THE ANALYSIS OF PT3 IMPLEMENTATION ON TEACHERS' UNDERSTANDING AND CURRENT PRACTICES IN TEACHING AND LEARNING SCIENCE

DEVIKI A/P K. MUNIANDY

SULTAN IDRIS EDUCATION UNIVERSITY

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DEVIKI A/P K. MUNIANDY

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ABSTRACT

This study aims to analyse the PT3 implementation on teachers' understanding and current practices in teaching and learning Science. A qualitative approach with an exploratory case study has been applied. This study uses purposive sampling method on the stakeholders involved, which includes four policy makers, five school administrators, four Science teachers and seven students as the informants. The instruments used are interview protocol sets, observation field notes, and rubric for document analysis. The interview protocols, observation field notes and rubric were validated by experts with percentages agreements of more than 80%. The reliability of the instruments were done through pilot test, member check, peer review, discussion and also consultation with the experts. There were 20 interviews, seven document analysis and seven observations were conducted. Interview data and field notes were analysed using coding method while the document analysis were analysed using rubric. The findings revealed four major elements emerged from the interviews; lack of ICT usage in teaching and learning Science, the needs of own exploration, ambiguity in higher order thinking skills, and negative attitudes towards Science practical work. Several major elements emerged from the document analysis and classroom observations; discrepancies between the understanding of daily lesson plans and the actual implementation in the classroom, lack of interests in Science among students, lack of communication skills among students, less appropriate assessment, and less implementation of group work. Framework of teaching and learning has been derived from the aforementioned result. In conclusion, all stakeholders understand the strength of the PT3 Science implementation that will produce holistic students in future. However there were many weaknesses highlighted that requires them to be equipped with the right knowledge and skills. The implications of this are that stakeholders could realise the framework of effective teaching and learning Science through teachers' training programs and mastery of Science concepts, as well as the emphasis on 21st century teaching and learning in order to produce students with quality thinking.

ANALISIS PELAKSANAAN PT3 TERHADAP PEMAHAMAN DAN AMALAN SEMASA GURU-GURU DALAM PENGAJARAN DAN PEMBELAJARAN SAINS

ABSTRAK

Kajian ini bertujuan untuk menganalisis pelaksanaan PT3 terhadap pemahaman dan amalan semasa guru-guru dalam pengajaran dan pembelajaran sains. Pendekatan kualitatif digunakan dalam kajian kes penerokaan ini. Kajian ini juga menggunakan kaedah persampelan bertujuan, terhadap beberapa pihak yang berkepentingan iaitu terdiri daripada empat orang pengubal dasar, lima orang pentadbir sekolah, empat orang guru sains dan tujuh orang pelajar sebagai pemberi maklumat. Instrumen yang digunakan ialah set protokol temu bual, nota lapangan pemerhatian dan rubrik untuk analisis dokumen. Protokol temu bual, nota lapangan pemerhatian dan rubrik adalah untuk menganalisis dokumen yang telah disahkan oleh pakar dengan persetujuan melebihi 80 peratus. Kebolehpercayaan instrumen dilakukan melalui ujian rintis, semakan peserta kajian, semakan rakan sebaya, perbincangan dan juga perundingan dengan pakar. Sebanyak 20 temu bual, tujuh analisis dokumen dan tujuh pemerhatian telah dilaksanakan dalam kajian ini. Data temu bual dan nota lapangan yang dianalisis menggunakan kaedah pengkodan manakala analisis dokumen telah dianalisis menggunakan kaedah rubrik. Hasil dapatan menunjukkan empat elemen utama telah dikenal pasti menerusi instrumen temu bual iaitu; kekurangan penggunaan teknologi maklumat dalam pengajaran dan pembelajaran Sains, keperluan penerokaan kendiri, kekurangan dalam kemahiran berfikir aras tinggi dan sikap negatif terhadap kerja amali Sains. Beberapa elemen utama juga muncul daripada analisis dokumen dan pemerhatian bilik darjah iaitu; percanggahan antara pemahaman rancangan pengajaran harian dan pelaksanaan sebenar di dalam kelas, kekurangan minat pelajar terhadap Sains dan kekurangan kemahiran komunikasi dalam kalangan pelajar, pentaksiran yang kurang sesuai dan kurang pelaksanaan kerja berkumpulan. Kerangka kerja pengajaran dan pembelajaran telah terhasil daripada keputusan di atas. Kesimpulannya, semua pihak yang berkepentingan memahami kekuatan pelaksanaan Sains PT3 yang dapat melahirkan pelajar yang holistik pada masa akan datang. Namun terdapat beberapa kelemahan diutarakan yang boleh diatasi jika pihak berkepentingan melengkapkan diri dengan pengetahuan dan kemahiran yang betul. Implikasi kajian ini adalah pihak berkepentingan dapat merealisasikan kerangka kerja pengajaran dan pembelajaran Sains yang berkesan melalui program latihan guru dan penguasaan konsep Sains serta penekanan pada pengajaran dan pembelajaran abad ke-21 untuk melahirkan pelajar dengan pemikiran berkualiti.

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LIST OF ABBREVIATIONS

ICT	Information Communication and Technology
HOTS	Higher Order Thinking Skills
PT3	Pentaksiran Tingkatan 3 (Form Three Assessment)
PPD	Pegawai Pendidikan Daerah (District Officers)
JPN	Jabatan Pendidikan Perak (State Officers)
T&L	Teaching Learning
DSKP	Document Standard Curriculum and Assessment
MOE	Ministry of Education
4C	Critical, Creative, Collaboration, Communication
STEM	Science, Technology, Engineering, Mathematics
SKPMg2	Standard Kualiti Pendidikan Malaysia Gelombang Kedua
LCE	Lower Secondary Examination
PMR	Penilaian Menengah Rendah
JU	Jurulatih Utama
KPI	Key Performance Index
NSW	New South Wales
OECD	Organization for Economic Co-operation and Development
NQPEL	National Professional Qualification for Executive Leadership
KSSM	Kurikulum Standard Sekolah Menengah
PISA	Program for International Student Assessment
TIMSS	Trends in International Mathematics and Science Study

APPENDIX LIST

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CHAPTER 1

INTRODUCTION

1.1 Overview

Malaysia currently has high stake and centralized examinations such as UPSR, SPM and STPM. The results show better performance year by year that makes us to assume that the education system in our country is up to the par. Thus, Malaysia decided to take part in international examinations such as Program for International Student Assessment (PISA) and Trends In International Mathematics and Science Study (TIMSS), which are held for 15 years old students, who are nearly going to complete their compulsory schooling (Ministry of Education (MOE), 2013). The PISA examination is coordinated by The Organization for Economic Co-operation and Development (OECD).

One of its main purposes is to have international examinations as such, in order to examine the level of Malaysia students' problem solving skills in promoting the Higher Order Thinking Skills (HOTS) among school children (MOE, 2013). The results of PISA examination which was held in our country in 2010 was a shock to the ministry, especially the Ministry of Education, Malaysia as forty three percent of students failed to achieve minimum skills in Science literacy (MOE, 2013). Moreover, Malaysia ranked the third lowest position among 74 countries that took part in this examination. The neighbouring countries such as Thailand and Singapore showed better performance compared to Malaysia. The difference of 38 marks determines the difference of one to three years of studies in Singapore, Hong Kong, and Shanghai as compared to the Malaysian students.

On the other hand, the TIMSS examination is held for form 2 students. Malaysia has been taking part in TIMSS since 1999. The result in 1999 showed 7% to 13% of students failed to achieve the minimum skills but in 2011, it has increased to 35%-38%, which was four times higher (MOE, 2013). In 2015, Malaysia only achieved 25 percentile with the score for Science literacy for Malaysia was 417 marks that was less than the average score (Provasnik, Malley, Stephens, Landeros, Perkins, & Tang 2016). In addition, the current high stake of Malaysia examinations, in the year 2010-2013, 3% (15,000) of Ujian Penilaian Sekolah Rendah (UPSR) candidates did not achieve the minimum competency level as well as 0.1% of Penilaian Menengah Rendah (PMR) (400 students) and 5% of Sijil Pelajaran Malaysia (SPM) (21,000 students), respectively (Plan, 2016).

Moreover, a research by Higher Education Leadership Academy (AKEPT) in the year 2010, showed that 50% of lesson delivered was insufficient due to more passive lecture content delivery thatt only focused on preparing students for the summative examination rather than cultivating HOTS, which led to low rate of graduate employability (Plan, 2016). In 2013, the graduate employability (GE) rate was 75% and feedback from employer stated that our graduates did not meet employer' requirements such as attitude, ability to solve problems and lack of communication skills (Plan, 2016). These facts suggested that Malaysian students have less ability to solve problems and fail to achieve the HOTS. After many years of going through the education system, questions such as 'How this could be happened?', 'Are our students acquiring insufficient knowledge and skills?' and 'What is happening in the classroom?' had been widely debated among the stakeholders. Investigations had been carried out by the Federal and State Department of Education, Malaysia of which finally reached to a conclusion that the Malaysian students lack the ability to answer HOTS questions during the main examinations (MOE, 2013).

Thus, the government proposed a new plan in order to overcome the issue. Malaysia Education Blueprint (PPPM) was launched in 2013 with objectives to improve students' achievement by providing an efficient education system (MOE, 2013). Hence, in 2011, Malaysia government came out with a new concept of learning assessment which is the School-Based Assessment (SBA) as well as PT3 in 2014.

1.2 Background of Research

One of the strategies in PPPM is the implementation of SBA (MOE, 2013). Since the late nineties and beginning of 2000, SBA has slowly made its way into the Malaysian classroom. Beginning 2003, the school-based oral assessment commenced for both Bahasa Malaysia and English language (Chan, 2007). SBA has been fully implemented in Malaysian schools for all subjects in 2011 for the primary school, while the lower secondary school in 2012. The teachers were given workshops and courses to implement the SBA in Malaysian schools.

1.2.1 Introduction of School Based Assessment

The Moe has engaged in aggressive effort to change the manner in which students' learning is assessed. The assessment system known as SBA refers to the move from reliance on centralized examination under the supervision of the Malaysian Examination Board to a system where the teachers and schools are empowered to gauge students' learning. Whilst it is not totally new, aspects of SBA have been mentioned by the former Minister of Education, Tan Sri Musa Mohamed in 2003 (Chan, Sidhu & Md. Rizal, 2007). The teachers should teach per content and assess per descriptors given. Teachers need to keep record of all students' achievement online. However, problems arose when teachers face difficulties in assessing too many students in classes as well as constraints in online system (MOE, 2014).

Thus, on 1st April 2014, the ministry came out with a new way to implement SBA. The workload of teachers with filing and the online system discontinued and the off-line system was then implemented. Under this system, teachers are given greater responsibility to design quality assessments that align with the learning outcomes as they are the most suitable people to assess their students and they have a better understanding of the context of the subject area. This system also provides opportunities for teachers to continuously monitor their students and to give constructive feedback to improve students' learning abilities (Brown, 2001; Association of American Colleges and Universities (AACU), 2011). There seems to be a sense of insecurity among teachers to conduct a formative evaluation during the process of Teaching and learning (T&L).

The application of formative assessment is still at low level as teachers are less exposed especially in integrating formative assessment techniques in the process of T&L (Black & Wiliam, 1998; Hall & Burke, 2004; Brookhart, 2007). Hence, SBA influences the process of T&L as teachers tend to drill the students with the same patterns of questions. The government, realizing the negative impact of teaching merely to produce students who can churn as many as possible began to improve the assessment system. It is hoped that by improving the assessment system that less emphasis on centralized, summative examinations, would somewhat change the approach to teaching. In short, the issue that the product of Malaysia education system is excellent in memorizing yet unable to put the knowledge learned into practice should not take place (Tan & Samyudia, 2009).

Nevertheless, the new SBA system faces a lot of criticisms all over the countries. Not only from educators, academicians and schools, but also parents (MOE, 2014). To overcome weaknesses of the SBA, many strategies have been proposed which includes the introduction of Form Three Assessment (PT3) replacing PMR at the end of the third year of secondary school in 2014 (MOE, 2014).

1.2.2 The HOTS

SBA was implemented in Malaysia to nurture the HOTS among Malaysian students. Changes in the Malaysian education system require teachers' willingness to implement the new teaching methods and mastery of HOTS. The success of a new curriculum drafted requires cooperation from everyone, which focuses on teachers' capability. Teachers play a vital role for the success of T&L objectives that are effective in fostering HOTS among students.

However, there are several other factors that led to the problem is teaching of HOTS that were emphasized. Some teachers argued that in the implementation of HOTS students need to first find out all the facts and concepts of a subject before they can be encouraged to think (Sukiman, 2012). The readiness and skills of teachers in T&L that implement elements of HOTS also affect the students' ability in HOTS as described in the study by Suhaili (2014). The study found that teachers assumed that they have implemented HOTS in teaching but the teaching strategies practiced did not indicate an effective integration.

Suhaili (2014) also suggested that professional development for teachers should be carried out to promote the implementation of HOTS. It is also aimed to enable teachers to have better understanding and implementing the concept of HOTS in T&L. Nagappan (2001) in his study also recognized that the knowledge, skills, and behavior of teachers are the important factors that need to be addressed in the application of HOTS among students. Both of these studies indicate that the role and teachers' skills are also factors that affect the ability of students in HOTS. In the implementation of learning, HOTS cannot be directly taught to students (Akyol & Garrison, 2011; Limbach & Waugh, 2010). Students should be trained about HOTS, as a skill, through learning activities that support its development. Active learning and student-centred learning are activities for training about HOTS (Akyol & Garrison, 2011; Limbach & Waugh, 2010). The active learning and student-centred learning such as problem-based learning (PBL) (Mokhtar et al., 2013), project-based learning (PBL) (Vidergor & Krupnik-Gottlieb, 2015), discovery learning, and inquiry-based learning (Orlich, Harder, Callahan, Trevisan, & Brown, 2012), or other learning models using contextual problems are some examples of methods for training students about HOTS.

In addition, (Goethals, 2013) and Miri, David, and Uri (2007) mentioned that group discussion and solving complex and interdisciplinary problems in the learning process are important activities to train students' HOTS. The outcomes of students' HOTS development can be achieved by the active role of teachers in planning, implementing, and evaluating HOTS-oriented learning. To be able to plan HOTS-oriented learning, teachers need knowledge of ways, strategies, methods to train students about HOTS (Bartell, 2012).

HOTS refers to the ability to apply knowledge, skills and values in reasoning, reflection, problem solving, decision making, innovating and creating something new (MOE, 2013). In the 21st century pedagogy, teachers are expected to inculcate HOTS elements to encourage deeper thinking activities among students. This is in line with the aspiration of the Malaysian Education Blueprint, 2013-2025. Thinking skill, which is the most basic skills that can be developed in the classroom and is the key to high achievement for all students (Nessel & Graham, 2006).

The concept of HOTS originated from the Bloom (1956) taxonomy of cognitive domain (Forehand, 2010). These cognitive domains involves knowledge and the development of intellectual skills and in hierarchically ordered from concrete knowledge to abstract (Pappas, Pierrakos, & Nagel, 2013). HOTS comprises of logical thinking, critical thinking and reasoning skills which are the basic skills for daily life, apart from the academic achievements (Marshall & Horton, 2011). As mentioned earlier, many studies have examined the level of HOTS among students at various educational levels in Malaysia (Mahyuddin et al., 2004; Mohamad, 2015; Heong, Yunos, Hassan, Othman, & Kiong, 2011). Mahyuddin, Pihie, Elias, & Konting, 2004*)* for instance, found that critical thinking skills, creative thinking skills as well as convergent/divergent thinking skills were incorporated in teaching and student learning of various subjects.

1.2.3 The Introduction of Form Three Assessment (*PT3)*

Initially in the year 2012, the form 1 students were not assessed through any examination. They were the pioneers for SBA which focus on students' learning in classroom. These students however sat for the PT3 examination instead of PMR in 2014. PT3 is not a centralized examination but it is a summative examination evaluated at school level. In PT3, the school teachers access the students based on the guidelines given by the Malaysian Examination Board who later will verify and moderate the PT3 results. PT3 results would be released after a verification was carried out by the examinations syndicate. The examination time table would be drawn up by the schools and would be carried out between October and November.

Schools could then choose these questions and use them when assessing the students via the written tests. The syndicate would monitor schools to ensure they chose questions which reflected the levels of difficulty and not questions that were considered too easy. The implementation of PT3 begins in stages from 1 July 2014 onwards based on the schedule set by the Examination Board and prepared by school. Whereas, students' achievement in PT3 will be reported in the form of grades A, B, C, D, E and F with respective interpretations (Malaysian Examination Council, 2014).

The PMR summative examination consisted of two papers namely paper 1 and 2 that usually emphasized on students' lower thinking skills in comparison to PT3 (MOE, 2014). Both PMR and PT3 have followed the Taxonomy Bloom's level in constructing the examination questions; PMR with 5:3:2 and PT3 3:4:3 representing low: middle: difficult ratio of questions respectively (MOE, 2014). When the PT3 was first implemented in 2014, there was a sudden drop in the results for almost all subjects compared to PMR.

A significantly higher number of problem solving questions in PT3 were included, causing a drop in performance in a majority of schools (DeWitt & Alias, 2016). The drop in performance of the first year's PT3 examinations results might seem to reflect poorly on the teachers' problem solving skills and practice. This is because there was a huge difference between the last PMR results and the first PT3 results.

However, the transition of the evaluation system from Lower Secondary Assessment, PMR to PT3 has seen a result drop for almost all subjects. Similiarly, Jamil and Mahmud (2019), also claimed that critically low of students' achievement in PT3, their study supports the idea that students' enrollment in Science stream is influenced by previous achievement. Science and Mathematics performance in PT3 during 2014 to 2016 has been rather alarming; less than a quarter passed Mathematics and Science with a minimum of C (Rahman, 2018). Only 23% of the PT3 students were eligible for Form Four Science stream in 2017, the pattern over the last five years showed less than 30% were eligibile annually (Rahman, 2018).

In 2014, PT3 results for Science subject at the national level is 39.94 percent (Malaysian Examination Council, 2014). This low passing percentage has caused an alarming situation among Science teachers. Debates and discussions between stakeholders have denoted the inability of Malaysian students to answer the HOTS questions as the main reasons for the declining performance of PT3 (MOE, 2014).

1.3 Problem Statement

Currently, only 29.2% (2012), 29.1% (2013) and 28.7% (2014) of the secondary school students are studying in Science stream (Facts, 2018). It is a long way to achieve the target of 60-40 percent of Science-art students, which undermines the goals of the human capital roadmap of Science and technology for a developed nation status by 2020. Efforts should be made to effectively improve students' interest in Science through many strategies such as encouragement from parents and family, teaching quality, school management effectiveness, ease infrastructure, Science-based academic extra-curricular activities, peer influence, financial provisions and incentives (Da Wan, 2018).

Science is one of the subjects accessed in PT3, which results will be the foundation of evaluation for students to enter the form 4 Science stream, boarding school, technical school as well as other type of schools to continue their studies. Since the PT3 results showed poor performance of Science subject, the students as well as parents became inconfident that their children were entitled to continue their studies in Science field. Cimer (2004) agreed that this was one of the causes in the declining of student’s interest on Science subjects. Many students have a negative attitude towards Science subjects (Aziz & Lin, 2011).

According to the statistics from the Moe, and the students’ percentage of entrance to form 4 Science streams in the year of 1981-2010 was lessening compared with other streams (Facts, 2018). The highest was 31.22% in 2005 (Facts, 2018). Christidou (2011), in her review of more than 100 references, argued that as the students advance from primary to secondary education, they rapidly lose their interest in Science and cease seeing the subject as a viable option for their future.

This author suggested that students with a high cognitive potential for Science do not pursue careers as scientists or engineers because they lost their interest during school (Christidou, 2011). Furthermore, although the questions for all PT3 subjects contain HOTS, Science subject shows the lowest performance. This creates confusion among teachers and those involve directly in PT3. Many questions arose; do teachers lack of knowledge to teach Science? Why are students not interested in learning Science? Even though many discussions with regard to this matter have been carried out, very few researches are focusing particularly on the low performance of Science subject in PT3 and the problems faced by the teachers and students which contribute to the poor performance of students in Science subject (MOE, 2016). According to (MOE, 2016), teachers tend to practice traditional pedagogy and teaching methods that are too focused on examinations.

As a result, the T&L process of Science subjects at school level is still focusing on the level of knowledge and understanding. The methods applied by teachers do not help in creating high-level thinking skills. Consequently, the students become less interested in learning Science, and this has led to ineffective T&L process. In addition, study done by Osman (2007) found that students' scientific attitudes towards Science are low. Teachers are often considered as technicians who act in accordance with the suggested curriculum innovation without any self-invention (Halim, Abdullah, & Meerah, 2014). Therefore, changes in traditional T&L methods of Science subject need to be made. These changes involve the aspects of innovation and quality of T&L of Science subject. The teachers' pedagogical practice is significant in influencing students' academic performance and personal development (Darling-Hammond, 2000; Rowe, 2003; Hayes, Mills, Christie & Lingard, 2006); Arbaa et al., 2010).

The fourth shift in the transformation of the national education system as stated in Malaysia Education Blueprint 2013- 2025 has highlighted the transformation of teaching into the profession of choice (MOE, 2012). As discussed earlier, the current development of Science education indicates that the teacher's factor in T&L process of Science field is very imperative. The number of students' enrolment into tertiary education in Science subjects is decreasing almost every year (Yunus & Ali, 2013). Yunus and Ali (2013) and Saleh (2014) in their research discovered that students have negative attitudes toward learning Science. This is because of two reasons. Firstly, it relates to the syllabus which is considered too wide and rigid. Secondly is the adoption of traditional method that is still a norm in Science teaching in secondary school. The strategies include; employing effective method of teaching, integrating instructional materials in teaching, questioning techniques (Rehman & Haider, 2013), providing and conducting Science experiment effectively, teachers' personality, teachers' ability to provide clear examples and applications of knowledge, provision of adequate T&L facilities for Science, increasing students' awareness about the relevance of Science in the everyday world and providing effective timetable for teaching Science (Halim et al., 2014). Thus, the purpose of this study is to explore the challenges, issues, strengths, weaknesses and problems faced by the Malaysian lower secondary school stakeholders, which include the Science teachers, students, policy makers as well as school administrators in implementing the T&L process which contribute low performance in Science subject in PT3. The study is also trying to investigate the discrepancies between the understanding of T&L in Science and the actual implementation process of T&L in Malaysian secondary schools. Furthermore, this study also looks for the suitable strategies to implement the T&L Science more effectively in Malaysian secondary schools.

1. 4 Research Questions

1. To what extend do the teachers understand the T&L Science in the Malaysia secondary schools?
2. How do the current practices in T&L Science affect students' performance?
3. What are the issues and challenges faced in the T&L Science in the Malaysian secondary schools?
4. What are the suitable strategies to be implemented in T&L Science effectively?

1.5 Research Objectives

1. To explore the teachers' understanding towards T&L Science in the Malaysian secondary schools?
2. To investigate the effect of current practices in T&L Science in the Malaysian secondary schools.
3. To investigate the issues and challenges faced in the T&L Science in the Malaysian secondary schools.
4. To explore the suitable strategies to implement T&L Science more effectively.

1.6 The Research Theoretical Framework

Formative assessment aims in making the learning to become better and not on how to get an A. It also reduces the achievement gap by helping low achievers the most (Volante, 2017). In normal situation, students usually do not look at the feedback given except marks and no correction is made. This research theoretical framework is based on several theories that are related to T&L Science, including formative assessment that influences students' performance. The focus is on the constructivist theory that includes the interconnection between four main elements including discovery learning, scaffolding, spiral curriculum and representation modes and their connection with the constructive alignment as shown in Figure 1.1.

In the discovery learning, students will explore the world around them and making connections with what they already know (Bruner, 1966). Exploration through discovery learning and constructivist alignment will mold the students to explore knowledge on their own. Scaffolding emphasizes on the guide, structured interaction between an adult and a child with the aim of helping the child to achieve a specific goal. Spiral curriculum focuses on revising what has been learnt every now and ensure deeper understanding. Finally, representation modes in which information or knowledge are stored in memory with the help of enactive, iconic and symbolic systems (Bruner, 1966).

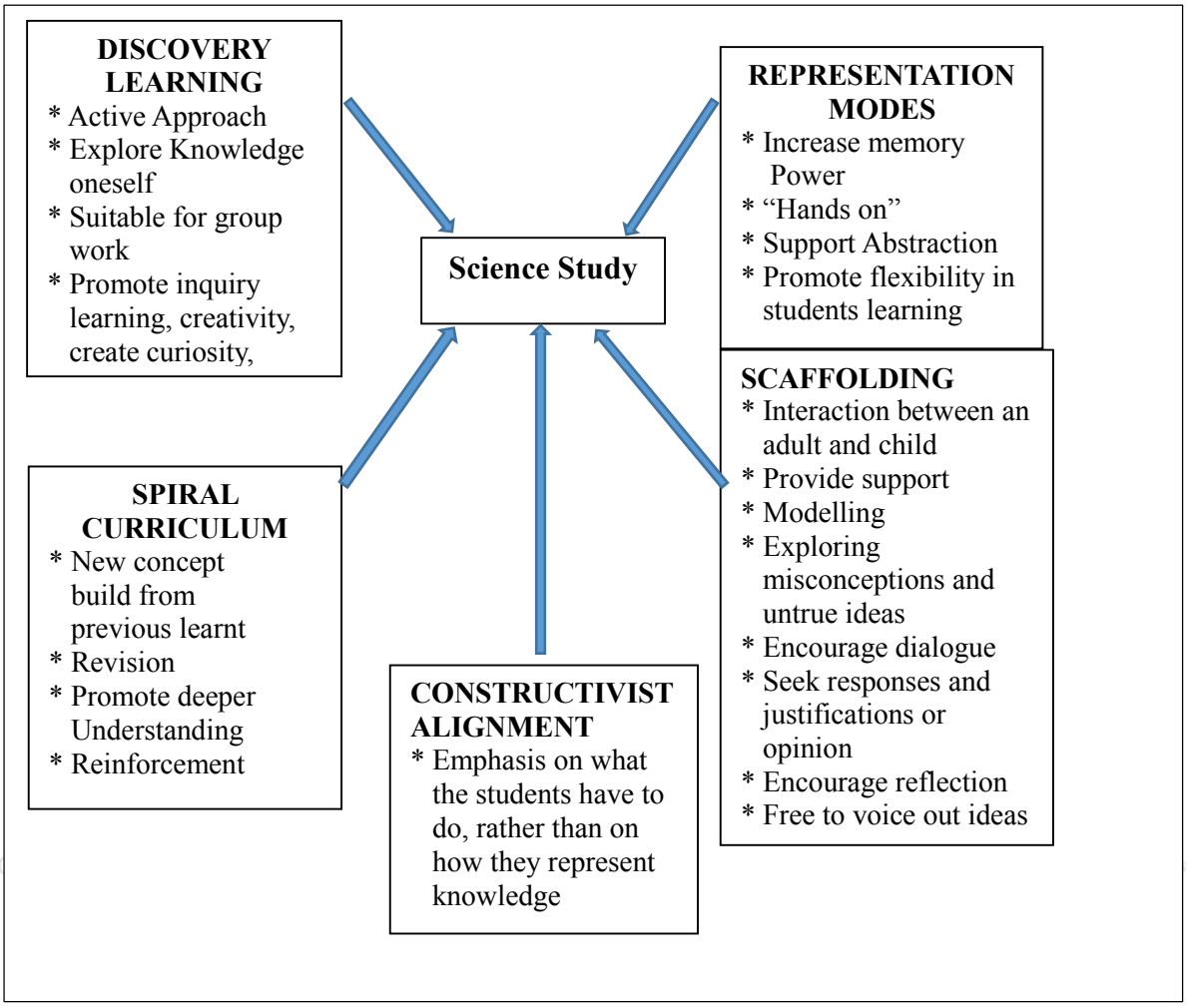

Figure 1.1. Connection Science study with Discovery Learning, Spiral Curriculum, Scaffolding, Constructivist Alignment and Representation Modes

The Critical Formative Assessment Component model by Pellegrino, Chudowsky & Glaser 2001) emphasized more on classroom assessment followed by interpretation or giving feedback to achieve the learning objectives. Additionally, the typology of formative assessment proposed by William and Thompson (2008) includes the assessment by minutes, lesson, daily, weekly, monthly and yearly with the various time interval of assessments. Formative assessment consists of questioning, feedback without grades, self-assessment and peer-assessment.

1.6.1 Representation

The enactive, iconic and symbolic modes are useful in T&L with formative assessment. According to Bruner (1966), the representation mode can be used for T&L Science. These modes emphasize on learning by doing, engaging students in activities, and exploring Science concept on their own to make the learning more attractive and understandable. Enactive mode can widely be used in laboratory work, field work and so on. This method is more to "hands on" activity. Science education is closely linked to experimentation and laboratory work. Whenever students do the experiments themselves, they learn and can understand it in long term memory. The beauty of this representation mode in T&L Science is regarding the memory that can be stored for a long period (Bruner, 1966). That means the students can understand the concept better and retain the knowledge longer. It is also a method of teaching which emphasizes the easiest to the more complex level.

Thus, increasing the students' active and vital participation in the learning process, as well as it helps students to acquire different skills and form positive attitudes towards Science learning (Al Musawi, 2015). In the Malaysian context, the schools have been implementing the evaluation laboratory work through PEKA (Penilaian Kerja Amali) for decades (MOE, 2016). PEKA which was an experiment report evaluation method for lower secondary was cancelled due to the rise of SBA. Although the PEKA itself did not successfully achieved its objectives but it provided the students the procedure of handling, recording, and analyzing the experiment data (Ishak, 2014). SBA took place with the hope that it will improve the T&L Science. Other than the enactive modes activities, the iconic modes that use images and animation is one of the best methods of learning Science.

The students can understand the Science concepts while watching images and talking about it. The higher level of activities is the symbolic modes. At this level, the students can learn Science verbally and achieve the level whereby the students will be assessed. Hence if the enactive, iconic and symbolic modes are fully implemented, students will achieve the learning objectives and able to answer the problem-solving questions easily.

1.6.2 Scaffolding

T&L Science needs the guidance of adults for school children to achieve better performance. Vygotsky (1980) has proposed a theory of cognitive development which several concepts including scaffolding arose from the theory that are important to classroom learning. Instructional scaffolding is a process through which a teacher facilitates students in order to enhance learning and assists in the mastery of tasks. The teacher does this by systematically building on students' experiences and knowledge as they are learning new skills. With the application of formative assessment, teachers become facilitators in classrooms. At the first stage, the teachers provide supports and guidance, while the students do the learning on their own until they manage to handle it. The guidance will be reduced and finally the students will react independently to achieve their goals later. In scaffolding, teachers will give feedback every time students perform their work (Vygotsky, 1980).

With the feedback, student may improve on it and continue to do better than before. Usually the correct answer is not given in order for students to further understanding the task. Facilitation in learning teaching Science will help students to achieve the higher level. Once, the students grasp the concept, the teachers can leave them to carry out further task. Hence the assessment will be a continuous process where the students improve their work gradually and learn more about it. With the formative assessment learning Science in PT3 can be very fun whereby the inquiries with questions will give the space and time for students to think beyond the normal situation. Further questions by teachers will encourage them to look for the answer and make them learn a task in depth.

1.6.3 Discovery Learning

Currently, one of the popular strategy in T&L is discovery learning. This learning strategy emphasizes more on the learner-centred learning that allows teachers to assess students more effectually. Unal and Engin (2006) also reached to the conclusion that structured activities through the discovery learning method along with the constructivist learning approach are more effective on the success of students in Science subject. In a research on discovery learning method used to teach language learners, the tasks offered the opportunity to be actively involved in constructing new knowledge and new meanings from authentic experiences in challenging situations (Cornelius-White & Hardbaugh, 2009). This is an obvious feature of learner-centered classrooms. Similarly, if this method is implemented in Science subject, teachers could encourage students to discover principles by themselves through an engagement in an active conversation.

Learners will be learning Science from general to specific skills and those skills can be used for other situations or real problems. Students will connect their findings with the real world which can make them understand the concept better and avoiding misconceptions. Teachers act as the guidance of the discovery process supposed to present the challenging tasks which suit students' cognitive levels (graded materials) to encourage participation. Knowledge is constructed using thinking processes when students cooperatively try to work out a solution for a problem.

Knowledge must be relevant, accessible and explainable as well as manipulable (Bruner, 1966). Teachers who are handling formative assessment should be knowledgeable. They need to prepare enough questions for the students and able to assist them towards their discovery. Questions must be based on revised Bloom Taxonomy which will help them answering the HOTS questions. Teachers also can make adjustment to their questions as well as assessment based on the students' performance. Students are also encouraged to generate questions which the teachers can use it for their examination later.

In addition, it is the teacher's role to always motivate the students to think. Discovery learning which is similar with PBL in such a way that use more on inquiry learning in many areas. Inquiry learning is a form of active learning that starts by posing questions, problems or scenarios. The inquiry-based instruction is principally very closely related to the development and practice of thinking and problem solving skills. Whenever the students learn Science through inquiry, they will think and try to understand the concept. Students normally will have curiosity towards Science.

With this discovery learning, teachers can enhance their curiosity towards their lesson by facilitating them to solve the problems. With these, students become more analytical and critical that eventually will lead to innovation and creativity. Students will also enjoy exploring Science world and be satisfied with their findings. For this purpose, teachers should encourage the widely use of laboratory work actively.

In laboratory, students can do experiment that is a part of discovery learning that provide them ways to create hypothesis and test their predictions. Assessment through discovery learning can be the application of collaboration or team work, self-assessment, presentation, projects, interviews with respondents and many more. With all of these types of assessment, teachers can build students' confidence to get through the assessment easily.

1.6.4 Spiral Curriculum

The formative assessment emphasizes more from general studies to specific studies. Similarly, the spiral curriculum begins with basic simple ideas to more complex. After the T&L is in progress, the learners are advised to revisit the basic ideas to enable them deepen their understanding. In learning Science, it can start with the textbook or any document that provide basic facts or Science concepts without the details. As the learning progresses, more details are introduced that are of more in-depth knowledge that allows the students to enter long term memory (Bruner, 1966). The spiral curriculum will help Science teachers to constructs lessons, activities or projects that target the development of thinking skills and facilitate the students to gain required performance. New knowledge will be introduced in the next lesson.

1.6.5 Constructive Alignment

This is an approach to enhance teaching, proposed by Biggs (1996), which claims to "represent a marriage between a constructivist understanding of the nature of learning, and an aligned design for teaching". Constructive alignment emphasizes more on what the students have to do rather than on how they represent knowledge (Biggs, 2003). In other way, constructive alignment postulates two aspects; the students construct meaning through relevant learning activities, while teacher sets up a learning environment that supports the learning activities appropriate to achieving the desired learning outcomes (Biggs, 2003).

Problem-based learning (PBL) and extensive recommended constructivist pedagogy are claimed to be a teaching-learning approach with a high degree of alignment. The degree of alignment is said to be a key factor in its success in areas such as medical education in which it has been widely adopted (Biggs, 2003). In constructing aligned teaching, first it is necessary to specify the desired level or levels of understanding of the content in question. These verbs then become the target activities that students need to perform, and therefore for teaching methods to be encouraged, and for assessment tasks to be addressed, in order to judge it or to what extent the students have been successful in meeting the objectives. This combination of constructivist theory and aligned instruction is the model of constructive alignment (Biggs, 2003). The key is that the components in the teaching system, especially the teaching methods used in Science and the assessment tasks are aligned with the learning activities assumed in the intended outcomes.

The learners, in a sense, are 'trapped', and find it difficult to escape without learning what they are intended to learn. In setting up an aligned system, the desired outcome of teaching is specified in terms not only of the topic content, but in the level of understanding that students need to achieve. An appropriate environment is then set up to maximise the likelihood that students will engage in the activities designed to achieve the intended outcomes. Finally, the assessment tasks are chosen that will determine how well individual students have attained these outcomes, in terms of graded levels of acceptability.

1.7 The Research Conceptual Framework

This study is investigating aspects in the T&L Science of PT3 at Malaysia secondary schools, which emphasises on teachers' understanding and the current practice in the classrooms as well as the issues and challenges in PT3 implementation of Science subject. The research conceptual framework is based on several elements of constructivist theory that may affect the T&L Science. Other factors such as professional development, curriculum selection and staff allocation may attribute to T&L Science in Malaysia classrooms and perhaps, to eventually impact the students' performance. These relationships are illustrated in Figure 1.2. The issues, challenges, strength and weaknesses in T&L PT3 Science are gathered from the stakeholders in the education system mainly the policy makers, school administrators, teachers, and students. The typology of formative assessment model is a model that explains how regular the assessment should be carried out at schools.

The assessment can be performed minute by minute or day by day or week by week or semester by semester or year by year depending on the assessment plan (Refer Figure 2.1). Furthermore, the critical formative assessment component emphasizes on how the assessment should be done in the classroom (Refer Figure 2.2).

Discovery Learning, Spiral Curriculum, Scaffolding, Constructivist Alignment and Representation modes which are the elements in constructivist theory are essential for the T&L Science. These elements make the learning a lot more meaningful and the students will have better understanding in Science concepts. In addition, the implementation of T&L PT3 Science will improve the students' performance if the education department and administrators give priority to the professional development of teachers and school administrators, concern on the program selection and evaluation, and allocate staffs according to the needs.

1.7.1 Professional Development

Professional development aims to improve teachers' teaching and practices, and students' learning (Loucks-Horsley et al., 2009). This was supported by Luft and Hewson (2014) that stated the professional development program can help teachers become more effective that can benefit their students. According to Yoon, Duncan, Lee, Scarloss and Shapley (2007), not all professional development program results in teachers' changing attitude or behaviour, and very few link to students' outcomes. Relatively very few studies connect the role of education leaders who plan and implement professional development program to the improvement of teachers' attitude and knowledge (Luft & Hewson, 2014).

Providing teachers with individualized feedback from the professional development program that is tailored to their needs and classroom environment can support teachers to make substantial change to their existing practices especially in teaching Science (Grierson & Woloshyn, 2013).

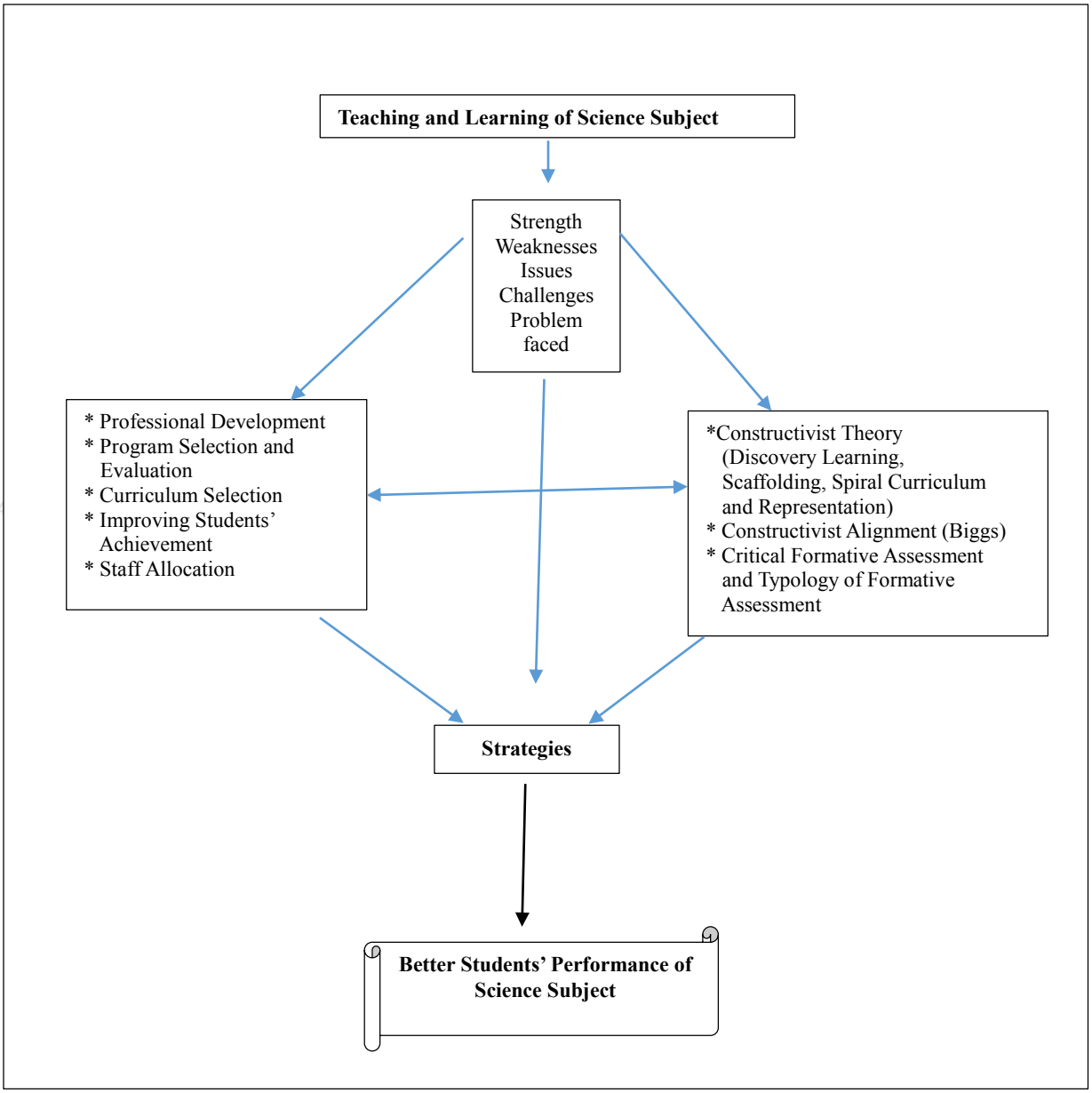

Figure 1.2. Conceptual Framework of the Study

1.7.2 Program selection and evaluation

Appropriate program selection and evaluation helps education department and school administrators making decisions about how to direct funding and resources toward identified areas of need Brunner, Fasca, Heinze, Honey, Light, Mardinach, & Fasca (2005), sometimes assists in taking the form of legitimizing existing programs and decisions (Coburn & Talbert, 2006). In general, program evaluation focuses on the central idea of whether programs should be kept or replaced. Program activities need to be continually monitored for implementation and effectiveness and changed as needed (Honig & Coburn, 2008). This can be done by looking at program and student achievement data to see if progress is present and, if not, what corrective action needed to be taken (Guerard, 2001). The low performance of PT3 Science can contribute to the evaluation of the program. Thus, the program's evaluation results will ensure the policy makers make the correct decision whether the program should be remained or not.

1.7.3 Curriculum selection

Curriculum selection includes general decisions about curriculum adoption (Honig & Coburn, 2008; Coburn, C. E., Judith, T., & Mika, Y., 2009). Administrators also make decisions about curriculum beyond selection, for example, decisions about curriculum frameworks (Coburn, Soung & Erica 2008), the best curricular approach (Honig & Coburn, 2008), and linking curriculum and instruction to standards (Mac Iver & Farley, 2003). The PT3 examination consists of three years of study which include form 1, 2 and 3 syllabuses all together. Students have to master the content of the three years of study to get good result in Science subject. The question is, whether the curriculum is appropriate to the standard of PT3 examination?

1.7.4 Students' achievement

Improving students' achievement cannot be done without understanding what did the students understand and not, and distinguishing the students who understand from those who cannot (Coburn & Talbert, 2006). For example, performance data are used to place students into different performance categories, and then measures are taken to provide students with appropriate interventions.

Evidence and activities that can be used to improve students' achievement also include: examining student gains, making predictions based on data, identifying topics that students need help in, creating individualized education plans, and examining curricular decisions that have been made based upon trends such as student achievement (Coburn & Talbert, 2006). In conjunction with this, the teachers should prepare interventions for the students. After each evaluation either simple test, quiz or semester examinations, the teachers should prepare proper intervention programs according to the level of students.

1.7.5 Staff allocation

In order to improve students' performance, policymakers need to allocate and prepare the staff with required knowledge, to implement successful educational programs (Honig & Coburn, 2008). Currently, the Moe using a system called e-*Operasi Borang Status Kedudukan Guru* (BSKG) to determine the number of teachers or staffs need to be allocated to the schools. The system will count automatically according to the options of the teachers and students number in school. No more per student ratios are used. Teachers allocated for Science subject is enough at all schools but the clerical works for teachers are abundant.

1.8 Significance of Study

This significance of this research lies in the provision of insight into particular T&L practice issues associated with SBA and PT3 Science in Malaysian Secondary Schools. The research findings provide details of teachers' understandings and current practices toward T&L PT3 Science in Malaysian secondary schools. It also gives insight to the strength, weaknesses, issues, challenges and problem faced for current and future challenges in T&L PT3 Science.

The framework of effective T&L Science proposed at the end of this research discusses and illustrates new strategies in T&L PT3 Science that provide learners with better performance for Science in Malaysian schools. A guide is also proposed at the end of this research also provides strategies to implement T&L Science more effectively. The teachers which play a vital role should be aware of the transformation of education system for the Science subject. Teachers as well as students' preparedness should be considered in implementing new strategies of assessing students. This study explore on HOTS exposure of the students in the T&L. The teachers' problems regarding HOTS are also highlighted. Moreover, this study also focused on the effectiveness conducting laboratory experiments in T&L. In addition, peer involvement in teachers as well as students also emphasized in this study. This study investigated the strengths and weaknesses of Science subject implementation, and thus, will help the government to strategize and plan the workable system to the entire schools in Malaysia as well as to ensure the success of Science subject.

1.9 Limitation of Study

The study is conducted among related policy makers, school administrators, teachers and students of Malaysian secondary schools. The policy makers are informers from Science department who are the state Science department officers and district Science department officers, whilst the school administrators consist of the principals, senior assistants, senior teachers and heads of Science subject. Informers from teachers are the ones who are teaching Science for form 1, 2 and 3 at the Malaysian secondary schools. Students are from form 1, 2, and 3 and also form 4 (the last batch PT3). This is due to constraints in term of time, resources and availability of researchers. The teachers are the busiest group of people involved and they can only be available during the school time.

Similarly with the students who can only be available during school time. Whereas the school administrators selected were also have Science based experience, otherwise they would have difficulty in understanding the content of the questions. Besides that, the interview questions also became the limitation of this study as they cannot be cynical when addressing sensitive issues regarding the weaknesses of the government policies. The researcher had to follow the duration time given by the research Moe in conducting the research. The collection of data occurred only from April to July year 2017.

1.10 Definition of Term

1.10.1 Implementation of Curriculum

The implementation of curriculum reform refers to the classroom practices which started from the planning of a lesson into conducting the lesson. According to Ysseldyke et al. (2003), teaching techniques (approaches and methods) are important steps for teachers to increase students' achievement. This is supported by Abdul Rahim (2001) that quoted teaching techniques or methods are important task for teacher to deliver sufficient amount of knowledge for pupils. Moreover, according to Mohammad Idris (2002), planning involves selection of teaching strategies, activities and teaching materials in accordance with achievability of the objectives.

1.10.2 The PT3 (Penilaian Tahap 3) Science

Science is the systematic study of nature and behavior of the material and physical universe, based on observation, experiment, and measurement, and the formulation of laws to describe these facts in general terms. PT3 is the form three assessment held in Malaysian secondary schools for the 15 years old students (MOE, 2014). This assessment consists of three years of syllabus namely form 1, 2 and 3. PT3 Science includes the objective and subjective questions. PT3 is not a centralized examination but it is a summative examination evaluated at school level. In PT3, the school teachers access the students based on the guidelines given by the Malaysian Examination Board who later will verify and moderate the PT3 results. PT3 results would be released after a verification was carried out by the examination syndicate.

The examination time table would be drawn up by the schools and would be carried out usually between October and November. Schools could then choose these questions and use them when assessing the students via the written tests. The syndicate would monitor schools to ensure they chose questions which reflected the levels of difficulty and not questions that were considered too easy. The implementation of PT3 were implemented by stages from 1 July 2014 onwards based on the schedule set by the Examination Board and prepared by school. Whereas, students' achievement in PT3 will be reported in the form of grades A, B, C, D, E and F with respective interpretations (Malaysian Examination Council, 2014).

1.10.3 T&L Science

Teaching is the process of attending to people's needs, experiences and feelings, and intervening so that they learn particular things, and go beyond the given. In much modern usage, the words 'teaching' and 'teacher' are wrapped up with schooling and schools (Smith, 2015). One way of approaching the question 'What is teaching?' is to look at what those called 'teachers' do – and then to draw out key qualities or activities that set them apart from others. The problem is that all sorts of things are bundled together in job descriptions or roles that may have little to do with what we can sensibly call teaching (Smith, 2015). T&L science in this study refers to a process that has to have focus and clear aims of the lesson. It is also signify that all students can and will learn, create a challenging, but non-threatening, learning environment, commit to the learning and intellectual growth of all learners, view oneself as capable, dependable, and generally positive (Staver, 2003).

1.10.4 HOTS

HOTS can be regarded as a complex non-algorithmic thinking which generates various solutions, which involves the application of criteria, reflection, and self-regulation (Resnick, 1987). HOTS involves cognitive processes (skills) that can be categorized as remember, understand, apply, analyze, evaluate, and create (Krathwohl & Anderson, 2001). According to Heong et al. (2011) HOTS needs to be nurtured as early as possible in order for students to use the thinking skills in a new challenge. HOTS demands someone to apply new information or knowledge that has been acquired and manipulates the information to reach possibility of answers in a new situation. The higher-order thinking conceived as the top end of the Bloom's cognitive taxonomy (Brookhart, 2010). "Being able to think" means students can apply the knowledge and skills they developed during their learning to new contexts that the student has not thought of before. In T&L Science, higher-order thinking is conceived as students are able to relate their learning to other elements beyond those they are taught to associate with. Active learning and student-centered learning are among activities for incorporating HOTS in learning Science (Akyol & Garrison, 2011; Limbach & Waugh, 2010). To be able to plan HOTS-oriented learning, teachers need to understand the pedagogical content knowledge and methods to be used (Bartell, 2012). Some teachers argue that students need to first find out all the facts and concepts of a subject before they can be encouraged to think (Sukiman, 2012).

1.10. 5 Training

Training is a planned process to modify attitude, knowledge or skill behaviour through a learning experience to achieve effective performance in any activity or range of activities. Its purpose, in the work situation, is to develop the abilities of the individual and to satisfy current and future manpower needs of the organization (Manpower Services Commission (MSC), 1981). Training is required when a gap between what teachers have and what are expected of them exists with regard to competencies, skills, knowledge and attitudes. Trainings organised for employees throughout their career add value to their substantive skills. Teachers' competency in achieving educational goals should be improved and this requires a wide range of training and development programs to motivate them and enhance their creativity in teaching and understanding the field of knowledge.

According to Rahmadhani (2014), the training process influences teachers and improves goal achievement. He added that training provide teachers or workers with knowledge and skills to be applied in their field. Continuous training add value to schools and organisations because the strategies gained from training can be used in the intended destination or mission. This finding is in line with the views of Rahman et al. (2011). They posited that training and development can be considered as a process for improving educator knowledge, skills and professional attitudes which help improve student learning. Ezeani and Oladele (2013) reported that continuous employee trainings or guidance provides latest knowledge on subject content, scope and networking in an organisation. Training has a direct effect on teacher productivity (Eze, 2016). Therefore, training in this study refers to any courses or development programs attended by teachers to gain knowledge in the T&L process.

1.10.6 Teachers' Understanding towards T&L Science

Secondary school teachers in Malaysia would have experienced a relatively conventional/traditional Science education which emphasized a 'following instructions' approach when conducting scientific investigations. This approach placed strong emphasis on scientific content, however, less focusing on procedural knowledge and skills of fair testing (Ong, Ismail & Fong 2006). Science education in Malaysian schools is examination-oriented, resulting in teachers focusing more on teaching to complete the content of the syllabus, and to present information and facts in order to prepare students for public examinations (Rose 2004). Therefore, this study seeks to what extend is the teachers' understanding towards T&L science lessons in the classroom. Teachers generally do not consider the importance of scientific inquiry in facilitating acquisition of conceptual knowledge; instead, they appear to focus almost exclusively on knowledge acquisition in terms of learning the products of Science and the use of this knowledge (Gyllenpalm, Wickman and Holmgren 2010).

1.10.7 Current Practices towards T&L Science

The traditional teaching practices have changed significantly through times. This traditional instructional practice incorporates repetitive learning styles, which led to the adoption of certain T&L techniques such as rote learning and spoon feeding (Tengku Kasim, 2014). According to Tengku Zainal, Mustapha and Habib (2009), some Malaysian teachers prefer to proceed the traditional practices as opposed to being creative or inventive.

They lean toward a traditional classroom approach rather than alternative teaching practices which require more effort, time and creative thinking during their lesson. Saleh and Aziz (2012) additionally showed that the instructional practice in Malaysia has a negligible level of interaction, whereby the Malaysian teachers did most of the talking and instructing while only several students contributed their views. Besides, Malaysian Science teachers used materials from textbooks, conducted demonstrations and laboratory activities occasionally to verify the concepts taught in classroom and to explain some exercises given at the end of the textbook, in order to familiarise students with examination questions (Saleh & Yakob, 2014b; Saleh & Aziz, 2012; OECD, 2009).

These are supported by Sim and Arshad (2013)'s investigation; their findings show that most of the Malaysian Science teachers conducted traditional instructional practices such as giving clarification in theory lessons. According to Saleh and Liew (2018), Malaysian teachers were trying to practice student-centred teaching approach, but they still dominated their classrooms. Therefore, the T&L science in this study focus on how teachers plan, prepare and implement the T&L elements of Science lessons in the classroom.

1.10.8 Strengths, Weaknesses, Issues, Challenges and Problem Faced in T&L Science

Government, schools, and teachers have encountered many challenges in the process of implementing the policies. The challenges are due to the fact that our country is a multicultural country and also due to rapid changes that occurred globally.

Questions have been raised as to whether teachers' education in Malaysia is able to prepare the teachers and students for the demands and challenges of the evolving global landscape. The MOE has set up a goal for Malaysia to rise to the top-third of system in TIMSS and PISA (MOE 2013). Furthermore, the MOE emphasizes on continuous professional development for the education staffs including teachers. MOE also recognizes the teachers who may require assistance in meeting new competencies, such as teaching the students the higher-order thinking skill. Nevertheless, according to a study conducted by Che Seman et al. (2017), the T&L in Malaysia were still monopolized by low-level thinking environment instead of higher order thinking. In addition, the findings from Kassim and Zakaria (2015) showed that the teachers are having difficulties in constructing higher order thinking questions for students' assessment.

Moreover, a study conducted by Hashim (2003) found that the courses or exercises related to this high-level thinking skill were not being introduced to teachers during teacher training and service. The teachers are not given enough exposure to teaching methods and pedagogy of high-level thinking skills. This proves that there is a problem that needs to be tackled for the good of the Malaysian educational institution. Unting and Yamat (2017) discovered one of the obstacles in implementing the program which is the lack of support and guidance for the teachers. Teachers are the implementers and thus play an important role in making the program a success. Therefore, teachers should be equipped with ample information and knowledge on the newly introduced program.

1.10.9 The Suitable Strategies to Implement T&L Science more effectively

Teaching is not just the effective transfer of knowledge. According to many education researchers, the best teachers have profound knowledge on the subjects they teach as well as understand the ways their students learn by taking the content into consideration. Students need to start learning and keep up with their engagement in learning to develop themselves into independent lifelong learners. The teacher should be able to have the capacity to assess the reasoning behind students' own particular techniques and identify students' common misconceptions (Coe et al., 2014). Besides, a good teacher has a good quality of instructions such as effective questioning and appropriate assessment.

The teacher must also have the capacity of asking diverse questions to achieve different objectives of the lessons (Ko & Sammons, 2013). Msimanga (2014) contended that students should be given a chance to reflect on what they have learnt to see whether effective learning occurred. Furthermore, Msimanga (2014) argued that effective learning requires more on making various connections of new ideas to old ones and sometimes requires the individual to fundamentally rebuild thinking. Effective learning happens when students are given a chance to reflect on their learning. It requires students to restructure their thinking by depending on acquired new knowledge (Msimanga, 2017). Thus, all criteria mentioned above are considered in identifying the most suitable strategies to be implemented in the Science T&L for a more effective T&L environment.

1.11 Conclusion

Science subject with SBA has taken place in Malaysia education system since 2014. It is vital for teachers to prepare themselves with the scientific skills and sufficient Science knowledge to carry out Science lessons in classrooms. This chapter has discussed the problems with regard to the new assessment in the implementation of PT3 Science as well as factors that may contribute to the performance of the students.