need to have the consistency in achieving high grade throughout the years. The school curriculum is based on the Ministry of Education Thailand curriculum where Grade 6 and Grade 9 students have to take the O-NET Exams. The medium of instruction is only in Thai language. The school also have the Mini English Program (MEP) where 80% of the instruction is in English Language. The MEP is now from Kindergarten 2 to Primary 4 which will expand along the years.

The school introduced the Intensive English Program (IEP) to the student of all the grades. Intensive English Program (IEP) consist of mathematics, science and english subjects
taught using only English language. Mathematics and science classes are held only once a
week for 50 minutes per class whereas English Language classes are held twice a week for 50
minutes per class. Intensive English Program follows the Ministry of Education curriculum as
well. This means whatever lesson or topic is been taught to the students from their Thai
teachers would also be taught in English instruction from their IEP teachers.

Science curriculum for Grade 6 students is based on the Thai Ministry of Education
Curriculum (MOE) where one of its vision is quality student-centered provided for everyone.
Unfortunately, most of the schools are not being able to implement this approach. Science
classes held in Panchasap School are based on teacher-centered learning methods where
teacher is the main focus, rote learning is used and lots of homework are given. Due to the
large number of student size with more than 40 students in each class, laboratory experiments
are rarely held. Activities, hands-on experiments project works are not focused as much.
CHAPTER III
RESEARCH METHODOLOGY

This chapter presents the methods and procedures used to conduct this research study. The sections included are research design, population, sample, research instrument, collection of data and data analysis. The purpose of this study was to compare whether there is a significant difference under two learning methods.

Research Design

This research was a quasi-experimental study as the students were randomly assigned to the instructional method but they were not randomly assigned to each of the five Grade 6 classes that participated in this study. The research was conducted on two groups in which one group was the control group using the teacher-centered learning method and the other group was the experimental group using inquiry-based learning method.

This research employed quantitative comparative design where two groups were compared to one another based on the results of their pretest and posttest to evaluate their academic achievement under two different learning methods.

The independent variables were the instructional method; teacher-centered learning method and inquiry-based learning method. The dependent variable was the student academic achievement.

The data were collected using the same set of test for their pre-and post-test where students were tested prior and after the eight weeks of instruction using two different methods. Means and standard deviations were found for each section as well as whether there was a significance difference between the two groups.
methods. Means and standard deviations were found for each section as well as whether there was a significance difference between the two groups.

**Population**

Grade 6 students of Panchasap School consisted of 208 students in total. The students were divided into five classes where 6/1 had 40 students, 6/2 had 44 students, 6/3 had 41 students, 6/4 had 41 students and 6/5 had 42 students. Grade 6/2 were the high achievers class which was also called as the King Classroom. The students needed to maintain their GPA scores in order to remain in this classroom. Grade 6/4 and Grade 6/5 were the average learning groups whereas Grade 6/1 and Grade 6/3 were the low achievers class. The sample was divided into two test groups; control group and experimental group.

**Sample**

Amongst the five classes of Grade 6 students, the researcher chose only two classes of Grade 6 from a total of five classes. This was done by using the previous semester test scores in science subject of all the five classes. Table 1 below shows the the means of all five classes where 6/4 and 6/5 classes’ means were similar to one another. 6/4 class mean was at 65.68 and 6/5 class mean was at 65.67 out of 100. This shows that both the classes were at par with one another in terms of their science knowledge.
Table 1

Descriptive Analysis of Grade 6 First Semester Scores of Science Class at Panchasap School

<table>
<thead>
<tr>
<th>Grade 6 class</th>
<th>No. of students</th>
<th>M</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>6/1</td>
<td>40</td>
<td>55.65</td>
<td>15.12</td>
</tr>
<tr>
<td>6/2</td>
<td>44</td>
<td>92.09</td>
<td>9.21</td>
</tr>
<tr>
<td>6/3</td>
<td>41</td>
<td>58.20</td>
<td>12.14</td>
</tr>
<tr>
<td>6/4</td>
<td>41</td>
<td>65.68</td>
<td>13.80</td>
</tr>
<tr>
<td>6/5</td>
<td>42</td>
<td>65.67</td>
<td>13.46</td>
</tr>
</tbody>
</table>

Statistical Analysis were used to determine whether Grade 6/4 and Grade 6/5 are significant different or not. Table 2 below shows that whether there is a significant difference between the two classes.

Table 2

Statistical Analysis of Grade 6/4 and Grade 6/5 First Semester Scores of Science Class at Panchasap School

<table>
<thead>
<tr>
<th>Grade</th>
<th>N</th>
<th>M</th>
<th>SD</th>
<th>df</th>
<th>t</th>
<th>Sig. (2-tailed)</th>
</tr>
</thead>
<tbody>
<tr>
<td>6/4</td>
<td>41</td>
<td>65.68</td>
<td>13.80</td>
<td></td>
<td>.09</td>
<td>.93</td>
</tr>
<tr>
<td>6/5</td>
<td>42</td>
<td>65.67</td>
<td>13.46</td>
<td>81</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Grade 6/4 (N = 41, M = 65.68, SD = 13.80) and Grade 6/5 (N = 42, M = 65.67, SD = 13.46) condition; \( t(81) = .09, p = .93 \) there was no significance difference in academic achievement between the two classes. Therefore, Grade 6/4 and Grade 6/5 were chosen for the research study.

The researcher used random sampling to assign the instruction method which was going to be used for each class. Amongst the two classes, Grade 6/4 had a better support from
from the homeroom teacher to conduct the experiments which were planned for the inquiry-based learning method. This made it more convenient for the researcher to choose Grade 6/4 as the experimental group. However, as this method is new for both the students and the teachers in Panchasap School, an external support from the homeroom teacher was beneficial. Therefore, the researcher assigned Grade 6/5 as the control group and Grade 6/4 as the experimental group. Table 3 below shows the detail stating that Grade 6/4 was chosen as the experimental group (inquiry-based learning method) and Grade 6/5 was chosen as the control group (teacher-centered learning method).

Table 3

Sample Details of the Sixth Grade Students at Panchasap School

<table>
<thead>
<tr>
<th>Grade 6 class</th>
<th>Number of students</th>
<th>Chosen for research</th>
<th>Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>6/1</td>
<td>40</td>
<td>X</td>
<td>-</td>
</tr>
<tr>
<td>6/2</td>
<td>44</td>
<td>X</td>
<td>-</td>
</tr>
<tr>
<td>6/3</td>
<td>41</td>
<td>X</td>
<td>-</td>
</tr>
<tr>
<td>6/4</td>
<td>41</td>
<td>✓</td>
<td>Experimental group</td>
</tr>
<tr>
<td>6/5</td>
<td>42</td>
<td></td>
<td>Control group</td>
</tr>
</tbody>
</table>
Research Instrument

The researcher used a test as a research instrument for this study. The test was created by the researcher which was used to collect the pretest and post test scores. The test was based on “Chapter 5; The Electric Circuit” from IEP Science Grade 6 book by Make a Wit Co., Ltd.

The test given was based on the factual and conceptual knowledge of the subject. The test measured the student’s learning dimension using the revised bloom’s taxonomy. The test also covered both the lower order thinking skills (LOTS) and the higher order thinking skills (HOTS).

The test was divided into three sections. Table 4 below shows the details:

- Part 1 was a multiple-choice section which focused on the understanding.
- Part 2 was the fill in the blanks section which focused on the understanding.
- Part 3 was the short answer questions which focused on the applying.

Table 4 below shows the detail of the pre-post test.

Table 4
Details of Pre-Post Test used for the Research Study

<table>
<thead>
<tr>
<th>Part</th>
<th>Types of items</th>
<th>Number of items</th>
<th>Points</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Multiple Choice</td>
<td>5</td>
<td>5</td>
<td>20</td>
</tr>
<tr>
<td>2</td>
<td>Fill in the blanks</td>
<td>10</td>
<td>10</td>
<td>40</td>
</tr>
<tr>
<td>3</td>
<td>Short answers</td>
<td>10</td>
<td>10</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>25</td>
<td>25</td>
<td>100</td>
</tr>
</tbody>
</table>
Table 5 below shows the interpretation table of the pre-post test that the researcher used for the study.

Table 5

*Interpretation Table of the Pre-Post Test Scores*

<table>
<thead>
<tr>
<th>Percentage (%)</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>85-100</td>
<td>Excellent</td>
</tr>
<tr>
<td>76-84</td>
<td>Very good</td>
</tr>
<tr>
<td>61-75</td>
<td>Good</td>
</tr>
<tr>
<td>50-60</td>
<td>Average</td>
</tr>
<tr>
<td>&lt;50</td>
<td>Below average</td>
</tr>
</tbody>
</table>

The pre-post test used for this research study was reviewed and validated by three senior science teachers with more than 5 years of teaching experience. A validity checklist for each part of the assessment were given. The teachers verified the test paper which indicated that the test can be used in the research study. (See Appendix D) The reliability of the test was done by five students of Grade 6/1 with similar science background knowledge. The result shows that the test is reliable as it was .72. (See Table 6) Therefore, the test could be carried out in this research study.
Table 6

*Reliability Statistics of Pre-Test and Post-Test*

<table>
<thead>
<tr>
<th>Cronbach’s alpha</th>
<th>Number of standardized items</th>
<th>Number of items</th>
</tr>
</thead>
<tbody>
<tr>
<td>.72</td>
<td>.68</td>
<td>25</td>
</tr>
</tbody>
</table>

**Experimental Procedures**

Table 7 presents the experimental procedures followed over a total of 10 weeks of instruction. Each week of instruction lasted 50 minutes. For detailed lesson plans (See Appendix B and C).

Table 7

*Experimental Procedures for Control Group and Experimental Group*

<table>
<thead>
<tr>
<th>Week</th>
<th>Period</th>
<th>Topic</th>
<th>Control group</th>
<th>Experimental group</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>Pre-test</td>
<td>Knowledge pre-test and motivation pre-test given to all students</td>
<td>Knowledge pre-test and motivation pre-test given to all students</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>Static electricity</td>
<td>Teacher explains about electricity and the two types of electricity; static electricity and current electricity. Students then answer the questions.</td>
<td>Students work together to find more about static electricity using balloons, wool, plastic pellets and salt/pepper. Group work</td>
</tr>
<tr>
<td>Week</td>
<td>Period</td>
<td>Topic</td>
<td>Control group</td>
<td>Experimental group</td>
</tr>
<tr>
<td>------</td>
<td>--------</td>
<td>----------------------------</td>
<td>-------------------------------------------------------------------------------</td>
<td>-----------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
<td>Basic electric circuit</td>
<td>Teacher explains the four components of electric current and their functions. Students make notes about the symbols in their notebook and complete the exercise given.</td>
<td>Students sit in groups and explore the components presented in a torch. Moreover, flashcards are used to match the components with their scientific symbols.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Individual work</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>4</td>
<td>Open and closed circuit</td>
<td>Teacher explains open and closed circuits. Students draw open and closed circuits in their notebooks. They complete the exercise in the book.</td>
<td>Students work in groups to connect the electric circuit using the 4 components. A prediction sheet is given where the students will perform to know whether there will be light or not. Students will differentiate between the open circuit and close circuit.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Individual work</td>
<td>Group work</td>
</tr>
</tbody>
</table>

(continued)
<table>
<thead>
<tr>
<th>Week</th>
<th>Period</th>
<th>Topic</th>
<th>Control group</th>
<th>Experimental group</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>5</td>
<td>Conductors and insulators</td>
<td>Teacher explains conductors and insulators that can be used in an electric circuit. Students complete their work in the book.</td>
<td>Students sit in groups where a worksheet is given with a list of materials. Each group will be given a few items of different materials which will be used to connect in the electric circuit. They will predict whether these materials will allow the current to flow or not. Students will be able to differentiate between conductors and insulators.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Individual work</td>
<td>Group Work</td>
</tr>
<tr>
<td>6</td>
<td>6</td>
<td>Series and parallel circuits</td>
<td>Teacher explains series and parallel circuit. Student draw and make notes about the circuits in the notebook. Exercise will be completed in their book.</td>
<td>Students sit in group where a prediction sheet is given. Students have to connect the electric circuit in different ways with different components. Students will be able to differentiate the two types of circuit and be able to explain that what happens to the two different types of circuit.</td>
</tr>
<tr>
<td>Week</td>
<td>Period</td>
<td>Topic</td>
<td>Control group</td>
<td>Experimental group</td>
</tr>
<tr>
<td>------</td>
<td>--------</td>
<td>------------------------</td>
<td>-------------------------------------------------------------------------------</td>
<td>-----------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>7</td>
<td>7</td>
<td>Flow of electric</td>
<td>Teacher explains voltage, current and resistance.</td>
<td>Students work in groups to know the battery can light up a bulb.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>current</td>
<td>Students use the Ohm’s Law equation to solve the word problems given in the book.</td>
<td>Balls were used as the electrons supplied from the battery and how is it different in series and parallel circuit. Students will be able to explain the Ohm’s law.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Individual work</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>8</td>
<td>Electromagnetism</td>
<td>Teacher explains magnets and electricity which can form electromagnets.</td>
<td>Students will sit in groups where they have to create an electromagnet using a battery, coils of wire, a nail and a compass. Students will be able to predict and explain different factors. Example: what happens if more coils of wire are used.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Different uses of electromagnets will also be given by the teacher.</td>
<td>Group work</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Students complete the exercise in the book.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Individual work</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>9</td>
<td>Inventors of electricity</td>
<td>Readings on the inventions by different scientists will be given.</td>
<td>Each group will be assigned a name of a scientist where they will have to research more about that scientist and his/her discoveries. make a mind map and present.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Students answer the questions in the passage.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Individual work</td>
<td></td>
</tr>
</tbody>
</table>
(continued)

<table>
<thead>
<tr>
<th>Week</th>
<th>Period</th>
<th>Topic</th>
<th>Control group</th>
<th>Experimental group</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>10</td>
<td>Post-test</td>
<td>Post-test given to all students</td>
<td>Post-test given to all students</td>
</tr>
</tbody>
</table>

**Collection of Data**

The data were collected during a period of 10 weeks compromising one course unit. The time-period stretched from December 2017 to February 2018. The data was collected by the researcher herself after asking the permission to collect the data from the school administrators and test validity checked by the expert teachers. Data collection included two sections; the pretest scores and the post test scores of Grade 6/4 and 6/5 students. Between the pretest scores and post-test scores were the teaching method applied. The teacher continued using the same teacher-centered learning method for Grade 6/5 whereas for Grade 6/4, an inquiry-based learning method was implemented. The classes had experiment, hands on activities, brain storming discussion sessions and project works. Sample lesson plans which were carried out in these eight weeks for both teacher-centered learning method and inquiry-based learning method are in the Appendices. (See Appendix B)

**Data Analysis**

Objectives 1 and 3 both were to determine the student academic achievement using means and standard deviations of pre-test and post-test. Objective 2 and 4 were to determine whether there is a significant difference in pre-post test of each teaching methods using paired samples $t$-test (two tailed) with a confidence level of .05. Objective 5 was to determine whether there is a significant different between the two methods using means and standard deviations as well as an independent samples $t$-test (two tailed) with a confidence level of .05
Summary of the Research Process

The research process of this study is summarized in the Table 8.

Table 8

Summary of Research Process

<table>
<thead>
<tr>
<th>Research objectives</th>
<th>Source of data or sample</th>
<th>Research instrument</th>
<th>Method of data analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. To determine Grade 6 science students’ academic achievement level under teacher-centered learning method in pre-test and post-test at Panchasap School, Bangkok, Thailand</td>
<td>School: Panchasap Subject: Science Grade: 6/5 Students: 42</td>
<td>Pre–test and post–test</td>
<td>Descriptive statistics Means and standard deviations</td>
</tr>
<tr>
<td>2. To determine if there is a significant difference in Grade 6 science students’ academic achievement level under teacher–centered learning method between pre-test and post-test at Panchasap School, Bangkok, Thailand.</td>
<td>School: Panchasap Subject: Science Grade: 6/5 Students: 42</td>
<td>Pre–test and post–test</td>
<td>Statistical analysis Paired samples t–test at the level of .05</td>
</tr>
</tbody>
</table>

(continued)
<table>
<thead>
<tr>
<th>Research objectives</th>
<th>Source of data or sample</th>
<th>Research instrument</th>
<th>Method of data analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>3. To determine Grade 6 science students’ academic achievement level under inquiry-based learning method at Panchasap School, Bangkok, Thailand.</td>
<td>School: Panchasap</td>
<td>Pre-test and post-test</td>
<td>Descriptive statistics</td>
</tr>
<tr>
<td></td>
<td>Subject: Science</td>
<td></td>
<td>Means and standard deviations</td>
</tr>
<tr>
<td></td>
<td>Grade: 6/4</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Students: 42</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. To determine if there is a significant difference in Grade 6 science students’ academic achievement level under inquiry-based learning method between pre-test and post-test at Panchasap School, Bangkok, Thailand.</td>
<td>School: Panchasap</td>
<td>Pre-test and post-test</td>
<td>Statistical analysis</td>
</tr>
<tr>
<td></td>
<td>Subject: Science</td>
<td></td>
<td>Paired samples</td>
</tr>
<tr>
<td></td>
<td>Grade: 6/4</td>
<td></td>
<td>t-test at the level of .05</td>
</tr>
<tr>
<td></td>
<td>Students: 41</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
5. To determine if there is a significant difference in Grade 6 science students’ academic achievement level under teacher-centered learning method and inquiry-based learning method at Panchasap School, Bangkok, Thailand.

<table>
<thead>
<tr>
<th>Research objectives</th>
<th>Source of data or sample</th>
<th>Research instrument</th>
<th>Method of data analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>5. To determine if there is a significant difference in Grade 6 science students’ academic achievement level under teacher-centered learning method and inquiry-based learning method at Panchasap School, Bangkok, Thailand.</td>
<td>School: Panchasap Subject: Science Grade: 6/4, 6/5 Students: 83</td>
<td>Post-test</td>
<td>Statistical analysis Independent samples $t$–test at the level of .05</td>
</tr>
</tbody>
</table>
RESEARCH FINDINGS

This chapter presents the research findings of the two different instructional method and links them to their corresponding objectives and hypothesis. The purpose of this research was to determine whether there is any significance difference in students’ achievement scores under two different teaching methods; teacher-centered learning method and inquiry-based learning method.

Main Findings

This section includes the research findings based on the research objectives.

Research Objective 1

Research Objective 1 was to determine Grade 6 science students’ academic achievement level under teacher-centered learning method in pre-test and post-test at Panchasap School, Bangkok, Thailand. Table 9 presents the means and standard deviations of pre-test and post-test under teacher-centered learning method.

Table 9

<table>
<thead>
<tr>
<th>Research instrument</th>
<th>M</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-test</td>
<td>68.00</td>
<td>11.92</td>
</tr>
<tr>
<td>Post-test</td>
<td>78.48</td>
<td>15.02</td>
</tr>
</tbody>
</table>
According to the findings in Table 9, the pre-test ($M= 68.00$) was lower than the post-test ($M= 78.48$). There was an increase of 15.41% in their academic achievement. This indicated that the students achieved higher after the instruction.

**Research Objective 2**

Research Objective 2 was to determine if there is a significant difference in Grade 6 science students' academic achievement level under teacher-centered learning method between pre-test and post-test at Panchasap School, Bangkok, Thailand.

Table 10 exhibited the analysis of differences in pre-post test under teacher-centered learning method ($n= 42, M=10.48, SD=11.42$). The analysis recorded that $t(41)= 5.95$ and $p < .001$ This objective was directly linked to the Research Hypothesis 1.

<table>
<thead>
<tr>
<th>Research instrument</th>
<th>$N$</th>
<th>$M$</th>
<th>$SD$</th>
<th>$df$</th>
<th>$t$</th>
<th>$p$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-test</td>
<td>42</td>
<td>68.00</td>
<td>11.92</td>
<td>41</td>
<td>-5.95</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Post-test</td>
<td>42</td>
<td>78.48</td>
<td>15.02</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

According to the findings in Table 10, there is a significant difference in Grade 6 science students' academic achievement level between pre-test and post-test under teacher-
centered method in Panchasap School, Bangkok, Thailand at the level of .05. Therefore, the researcher accepted the Research Hypothesis 1.

**Research Objective 3**

Research Objective 3 was to determine Grade 6 science students’ academic achievement level under inquiry-based learning method in pre-test and post-test at Panchasap School, Bangkok, Thailand.

Table 11 presents the means and standard deviations of pre-test and post-test under inquiry-based learning learning method.

<table>
<thead>
<tr>
<th>Research instrument</th>
<th>M</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-test</td>
<td>67.80</td>
<td>11.45</td>
</tr>
<tr>
<td>Post-test</td>
<td>85.66</td>
<td>11.00</td>
</tr>
</tbody>
</table>

According to the findings in Table 11, the pre-test ($M=67.80$) was lower than the post-test ($M=85.66$). There was an increase of 26.34% in their academic achievement. This indicated that the students achieved higher after the instruction.
Research Objective 4

Research Objective 4 was to determine if there is a significant difference in Grade 6 students' academic achievement level under inquiry-based learning method between pre-test and post-test at Panchasap School, Bangkok, Thailand.

Table 12 exhibited the analysis of difference in pre-post test under the inquiry-based learning method.

Table 12

Paired Samples t-Test of Pre-Test and Post-Test under Inquiry-Based Learning Method (n= 41)

<table>
<thead>
<tr>
<th>Research instrument</th>
<th>N</th>
<th>M</th>
<th>SD</th>
<th>df</th>
<th>t</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-test</td>
<td>41</td>
<td>67.80</td>
<td>11.45</td>
<td>40</td>
<td>-14.65</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Post-test</td>
<td>41</td>
<td>85.66</td>
<td>11.00</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

According to the findings in Table 12, pre-post test under inquiry-based learning method (n= 41, M= 17.85, SD= 7.80). The analysis recorded that \( t (40) = 14.65 \) and \( p = <.001 \). This objective was directly linked to the Research Hypothesis 2. There is a significant difference in Grade 6 science students' academic achievement level between pre-test and post-test under inquiry-based learning method in Panchasap School, Bangkok, Thailand at the level of .05. Therefore, the researcher accepted the Research Hypothesis 2.
Research Objective 5

Research Objective 5 was to determine if there is a significant difference in Grade 6 science students’ academic achievement level under teacher-centered learning method and inquiry-based learning method at Panchasap School, Bangkok, Thailand.

Table 13

*Independent Samples t-Test of Post-Tests under Teacher-Centered Learning Method and Inquiry-Based Learning Method (n= 83)*

<table>
<thead>
<tr>
<th>Post-test group</th>
<th>N</th>
<th>M</th>
<th>SD</th>
<th>df</th>
<th>F</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control Group</td>
<td>42</td>
<td>78.48</td>
<td>15.02</td>
<td>81</td>
<td>2.48</td>
<td>.02</td>
</tr>
<tr>
<td>Experimental Group</td>
<td>41</td>
<td>85.66</td>
<td>11.00</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 13 exhibited the analysis where the control group which was the teacher-centered learning method ($n=42$, $M=78.48$, $SD=15.02$) and the experimental group which was the inquiry-based learning method ($n=41$, $M=85.66$, $SD=11.00$) were compared. The analysis recorded that $t(81)=2.48$ and $p=.02$. This objective was directly linked to the Research Hypothesis 3 and according to the findings there is a significant difference of Grade 6 Students’ achievement level under teacher-centered learning method and inquiry-based learning method in Science class at Panchasap School, Bangkok at the level of .05. Therefore, the researcher accepted the Research Hypothesis 3.
This chapter presented the study findings related to the objectives and hypothesis. Three objectives and one hypothesis were analyzed in this chapter. Chapter V will include the discussions, conclusions and recommendations of the findings analyzed in Chapter IV.
CHAPTER V

CONCLUSIONS, DISCUSSION AND RECOMMENDATIONS

In the previous chapter, the researcher analyzed the research findings based on the three objectives and the hypothesis. In this chapter, a brief summary, discussion, conclusion and recommendation of the study will be presented.

Summary of the Study

The purpose of this study was to determine whether there is a significant difference between two teaching methods: teacher-centered learning method and inquiry-based learning method. The research took place in Grade 6 science class in the Intensive English Program at Panchasap School, Bangkok, Thailand. The classes were held once a week for 50 minutes. A total of 10 weeks was used for this research which included two weeks for the pre-post test and eight weeks for the instruction period based on the electric circuit lessons of chapter 5 Grade 6 science textbook. This study was a quasi-experimental study where two groups were used; Grade 6/4 and Grade 6/5. Both groups had similar background knowledge related to science. Class 6/5 was the control group where a teacher-centered learning method was implemented. Techniques like rote learning, memorization, and direct instruction were used. The class consisted of 42 students. On the other hand, Class 6/4 was the experimental group which consisted of 41 students. Inquiry-based learning method was implemented where techniques like project work, group work, differentiated learning, hands on activities and experiments were used. Five objectives and three hypotheses were used for this research study.
The research objectives were:

1. To determine Grade 6 science students' academic achievement level under teacher-centered learning method in pre-test and post-test at Panchasap School, Bangkok, Thailand.

2. To determine if there is a significant difference in Grade 6 science students' academic achievement level under teacher-centered learning method between pre-test and post-test at Panchasap School, Bangkok, Thailand.

3. To determine Grade 6 science students' academic achievement level under inquiry-based learning method at Panchasap School, Bangkok, Thailand.

4. To determine if there is a significant difference in Grade 6 science students' academic achievement level under inquiry-based learning method between pre-test and post-test at Panchasap School, Bangkok, Thailand.

5. To determine if there is a significant difference in Grade 6 science students' academic achievement level under teacher-centered learning method and inquiry-based learning method at Panchasap School, Bangkok, Thailand.

The research hypotheses were:

1. There is a significant difference in Grade 6 science students' academic achievement level between pre-test and post-test under teacher-centered method in Panchasap School, Bangkok, Thailand at the level of .05.

2. There is a significant difference in Grade 6 science students' academic achievement level between pre-test and post-test under inquiry-based learning method in Panchasap School, Bangkok, Thailand at the level of .05.
There is a significant difference in Grade 6 science students' academic achievement level under teacher-centered method and inquiry-based learning method in Panchasap School, Bangkok, Thailand at the level of .05.

Summary of the Findings

The first objective was to determine Grade 6 science students' academic achievement level under teacher-centered learning method in pre-test and post-test. As expected, post-test mean score was higher than the pre-test mean score. There was an increase in their academic achievement level.

The second objective was to determine if there is a significant difference in Grade 6 science students' academic achievement level under teacher-centered learning method between pre-test and post-test. The findings indicated the significance difference between the pre-post test. Therefore, the researcher had to accept the hypothesis which stated that there is a significant difference in Grade 6 science students’ academic achievement level between pre-test and post-test under teacher-centered method in Panchasap School, Bangkok, Thailand at the significance level of .05.

The third objective was to determine Grade 6 science students' academic achievement level under inquiry-based learning method in pre-test and post-test. As expected, post-test mean score was higher than the pre-test mean score. There was an increase in their academic achievement level.

The fourth objective was to determine if there is a significant difference in Grade 6 science students' academic achievement level inquiry-based learning method between pre-test and post-test. The findings indicated the significance difference between the pre-post test. Therefore, the researcher had to accept the hypothesis which stated that there is a significant
difference in Grade 6 science students’ academic achievement level between pre-test and post-test under inquiry-based learning method in Panchasap School, Bangkok, Thailand at the significance level of .05.

The fifth objective was to determine if there is a significant difference in Grade 6 science students’ academic achievement level under teacher-centered learning method and inquiry-based learning method. The statistical findings indicated that students exposed to the inquiry-based learning method achieved higher that the students in the teacher-centered learning method. Therefore, the researcher had to accept the hypothesis which stated that there is a significant difference in Grade 6 science students’ academic achievement level under teacher-centered method and inquiry-based learning method in Panchasap School, Bangkok, Thailand at the significance level of .05.

Conclusions

The first objective was to determine the students’ academic achievement level in pre-test and post-test under teacher-centered learning method in Grade 6 Science class. The post-test means had an increase of 15.41% (see Table 9) compared to the pre-test mean. This indicates that the students achieved higher after the teacher-centered learning method instruction. The second objective which was linked to research hypothesis one was to determine if there is a significant difference in Grade 6 science students’ academic achievement level under teacher-centered learning method between pre-test and post-test. The statistical findings reveal that there is a significant difference in the means of the pre-post test as the students’ academic achievement level increased. The third objective was to determine the students’ academic achievement level in pre-test and post-test under inquiry-based learning method in Grade 6 Science class. The post-test means had an increase of 26.34% (see Table 10) compared to the pre-test means. This indicates that the students
achieved higher after the teacher-centered learning method instruction. The fourth objective which was linked to research hypothesis two was to determine if there is a significant difference in Grade 6 science students’ academic achievement level under inquiry-based learning method between pre-test and post-test. The statistical findings reveal that there is a significant difference in the means of the pre-post test as the students’ academic achievement level increased. The fifth objective which was also linked to the research hypothesis three was to determine if there is a significant difference in Grade 6 science students’ academic achievement level under teacher-centered learning method and inquiry-based learning method. The statistical findings indicated that there is a significant difference in students’ achievement scores towards science under the two different teaching methods. Therefore, this implies the effectiveness of learning science under the inquiry-based learning method.

Overall, the findings of this study have revealed great improvements in their science achievements for both teacher-centered learning method and inquiry-based learning method. However, there was a larger difference in means under the inquiry-based learning method comparing to the difference in means under teacher-centered learning method. Therefore, inquiry-based learning can be successfully used to promote academic achievement in science class.

Discussion

The result of this study determined that there is a significant difference in students’ achievement under teacher-centered learning method and inquiry-based learning method. Grade 6/5 which was the control group went through the teacher-centered learning method. The 15.41% increase in their means of the pre-post test and a significant difference between the pre-post test indicates their academic achievement level. There was an improvement in their learning indicating that students did gain knowledge in their science class when treated
with teacher-centered learning method. Students in Panchasap School have always been treated with this traditional approach. The increase in the academic achievement level can be due to the incorporated learning method which was used throughout their school life. Students are more accustomed and familiar with this learning method. The drill practice or the rote learning have always been their way to gain new knowledge. For this method to be efficient, students must demonstrate a high level of individual motivation towards academic activities (Andersen, 2011).

On the other side, Grade 6/4 students which was also the experimental group went through the inquiry-based learning method during this period. There was an increase of 26.34% in the means between the pre-post test. Students in this group achieved higher than the control group. The science teacher noted real difference in learning and understanding looking at the difference in the students' mean scores. According to NFER (2011), students prefer a practical approach to science as it makes the subject more interesting. Moreover, it also engages the students, which is important when a class size like in Panchasap School is more than 40 students with a multitude of different interests. Science is an integral part of STEM education and with the help of a student-centered approach allows the student to develop skills in analytical thinking, solving problems and creating innovations (Boonruang, 2015).

The researcher adopted the inquiry-based learning method for Grade 6/4 as according to previous researchers, it is believed that this approach can increase the students' engagement in science class as well as develop their higher order thinking skills which ultimately leads to higher achievement scores. Therefore, all the lessons for this class were planned to use the BSCS 5E instructional model. This model consists of five phases that learners goes through. It includes Engage, Explore, Explain, Elaborate and Evaluate. This model provides an opportunity for the students to use their prior knowledge to develop an
understanding of new concepts through hands-on activities. (5Es Teaching and Learning Model, 2017). It was a new learning method for these students as they were always treated with a teacher-centered approach. However, it did not become of an obstacle for the teacher to implement the method. Students were very cooperative and excited to learn a science lesson in a different way. The lessons were started with an open-ended question which allowed students to engage in brainstorming by asking more questions to seek for answers, collect the information and filter out what is needed, reasonable answers with provided evidence, solving problem creatively and reflect on their own answers. Students had fun in finding their own ways to build an electric circuit, learned about conductors and insulators by actively participating in the experiments. Moreover, created an electric bell working model using their creativity and their understanding. Hands on experiments, group projects, engaging activities and games allowed the students to seek the information, understand, analyze, apply and solve the problems. This can be achieved by making students more thoughtful, more motivated and more engaged in their own inquiries. However, for the teacher-centered learning method, there were direct instructions in class using books, whiteboard and PowerPoint slides, take notes in their notebook, complete the worksheets as well as a homework was followed.

According to Johnson, Johnson and Smith (1991), learning does not only occur between the teachers and students, but between students and their environment, and the students themselves. The teacher noticed more engagement in the class where students were actively participating. The researcher also spoke to the experimental group about the learning experience using the inquiry-based learning. The responses were positive indicating the excitement they had doing the experiments, they enjoyed the class, were more engaged with the learning as well as get to work as a group and not an individual project. Students loved sharing ideas with each other.
Towns (2008) stated that inquiry-based learning develops and validates habits of mind to become lifelong learners. It gives opportunities for students to take ownership of their own learning. This directly links to Piaget's (1972) theory of cognitive development. Piaget believed that students must construct their own knowledge and that they build knowledge through experience. These experiences create schemas and thus lead to learning.

In conclusion, there was a significance difference in students' achievement under two instructional approaches. According to a study done in Thailand (Upadhya & Lynch, 2017), students' achievement with a student-centered method was not significantly different when treated under the teacher-centered learning method. However, students were more motivated in the student-centered classroom. This could have been due to the limited time span in which the research was carried out or the students' adaptability and passivity to the lessons (Upadhya & Lynch, 2017).

Panchasap School has a strong EP program where students' language skills are at an intermediate level, made it easier to implement the teaching method. There can be difficulty in applying it to other regular schools in Thailand as Thai students seem to be more comfortable with the traditional instruction which has been implementing for years. However, according to Chang and Mao (1998), inquiry-based science instruction for middle and high school students had positive effects on students' science achievement, cognitive development, laboratory skills, science process skills, and understanding of science knowledge when compared to students taught using a traditional approach.

**Recommendations**

Based on the results of this study, there are few recommendations which can be useful for the school administrators and teachers of Panchasap School, Bangkok, Thailand as well as for future researchers interested in conducting a similar study.
Recommendations for School Administrators

This study showed a positive result in terms of the achievement of students in Science class using the inquiry-based learning method. Therefore, the implementation of this method is highly recommended for science class and not only for Grade 6 but for other grade levels in the school as well. School administrators should motivate and encourage the involvement of teachers, parents and students for an effective implementation of the method which can lead to a better achievement result. This can be done by providing professional development programs for the teachers or even having meet up sessions with the parents.

Recommendations for Teachers

Teachers at Panchasap School should be more aware and prepared for STEM Education, using student-centered approaches generally and for the inquiry-based learning method specifically. It would be difficult for the teachers who have used a teacher-centered approach for years to suddenly change their perception towards their instruction and classroom management strategies. With professional development programs and support from the school, parents and students as well as the willingness to make a change may equip the students with the 7C’s required in the 21st century world.

Recommendations for Future Researchers

Obtaining a positive result from this study can be due to the students’ participation and interest towards the inquiry-based learning method. Moreover, their English language skills are at an intermediate level which made it easier for the teacher to communicate and implement the instruction. However, the implementation of this method to other schools in Thailand may not be as effective as it was in Panchasap School. Factors which can affect the
research can include the English knowledge deficiency, the length of the study, student "passivity as well as the support from the school and the teachers. Future researchers should take these elements into consideration for their research designs. Perhaps the research study would be more efficient if the researcher randomly selects the treatment group. Moreover, the researcher can explore in other fields other than Science as well as for different grade levels could be implemented as well.
REFERENCES


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APPENDIX A

Pre-Test and Post-test
Primary 6 Pre-Test

<table>
<thead>
<tr>
<th>Part</th>
<th>Question type</th>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Part 1</td>
<td>Multiple choice</td>
<td>1 point each (total 4 points)</td>
</tr>
<tr>
<td>Part 2</td>
<td>Fill in the blanks</td>
<td>1 point each (total 10 points)</td>
</tr>
<tr>
<td>Part 3</td>
<td>Short answers</td>
<td>1 point each (total 10 points)</td>
</tr>
</tbody>
</table>

Total 25 Points

PART 1: Choose the correct answer (5 Points)

1. What supplies energy in an electric circuit?
   a. a conductor   b. light bulb
   c. a wire        d. a battery

2. Which material is a conductor?
   a. plastic       b. silver
   c. glass         d. wood

3. Which type of circuit is Circuit A?
   a. series        b. parallel
   c. perpendicular d. current

4. What is electromagnetic?
   a. Temporary magnet caused by electricity.
   b. Permanent magnet caused by electricity.
c. Temporary magnet caused by nature.

d. Permanent magnet caused by nature.

5. What is the use of electromagnet?

a. Agriculture  b. Construction

c. Finance  d. Transportation

Part 2: Fill in the blanks using the words given in the box (10 Points)

<table>
<thead>
<tr>
<th>Circuit</th>
<th>Glass</th>
<th>Insulators</th>
<th>Conductors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electric current</td>
<td>Rubber</td>
<td>Series</td>
<td>Parallel</td>
</tr>
<tr>
<td>Resistor</td>
<td>Copper</td>
<td>Battery</td>
<td>Silver</td>
</tr>
</tbody>
</table>

1. The flow of electricity is an ____________________________

2. A path that an electric current follows is a ____________________________

3. A __________________ supplies energy to move electricity through a circuit.

4. __________ are materials that electrical current cannot pass through.

5. __________ are materials that electrical current can easily pass through.

6. __________ and __________ are examples of materials that are conductors.
7. ___________ and ___________ are examples of materials that are insulators.

8. A ___________ is a material that cuts down the flow of current, but does not stop it.

9. A ___________ circuit is a circuit in which electrical current can follow only one path.

10. A ___________ circuit is a circuit in which electrical current has more than one path to follow.

Part 3: Answer the following question. (10 Points)

In a series circuit electric current has only one path to follow while parallel circuit has more than one path. All parts are connected one after another. Electric current flows from the negative side of the battery around in a loop to the positive side.

1. Draw arrows to show the path of electric current in this series circuit.

![Series Circuit Diagram]

2. Draw arrows to show the path of electric current in this parallel circuit.

![Parallel Circuit Diagram]
State whether the following bulb "will light" or "will not light" based on the circuit.

3. 

4. 

State whether the following circuit is a 'series' circuit or 'parallel' circuit

5. 

6.
Label the following symbols which are present in an electric circuit

7. 

8. 

9. 

10.
Primary 6 Post-Test

Name ___________________________ Class ________ No. _____

<table>
<thead>
<tr>
<th>Part</th>
<th>Question type</th>
<th>Marks</th>
</tr>
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<tbody>
<tr>
<td>Part 1</td>
<td>Multiple choice</td>
<td>1 point each (total 4 points)</td>
</tr>
<tr>
<td>Part 2</td>
<td>Fill in the blanks</td>
<td>1 point each (total 10 points)</td>
</tr>
<tr>
<td>Part 3</td>
<td>Short answers</td>
<td>1 point each (total 10 points)</td>
</tr>
</tbody>
</table>

Total 25 Points

PART 1: Choose the correct answer (5 Points)

1. Which type of circuit is Circuit A?
   a. series b. parallel  c. perpendicular d. current

2. What is the use of electromagnet?
   a. Agriculture b. Construction  c. Finance d. Transportation

3. Which supplies energy in an electric circuit?
   a. a conductor b. light bulb  c. a wire d. a battery

4. Which material is a conductor?
   a. plastic b. silver  c. glass d. wood
5. What is electromagnetic?

a. Temporary magnet caused by electricity.

b. Permanent magnet caused by electricity.

c. Temporary magnet caused by nature.

d. Permanent magnet caused by nature.

Part 2: Fill in the blanks using the words given in the box (10 Points)

<table>
<thead>
<tr>
<th>Circuit</th>
<th>Glass</th>
<th>Insulators</th>
<th>Conductors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electric current</td>
<td>rubber</td>
<td>Series</td>
<td>Parallel</td>
</tr>
<tr>
<td>Resistor</td>
<td>copper</td>
<td>Battery</td>
<td>Silver</td>
</tr>
</tbody>
</table>

1. ________ and ________ are examples of materials that are conductors.

2. A ________ is a material that cuts down the flow of current, but does not stop it.

3. ________ are materials that electrical current cannot pass through.

4. The flow of electricity is an ________________

5. A ________ circuit is a circuit in which electrical current can follow only one path.

6. A path that an electric current follows is a ________________.
7. A ________ supplies energy to move electricity through a circuit.

8. ________ and _________ are examples of materials that are insulators.

9. A ________ circuit is a circuit in which electrical current has more than one path to follow.

10. ________ are materials that electrical current can easily pass through.

Part 3: Answer the following question. (10 Points)

In a series circuit electric current has only one path to follow while parallel circuit has more than one path. All parts are connected one after another. Electric current flows from the negative side of the battery around in a loop to the positive side.

1. Draw arrows to show the path of electric current in this series circuit.

2. Draw arrows to show the path of electric current in this parallel circuit.
State whether the following bulb “will light” or “will not light” based on the circuit.

3. 

4. 

State whether the following circuit is a ‘series’ circuit or ‘parallel’ circuit

5. 

6.
Label the following symbols which are present in an electric circuit

7. 

9. 

8. 

10.
APPENDIX B

Samples of Inquiry-Based Learning Lesson Plans
LESSON PLAN

Teacher: Shriya Gorowara

Week 1

Subject / Grade level: Science Grade 6

Materials:

- Grade 6 Science Book
- Balloons, Plastic pellet, Wool, Salt and Pepper.
- Power point

Lesson objective(s):

- Students will be able to define electricity.
- Students will be able to distinguish between static and current electricity.
- Students will be able to list the ways we use electricity each day.

ENGAGEMENT

Find out what students already know about electricity. Ask:

- What is electricity?
- What are the different types of electricity?
EXPLORATION

• Students are arranged into groups of 4 or 5 students.
• Each group is given a balloon, wool, and a plastic pellet.
• Students will blow up the balloons and rub them with the yarn.
• Students will then hold the balloons over the pellet and observe.
• Next, students will be given a worksheet to predict their assumptions.
• Salt and pepper will be given to each group where they have to rub the balloon with the wool and place it near the pile of salt/pepper.

EXPLANATION

Discussions between students and teacher

• What is static electricity?
• What charges are there on the balloon when it is rubbed (Positive or Negative)?
• Why did the plastic pellet attract the balloon?
• What happened to the salt/pepper when it was near the balloon?

ELABORATION

• Ask students to rub their balloons with the wool and then place it to the friend’s hair.
• What is the type of electricity that we use every day in our lives. Such as to use computer, watch TV...
or even turn on the lights in the room. How is it different from static electricity?

EVALUATION

- Students will do the exercise given in the Science book on Page 165
Scientific Method

Experiment 1: Static Electricity

**Purpose:** Comparing the affect of charges on the movement of objects.

**Question:** Which material will attract to the balloon that is rubbed with wool -- the salt or pepper?

**Hypothesis:**

**Materials:** Balloons, wool, salt and pepper

**Procedure:** Rub the balloon with a piece of wool. Hold the balloon close to a pile of salt and pepper. Record what the salt and pepper does in the Data chart.

<table>
<thead>
<tr>
<th>Test</th>
<th>Movement of Salt/Pepper</th>
<th>Results</th>
<th>What did you observe about the affect of charges on the movement of objects?</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>2</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>3</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Conclusion**
Teacher: Shriya Gorowara

Week 2

Subject / Grade level: Science Grade 6

Materials:

- Grade 6 Science Book
- Torch: Switch, Battery, Bulb and Wire
- Worksheet
- Flash cards

Lesson objective(s):

- Students will be able to identify parts of a simple circuit.
- Students will be able to understand symbols used to diagram an electric circuit.

ENGAGEMENT

Find out what students already know about electricity. Ask:

- What is electricity?
- What is electrical current?
- What is an electric circuit?
EXPLORATION

- Students are arranged into groups of 4 or 5 students.
- Each group is given a torch and was asked
  "How do you think a torch works?"
  "What do you think is inside the torch?"
- The groups are told to remove the parts of the components in the torch and identify the parts with vocabulary words given, (Bulb, Switch, Wire, Battery)
- A pile of flashcards are given which had the symbols of each electric components on it. Students are told to match the symbols with the correct components and vocabulary word.
- Handouts will be given where the students will have to predict the functions of each components in the circuit.

EXPLANATION

Have students report their findings. Ask:

- List out the components found in the torch?
- Which component do you think gives the energy?
- Which component do you think gives the light?
- Which component do you think connects every component together?
- Which component do you think can be used to turn on-off the torch?
ELABORATION

• Ask students to work in groups to illustrate the symbols if there were more than one component.

   Example: How to draw a symbol for two batteries connected together.

EVALUATION

• Students will do the exercise given in the Science book on Page 168
LESSON PLAN

Teacher: Shriya Gorowara

Week 3

Subject / grade level: Science Grade 6

Materials:

- Grade 6 Science Book
- Electric circuit components: Switch, Battery, Bulb and Wire
- Worksheets
- Power point
- Learning Videos

Lesson objective(s):

- Students will be able to draw and setup simple open circuits and closed circuits.
- Students will be able to differentiate between open circuit and closed circuit.

ENGAGEMENT

Find out what students already know about electricity. Ask:

- What is electricity?
- What is electrical current?
- What is an electric circuit?
**EXPLORATION**

- Students are arranged into groups of 4 or 5 students.
- Each group is given a light bulb, two wires, and a battery.
- The groups are told to "make the light bulb light up" (no other instructions are given). Let the students work on it until they figure it out.
- Tell the groups to put their hand up when they've figured it out. As each group figures it out, go to that group and have them explain to you exactly how they got the light bulb to light up (i.e., what exactly is going on)?
- Handouts will be given where the students have to predict what will happen in each situation. It is very important that they make their predictions first, and then they can test out whether they are right.

**EXPLANATION**

Have students report their findings. Ask:

- Did you get the bulb to light?
- In what order did you connect the parts?
- How did you know that electricity flowed?
- Can you trace the path of electrons in your circuit?
• What happened if the circuit was broken, that is, if there was a gap in the circuit?

ELABORATION

• Ask students to work in groups to act out a battery-bulb circuit and what happens when the light bulb burns out.

EVALUATION

• Students will do the exercise given in the Science book on Page 173 - 174.
Prediction Sheet 1

Will the bulb light? If you are not sure, try it and see!
Prediction Sheet 2

In which examples will the bulbs light? Mark a / for those which will and an X for those which will not light.
Teacher: Shriya Gorowara

Week 4

Subject / Grade level: Science Grade 6

Materials:

Components:

- Bulb holder with bulb
- Three 15 cm with stripped ends
- D cell battery
- Electrical tape
- Bag of conductors and Insulators

Worksheets
Power point
Learning Videos

Lesson objective(s):

1. Students will be able to differentiate electrical conductors and insulators.
1. Review what students learned in the previous three lessons about electric current. For example, ask:

- What objects does someone need to build a simple electric circuit?
- What makes a complete, or closed, circuit?
- How do they know when electric current is flowing through a circuit?

2. Ask the class whether they could build an electric circuit using any object or material. Do they think they could complete a circuit with cotton string instead of metal wire? Why or why not?

**EXPLORATION**

- 1. Have groups assemble bulb and battery circuits similar to the ones they made in the previous class. This time, however, specify that they use three wires. They should:
  - Clip the end of one wire to the bulb holder, and tape the other end to a terminal of the D-cell battery.
  - Clip the end of the second wire to the bulb holder, and leave the other end free to be a tester.
  - Tape the end of the third wire to the other terminal of the D-cell battery, and leave the other end free to be a tester.
  - Touch the two free wire ends together to see if the bulb lights. If it does, the tester is set up correctly.

2. Give each group a reseal able plastic bag containing a collection of conductors and insulators. They should:

   a. Write the name of each object in the first column of the worksheet
   b. Predict whether the object is a conductor or insulator in the second column
EXPLANATION

Explain that the objects and materials can or cannot be used to complete a circuit, then explain

- Conductor—Electric current can flow through easily
- Insulator—Electric current cannot flow through easily

ELABORATION

Continue investigating

1. What happens if more than one conductive object is put between the two free wires?
2. What other objects in the room work as conductors or insulators?
3. Do some conductive objects make the light bulb shine more brightly than others?

EVALUATION

- Students will do the exercise given in the Science book
### Identifying Conductors and Insulators

**Predictions and Results:**

<table>
<thead>
<tr>
<th>Object to be Tested</th>
<th>Prediction (Circle one)</th>
<th>Testing Result (Circle one)</th>
<th>Material</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conductor</td>
<td>Insulator</td>
<td>Conductor</td>
<td>Insulator</td>
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<tr>
<td>Conductor</td>
<td>Insulator</td>
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<tr>
<td>Conductor</td>
<td>Insulator</td>
<td>Conductor</td>
<td>Insulator</td>
</tr>
</tbody>
</table>

**Conclusions:**

Explain your results. How are the materials that worked to complete the circuit alike?
APPENDIX C

Samples of Teacher-Centered Learning Method

Lesson Plans
Learning Unit 5: Static Electricity

Subject: IEP Science

Semester: Week 1

2/2017

1. Basic Concept

Static Electricity, Current Electricity, Electrons transferred, Positive charge, Negative charge, Attract, Repel

2. Learning Objective(s)

- Students will be able to define electricity.
- Students will be able to distinguish between static and current electricity.
- Students will be able to list the ways we use electricity each day.

3. Teaching Materials

1. Power-point Projector
2. Laptop
3. Worksheets, textbook, workbook
Learning Activities

Teacher introduces new vocabulary words to the students.

- Electricity
- Static Electricity
- Current Electricity
- Attract
- Repel
- Positive charge
- Negative charge

- Teacher discuss about what is static electricity and current electricity.
- Teacher explains the charge that is transferred when one thing rubs the other which causes the attraction or repulsion.
- Students discuss about the use of electricity in everyday lives.
- Students to read the textbook and answer question in the workbook.
- Students complete the work on Page 165 Exercise 5.1
Learning Unit 5: Basic Electric Circuit

Subject: IEP Science

Semester: Week 2
2/2017

1. Basic Concept

Electric circuit, Switch, Battery, Bulb, Wire, Symbols

2. Learning Objective(s)

- Students will be able to identify parts of a simple circuit.
- Students will be able to understand symbols used to diagram an electric circuit.

3. Teaching Materials

- Power-point Projector
- Laptop
- Worksheets, textbook, workbook
Learning Activities

Teacher introduces new vocabulary words to the students.

- Switch
- Bulb
- Wire
- Battery

- Teacher explains the definition of electric circuit.
- Teacher explains the four basic electric components found in an electric circuit.
- Teacher explains the function of each electric component.
- Students illustrate the symbols used for each electric component.
- Students to read the textbook and answer question in the workbook.
- Students complete the work on Page 168 Exercise 5.2
Learning Unit 5: Open circuit and Closed circuit

Subject: IEP Science

Semester: Week 3
2/2017

1. Basic Concept

Electric circuit, Switch, Battery, Bulb, Wire, Open circuit, Closed circuit, Open switch, Closed switch

2. Learning Objective(s)

- Students will be able to draw and setup simple open circuits and closed circuits.
- Students will be able to differentiate between open circuit and closed circuit.

3. Teaching Materials

- Power-point Projector
- Laptop
- Worksheets, textbook, workbook
- Learning videos
Learning Activities

Teacher introduces new vocabulary words to the students.

- Open circuit
- Closed circuit
- Open switch
- Closed switch

- Teacher explains the two types of circuit and how it is different.
- Teacher uses learning videos to explain it clearer to the students.
- Students draw the two types of circuit in their notebook and explain.
- Students read the textbook and answer questions in the workbook.
- Students complete the work on Page 173-174 Exercise 5.3
Learning Unit 5: Conductor and Insulator

Subject: IEP Science

Semester: Week 4

2/2017

1. Basic Concept

Electric circuit, Conductor, Insulator, Light on, Light off, Current pass

2. Learning Objective(s)

- Students will be able to differentiate the conductors and insulators in an electric circuit.

3. Teaching Materials

- Power-point Projector
- Laptop
- Worksheets, textbook, workbook
- Learning videos
Learning Activities

Teacher introduces new vocabulary words to the students.

- Conductor

- Insulator

- Teacher explains the two types of material which can be used in an electric circuit.
- Teacher uses learning videos to explain it clearer to the students.
- Students give examples of conductors and insulators found in everyday life.
- Students to read the textbook and answer question in the workbook.
- Students complete the work on Page 179 Exercise 5.4
APPENDIX D

Pre-Post Test Validity Checklist
The checking list for the validity

Please check if the test covered the content

<table>
<thead>
<tr>
<th>Part</th>
<th>Content</th>
<th>Agree</th>
<th>Not agree</th>
</tr>
</thead>
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<td>Electromagnetism</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Open and Closed circuit / Conductors and Insulators</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Electric circuit components / Series and Parallel</td>
<td>✓</td>
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Signature: [Signature of the person]

Date: 01 - 12 - 2017
The checking list for the validity

Please check if the test covered the content

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<th>Part</th>
<th>Content</th>
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<td>1</td>
<td>Electromagnetism</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Open and Closed circuit, Conductors and Insulators</td>
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<td></td>
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<tr>
<td>3</td>
<td>Electric circuit components / Series and Parallel circuit</td>
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Signature: Phapuch Phaenchai

Date: 07/12/2017
The checking list for the validity

Please check if the test covered the content

<table>
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<tr>
<th>Part</th>
<th>Content</th>
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<th>Not agree</th>
</tr>
</thead>
<tbody>
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<td>1</td>
<td>Electromagnetism</td>
<td>☑</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Open and Closed circuit / Conductors and Insulators</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Electric circuit components / Series and Parallel circuit</td>
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<td></td>
</tr>
</tbody>
</table>

Signature: Wimelruedee Chotikmas

Date: 01/12/2014
BIOGRAPHY

Shriya Gorowara was the researcher of this thesis as well as the teacher for Grade 6 Science class at Panchasap School, Bangkok, Thailand. Shriya completed her schooling from Modern International School Bangkok in 2010. She then joined Assumption University Thailand for her undergraduate program. She completed her Bachelors of Science in Biotechnology in 2014. She continued her education doing Masters of Education majoring in Curriculum and Instruction as well as worked as a Science teacher for Intensive English Program at Panchasap School, Bangkok, Thailand.