



TEACHING METHODS EMPLOYED BY EXEMPLARY  
SCIENCE TEACHERS: A CASE STUDY IN SELECTED  
INTERNATIONAL SCHOOLS

BY

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## **ABSTRACT**

Science is a systematic study of nature by means of careful observation, experimentation, logical reasoning and conclusion. Through proper teaching methodologies, science teachers can produce students who would be able to contribute to the technological advancement of the nation at large. Therefore, the investigation on effective teachers who are identified to be “exemplary” is necessary so that their teaching methods could be studied and their practices documented. This study was carried out to investigate how “exemplary” science teachers teach and what their perceptions are regarding effective teaching and learning. Three teachers who were nominated as being exemplary by their respective school principals participated in this study. Investigations on the methods they employed in the classroom were carried out by means of observation and interviews. Additionally, their lesson plans were scrutinized for evidence of effective pedagogical use. The findings reveal that the exemplary teachers fulfilled several of the criteria mentioned in Cimer’s (2007) six principles of effective science teaching that were adopted as the framework for this study. This implies that the six principles are applicable to the Malaysian science education context. Teachers in this study were found to employ different strategies depending on several factors, such as students’ age group, available resources and the topic itself. The study also reveals the use of novel teaching methods by the exemplary teachers that were proven to be effective. The teachers expressed their concerns regarding the poor performance of Malaysian students in international benchmarks, and offered probable solutions to tackle the issue which include a review of the curriculum in place.

## خلاصة البحث

يركفتلو بوجتولو تقيقدالا تظحالما قيوط نء تعيطلالا تيجهنم ةسراد نء قبايع هولعل هولعلا يملعل نكيم ، قبالندا سولتلا تايجهنم لالاخ نءو . قيقدالا جاتنتسلالو يقطنلا قيققو لعي ، لك لالا . لك ك ةملاأ يمولونكتلا ملقتلا في ةماسلا يء نرداق بلاط جاتنلا قيوط ةسراد نكيم تي حارورض " نويللثم " مئأ يء مهاديدتو تم نيدلا بين للعفلا بين ملعللا بين ملعللا " ميلعة تيفيك ةقوعلا ةسرادلا مده توجأ . مئاسوام قيقوق مبه ةصالخا سولتلا ةثلاثة ةسرادلا مده في لؤاشدقو . بين للعفلا ملعلتو ميلعتلا لوح موصوق هولعلا في " بينيللثا قيوطلا نء تالميقحتلا عارجلو . مبهتسودم ريدم لبق نء بينيللثمك مبهحيشوتو تم بينسودم نأ جاتنلا فشكلو . للعفلا يوقرلا تالابلقلو تظحالما قيوط نء لصفلا في لوملختسا بينيللثا بين ملعللا مللختسالا يء ليلد نء لئبج مهورد ططخ صءف تم لك لالا ةفاضلا باهءامتعا تم تي لالا للعفلا هولعلا سولتلا ةتسلا ةءابلا في قوكلما يرياعلا نء مديلعلا لوفوتسا في قبيطتلا ةلباقا للعفلا هولعلا سولتلا ةتسلا ةءابلا نأ نيءي لذه . ةسرادلا مده راطاك يء ولسمتعا ةسرادلا مده في بينملعلا نأ امضياً فشتكو ةقويلالما هولعلا ميلعة قاييس قوفتلا رولولو بلاطلا قومعلا ةقفلا لمللموع قءء يء اءامتعا ةفلقخ تايحيتتوسا نويللثا نوملعللا اهرهظأ قديءج تايجهنم نء امضياً ةسرادلا تفتشكا مسفن مع ضوللو بلاطلا فبعضلا ءادلااب قلعتي اميف مهللق نء نوملعللا تبتلو . مبهتيللعو لوتبتأ نيدلا ةعجرام نءمضتة تي لالا تيضقلا مده لءاعل ةلمتحو لولاح لوضوعو ةقيلودلا يرياعلا في بينويلالما ةمئلقللا قيسرادلا جءانملا .

## **APPROVAL PAGE**

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## DECLARATION

I hereby declare that this dissertation is the result of my own investigations, except where otherwise stated. I also declare that it has not been previously or concurrently submitted as a whole for any other degrees at IIUM or other institutions.

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# CHAPTER ONE

## INTRODUCTION

### 1.1 BACKGROUND OF THE STUDY

Education is of the utmost importance in order to prepare the nation builders of tomorrow. Education builds human capital, which is one of the prime assets for any nation to attain economic growth (Damodharan&Rengaraan, 2007). From the Islamic perspective, education is regarded as a lifelong process of nurturing an individual to actualize his role as a vicegerent of Allah (*khalifah*) on earth which requires from him positive contributions to the society at large (Hassan, 1989). According to Khamis and Salleh (2010), in every Muslim community, there needs to be some people who are proficient in the distinguished fields of acquired knowledge such as mathematics and science. Therefore, it is essential that we acknowledge learners and education as integral parts of society.

Education is a basic human right. All individuals should be given equal access to education, and that access must be matched by quality teaching to improve the lives of people. According to Ekine and Abay (2013), a country's ability to secure good health, fight against disease, protect the environment, produce food for its citizens, and develop new industries and technologies, is drawn among others from the scientific knowledge and skills of its people. In this technological world, science plays an increasingly important role in all aspects of daily life such as at the workplace, in public spheres and in the home. As citizens and consumers, all individuals in the current world have become dependent on science and on technology (Schreiner&Sjøberg, 2004). In relation to this study, science education is a vital

component that contributes to the development of individuals and nations. Therefore, teachers' use of effective methods to teach science is important to all students, and may contribute to enhanced science learning and understanding.

The quality of education in any educational institution depends largely on the teacher factor according to several research studies over the years (Archibald, 2006; Hake, 1998). It is the teachers who need to ensure that students acquire creative and critical thinking skills that enable them to face the challenges of the 21<sup>st</sup> century. In order to do so, teachers need to be able to design teaching sequences that develop in students the abilities to respond accordingly to situations, thus leading to meaningful learning (Darling-Hammond & Baratz-Snowden, 2005). This suggests that the teacher's role in creating a conducive learning atmosphere that allows for meaningful classroom interactions with students cannot be underestimated.

Effective learning of science takes place when the learners take responsibility of their own learning through active construction and reconstruction of their own meanings of concepts, events, experiences and phenomena (Brass, Gunstone, & Fensham, 2003). Student-centered learning is a broad teaching approach that encompasses replacing lectures with active learning, integrating self-paced learning programs or cooperative group situations, ultimately holding the student responsible for his own advances in education. Student-centered learning environments have a heightened advantage over the traditional teacher-centered instruction, in the sense that they provide complimentary activities, interactive in nature, enabling individuals to address their own learning interests and needs and move forward into increasingly complex levels of content to further their understanding and appreciate subject matter. Student-centered learning, when used properly, can change the face of education into a lifelong learning process.

TIMSS is an international benchmarking study conducted by the International Association for the Evaluation of Educational Achievement (IEA). It is a large-scale survey conducted to give an international overview on the teaching and learning of science and mathematics so that participating countries can make informed decisions about educational policy and practice. Malaysia participated in TIMSS to see the effectiveness of the science and mathematics lessons compared to that in other countries. TIMSS 2015 was held simultaneously across the country on Oct 28, 2014, with researchers randomly choosing more than 9000 secondary students from 207 schools nationwide. The large-scale TIMSS survey is conducted every four years and Malaysia participated in all the editions held between 1999 and 2015.

## **1.2 STATEMENT OF THE PROBLEM**

Malaysia's ranking in the 2015 Trends in International Mathematics and Science Study (TIMSS) is still below average, despite recording an improved performance compared to the previous benchmarking exercise in 2011. Out of the 39 countries participating in the secondary science category, Malaysia ranked only 24<sup>th</sup> with a score of 471, while Singapore topped the list with 597 (Martin, Mullis, Foy, & Hooper, 2016). Malaysia aimed to attain a score of 500 for science in TIMSS 2019 and believes that the participation will help achieve the objectives outlined in the Malaysian Education Blueprint 2013-2025. In order to do so, the existing curriculum needs to be revised and improvised, and one of the key elements of the curriculum is the teaching pedagogy.

There are numerous issues relating to the teaching and learning of science. Several past studies indicate that students, regardless of their nationality, find it difficult to understand science (Osborne & Dillon, 2008). One of the prime reasons for

this is due to poor understanding of science concepts, which is primarily attributed to poor teaching pedagogy (Abell & Driel, 2010). According to researchers, students are unable to develop scientific thinking due to the lack of engaging activities and problem solving. Science teachers face the challenge of having to relate the teaching and learning to real life situations for students to understand the fundamental concepts. This eventually leads to students' having a negative attitude towards science, and thus leading to poor performance in standardised tests.

Science is the study of living organisms, which include plants, animals and human beings, as well as the environment they operate in. Therefore, in order to study and comprehend science as nature, one needs to go through process. This makes science a systematic study of nature by means of careful observation, experimentation, logical reasoning and conclusion. Teaching and learning of science need to be integrated with practical hands-on activities. For example, the teaching of electrical circuits can only be fully appreciated when students have access to the physical accessories and the circuit components. Only then can students use their creativity to demonstrate and enhance their learning. Teaching and learning about science is a way of developing an in-depth understanding of the nature of science (Hodson, 2009). Exemplary teachers are the ones who not only nurtures the conceptual understanding of science but also develops a scientific thinking within the students so that they are able to apply in the real-life context.

### **1.3 RESEARCH OBJECTIVES**

The research objectives of this study are as follows:

- i. To ascertain the views of exemplary teachers on effective teaching and learning methods in science;

- ii. To investigate how exemplary teachers in science teach; and
- iii. To explore exemplary teachers' views on changes to be made to science instruction that can enhance the science education standard in Malaysia.

#### **1.4 RESEARCH QUESTIONS**

In order to guide the study, the following research questions are formulated based on the research objectives stated above:

- i. How do exemplary science teachers perceive effective teaching and learning methods in science?
- ii. How do exemplary science teachers teach their classes?
- iii. In the views of exemplary science teachers, what changes need to be made to science instruction that can enhance the science education standard in Malaysia?

#### **1.5 THEORETICAL FRAMEWORK**

Traditionally, science is taught via the direct method, due to its convenience of implementation. Although questions from students are expected, it rarely happens. In a direct instruction class, students would just listen while the instructor goes through his notes. Learning happens by listening and not by doing, which is not an efficient way of learning because students end up memorizing the facts. This method lacks the ability to develop analytical skills in students, and as a consequence, the sciences are perceived as cryptic and difficult, and students who excel in science are considered very smart. To experience meaningful science learning, students must explore and acquire knowledge through discovery. Students will then construct their own

knowledge, where teachers will act as guides or facilitators. These ideas about non-traditional learning coincide with what the theory of constructivism espouses.

Constructivism has its roots in the works of Jean Piaget, followed by Vygotsky (1962), Bruner (1960), Ausubel (1963) and Slavin (1988), to name a few. Their theories support student-centred and active learning, which is considered crucial in the development of scientific knowledge. The underlying theory of constructivism states that knowledge is not transmitted directly from one person to another, but rather is actively developed by the learner (Cobern, 1998). Constructivism stresses on the role of a quality learning environment in the development of cognition. A constructivist classroom is a learner-centered classroom.

The theory of constructivism is able to explain the conceptual framework from Çimer (2007) that is chosen for this study, which has listed down six principles of effective teaching in science. This will be further explained in Chapter Two.

## **1.6 CONCEPTUAL FRAMEWORK**

The model that was used in this study is adapted from Çimer's (2007) model of effective science teaching. In a study that investigated effective teaching in science, Çimer (2007) identified six main principles. The first is *dealing with students' existing ideas and conceptions*. It is important for teachers to help students construct their own understanding and knowledge. This requires teachers to help students activate their existing ideas and conceptions, be aware of them, and in the light of scientifically accepted knowledge, modify, change or develop them further. For this purpose, such teaching methods and activities as question-and-answer, discussions via small group or whole class, small group activities, practical work, and using ICT facilities can be employed.

The second principle is *encouraging students to apply new concepts or skills into different contexts*. In order to do this, teachers can use practical work, field trips, simulations, writing activities, and role-play. The third principle identified is *encouraging student participation in lessons*. Involvement may be galvanized through a wide range of teaching and learning activities, such as inquiry-based teaching, cooperative learning groups, questioning, discussions, field trips, role playing, and so on. *Encouraging student inquiry, encouraging cooperative learning among students and offering continuous assessment and providing feedback* are other principles identified from the literature. The model shown in Figure 1.1 below has been adapted for this study. This model will also be discussed further in Chapter Two.

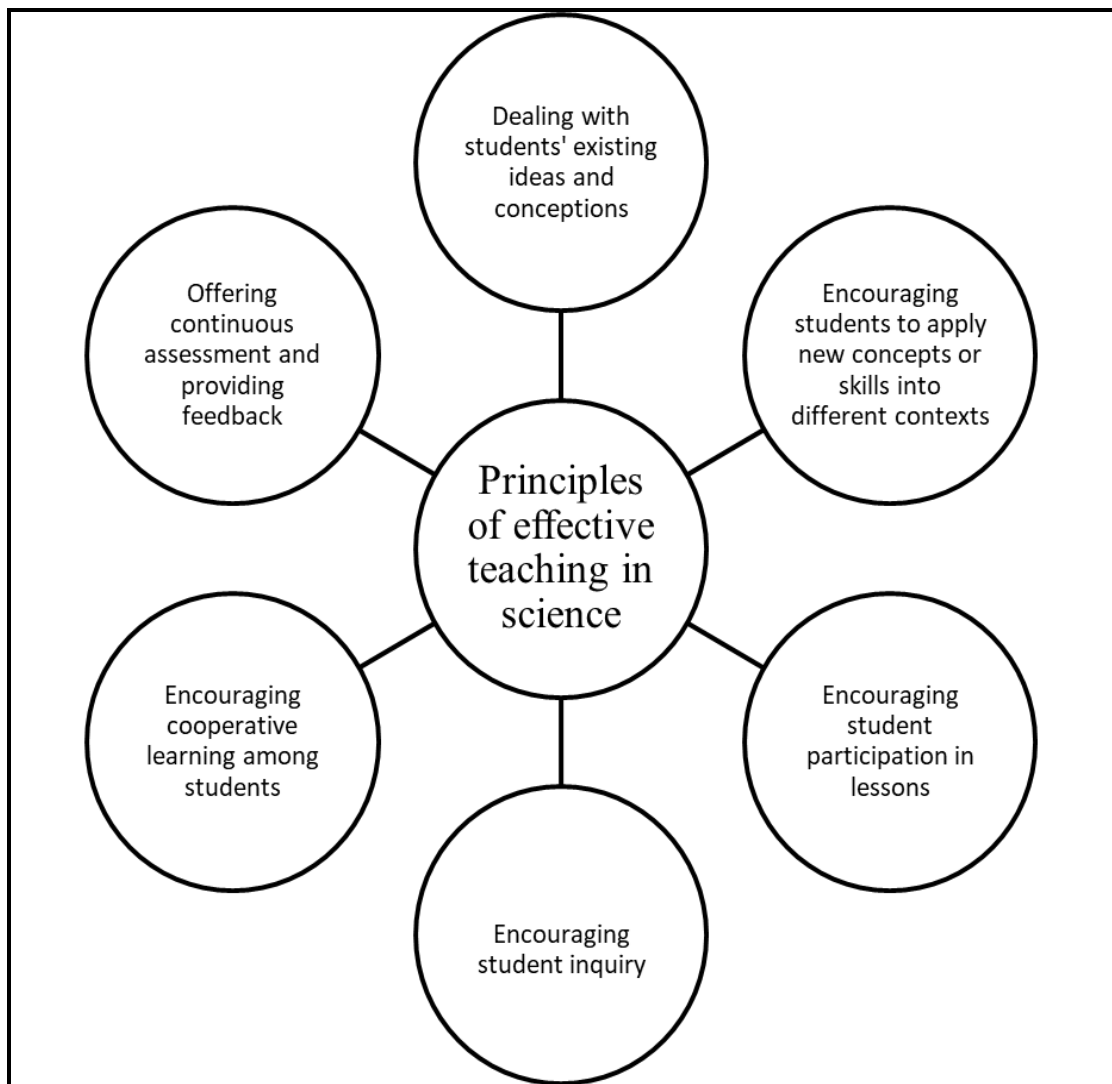


Figure 1.1 Six Principles of Effective Science Teaching (Çimer, 2007)

### 1.7 SIGNIFICANCE OF THE STUDY

The U.S National Science Education Standards state that “what students learn is greatly influenced by how they are taught” (National Research Council, 1996, p. 28). The standards further state that a pedagogical shift from a teacher-centered to a student-centered paradigm is necessary. It is believed that when student-centered learning is incorporated, students become engaged in socially interactive scientific inquiry, which in turn facilitates lifelong learning. Existing literature also supports the idea that a move towards pedagogies involving full interaction, collective reflection

and the development of consensual knowledge would lead to improved learning and attainment (Smart & Marshall, 2012).

Despite the significance of science in the field of education, studies have shown that there is persistent inappropriate teaching of science in schools and colleges across the world, especially in developing nations (Schreiner, 2006). Literature also suggests that it is the teacher who plays the most important role in sustaining students' interest and improving their performance (Hattie, 2003). Hence investigating teaching pedagogy is crucial to science education.

This study attempts to investigate the existing teaching practices by current excellent teachers in selected international schools across Selangor, which are proven to enhance student understanding and performance in light of the adopted framework. Although many studies have been conducted to investigate science teaching practices across the globe, not much is addressed in the local context, especially when it concerns secondary education. Therefore, this study aims to make a significant contribution to the existing literature of secondary science education. The result of this study will be valuable to for the betterment of science education practices in Malaysia.

The findings from this study may assist school leaders to make informed decisions with regard to teacher training on effective teaching methods that are compatible with the Malaysian education setting. In conclusion, this study should benefit not only the students and teachers, but also all the relevant stakeholders, including the curriculum developers and the Ministry of Education, in achieving the goals set forth in the Malaysian Education Blueprint 2013-2025.

## **1.8 DELIMITATION OF THE STUDY**

The main delimitation of the study is due to the restriction put on this research. Qualitative research tends to be exploratory in nature, which enables a thorough understanding of the underlying reasons, opinions and concepts. It provides insights into the problem under investigation, and a rich description of the relevant individuals' personal experiences and ideas. The study is restricted to secondary science teachers in the selected international schools.

## **1.9 DEFINITIONS OF TERMS**

### **Teaching Methods**

“Teaching methods” refers to the channelled activities planned by instructors in order to attain the desired learning outcomes. According to Kasim and Tamuri (2010), teaching methods also include constructing the learning environment and the framework which gathers knowledge and constructs ethics and moral practices.

### **Exemplary Teachers**

In this study “exemplary teachers” refers to the teachers nominated by the selected school principals to be outstanding and impressive teachers in their respective subjects.

### **Secondary Science Education**

Secondary science education refers to the science curriculum taught in selected international schools, namely the International General Certificate of Secondary Education (IGCSE), which is supervised by the University of Cambridge.

## **CHAPTER TWO**

### **LITERATURE REVIEW**

#### **2.1 INTRODUCTION**

This chapter reviews the existing literature that is related to pedagogy. It introduces the concept of pedagogical content knowledge, which is followed by a brief discussion on the importance of pedagogy and how it contributes to effective teaching and learning. The conceptual framework of the study, which deals with the six principles of effective science teaching, will be explained in detail, based on the constructivist theory in the following section, with specific practical examples for each principle highlighted. The chapter will then provide a brief description of the history and present condition of science education in Malaysia. Finally, a brief review of research related to practices of exemplary teachers from abroad and locally will be presented.

#### **2.2 PEDAGOGICAL CONTENT KNOWLEDGE**

In the era of globalisation, education needs more practical and authentic instruction. Teaching is regarded as a highly complex cognitive activity in which the teacher is required to apply knowledge from multiple domains (Resnick, 1987). Knowledge that is often associated with teaching is broadly classified into two categories, namely content knowledge and pedagogical knowledge. Content knowledge refers to the knowledge of the subject matter, for instance science, without consideration about the delivery. Pedagogical knowledge, on the other hand, deals with generic knowledge

about the pedagogy, how students learn, the different teaching approaches, assessment and so on.

Pedagogical content knowledge (PCK) is a blending of content and pedagogy in order to enhance the understanding of how particular topics, problems, or issues are organized, represented, and adapted to suit the diverse interests and various levels of learner abilities (Shulman, 1987). PCK includes an understanding of what makes the learning of specific topics easy or difficult. The conceptions and preconceptions that students of different ages and backgrounds bring with them to the learning of those most frequently taught topics and lessons (Shulman, 1986). One of the most important skills a teacher should possess is the ability to transform the knowledge to be taught to students in a concrete way that can be easily understood. It is believed that teachers' understanding of the subject matter will impact upon students' learning.

Shulman (1986) distinguished between regular teachers and subject matter specialist by means of pedagogical content knowledge. According to the PCK framework, having the knowledge about science is necessary, but it is not a sufficient condition for teaching. Science teachers must also have knowledge regarding the science learners, the curriculum, instructional strategies and assessment. This will help transform the scientific knowledge into effective teaching and learning.

### **2.3 IMPORTANCE OF PEDAGOGY**

Pedagogy has been defined as the strategies planned by teachers prior to entering a classroom in order to accomplish the objectives and goals of the lesson (Arifin, 2004). Teaching and learning are correlated because the effectiveness of teaching can be assessed based on, amongst other determinants, students' learning. Similarly, teachers and teaching methods remain among the significant factors for effective learning (Al

Harthy, 2013). Part of the teaching pedagogy is to guide the students to use effective learning strategies which enable them to become successful learners (Sani, 2014).

In order to meet the challenges and expectations of the 21st century, educators need to be equipped with diverse teaching pedagogies. According to Million and Graham (2000), one of the most important elements of effective teaching is teachers' employment of a variety of teaching techniques. In a study conducted by Woolnough (1994), it was discovered that students' choice of participating in science is influenced by the way teachers teach science. Even with regard to students' interest and participation in professional science careers, great emphasis is placed on the quality of teachers' pedagogy.

With regard to the implementation of an integrated curriculum, studies have highlighted that there exists a correlation between the use of effective teaching pedagogy and effective implementation of the integrated curriculum. Among the challenges faced by teachers in implementing an integrated curriculum is the lack of content knowledge, pedagogical knowledge and proper strategies (Beane, 1992). A meaningful learning experience necessitates active engagement of both students and teachers in the classroom according to the designed learning activities (Abdullah, Bakar & Mahbob, 2012). Each student is unique in their own distinctive way, which poses a challenge for the teacher to keep all of them engaged simultaneously within the classroom. The pedagogy needs to cater to the diverse needs, interests and learning styles of students. Therefore, using a variety of teaching techniques is important to attract and sustain students' interest (Hussin, Noh & Tamuri, 2014).