INTEGRATION OF INTERACTIVE WHITEBOARD TECHNOLOGY IN TEACHING PRIMARY SCIENCE

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FACULTY OF EDUCATION
UNIVERSITY OF MALAYA
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ABSTRACT

The research aimed to explore science teachers' integration of IWBT for teaching and learning in a selected fully equipped IWBT Chinese primary school. In relation to this, factors that could lead to the reluctance in the integration of IWBT were determined and an instructional guide for more effective integration of IWBT to overcome reluctance for science teaching and learning was put forward. The research utilised a qualitative case study approach. The case selected for the study was the bounded system of an atypical Chinese government aided primary school within which the use of IWBT in the science classroom was investigated. There were six teachers from standard one to standard six who participated in the study. Multiple data collection techniques were utilised. Thirteen lesson observations and six interviews were recorded after the lesson observations. The documents related to the lessons were also collected to gain more understanding about IWBT integration and for triangulation purposes. Analysis revealed that the majority of the IWBT features were not utilised by the teachers. From a technological perspective most of the science teachers only managed to use 1 to 2 features of the IWBT in their teaching and learning activities in the classrooms. The most frequently used features were the 'freeze' and 'zoom in' of the visualizer but none of the interactive whiteboard features were utilised. Four factors that emerged from the study data which may lead to reluctance in the integration of IWBT in science classrooms, were 'Time', 'Training', 'Attitude' and 'Unsolved Technical Problems'. In order to overcome the reluctance in integrating IWBT in the science classroom, an IWBT instructional guide booklet for science lessons based on the topics observed during the length of the study was prepared. The instructional guide covered topics from Year 1 until Year 6 of Primary Science of the Malaysian Curriculum. The IWBT instructional

guide booklet suggests ideas for more effective integration of IWBT in the science classrooms. The users of the IWBT instructional guide booklet can select the IWBT features according to classroom activities and time frames proposed in the guide. The novelty of the IWBT instructional guide booklet is that science process skills can simultaneously be infused. Finally, the richness of the data collected allowed for the formulation of a rubric specifically to assess science teachers' TPACK elements in integrating IWBT. The TPACK model underpinned the theoretical framework of the study. This rubric could be a future tool that can be used among teachers in schools, though more testing is needed. Implications of this research as well as some suggestions for further research were put forward.

INTEGRASI TEKNOLOGI PAPAN INTERAKTIF DALAM PENGAJARAN SAINS DI SEKOLAH RENDAH

ABSTRAK

Kajian ini bertujuan untuk meneroka integrasi teknologi papan interaktif (IWBT) di kalangan guru sains dalam pengajaran dan pembelajaran sains di sekolah rendah jenis kebangsaan Cina yang dilengkapi dengan IWBT sepenuhnya. Berkaitan dengan perkara ini, faktor-faktor yang mungkin boleh menyebabkan keengganan guru sains dalam penggunaan IWBT dikenal pasti dan sebuah buku panduan instruksi untuk integrasi papan interaktif yang lebih berkesan untuk mengatasi keengganan dalam pengajaran dan pembelajaran sains telah dikemukakan. Kajian ini menggunakan pendekatan kajian kes kualitatif. Kes yang dipilih untuk kajian ini ialah sebuah sekolah rendah jenis kebangsaan Cina yang istimewa di mana penggunaan IWBT dalam bilik darjah sains disiasat. Terdapat enam orang guru darjah satu hingga enam mengambil bahagian dalam kajian ini. Kajian ini menggunakan pelbagai teknik pengumpulan data. Tiga belas kali pemerhatian dalam pengajaran dan pembelajaran dalam bilik darjah sains dan enam kali temu bual direkodkan selepas pemerhatian tersebut. Dokumen yang berkaitan dengan pengajaran dan pelajaran juga dikumpulkan untuk mendapatkan lebih banyak pemahaman mengenai kajian kes ini dan bertujuan untuk triangulasi data yang terkumpul. Kajian ini mendedahkan majoriti fungsi IWBT tidak digunakan oleh guru-guru. Dari perspektif Teknologi, kebanyakan guru sains hanya menggunakan 1 hingga 2 fungsi IWBT dalam aktiviti pengajaran dan pembelajaran mereka di bilik darjah sains. Yang paling kerap digunakan ialah fungsi 'membekukan' dan 'zum dekat' pada visualizer tetapi fungsi pada papan interaktif tidak digunakan langsung. Kajian ini mendedahkan bahawa

terdapat empat faktor yang boleh menyebabkan keengganan dalam mengintegrasikan IWBT di dalam bilik darjah sains. Empat faktor yang timbul hasil daripada data kajian mungkin menyebabkan keengganan dalam mengintegrasi IWBT di bilik darjah sains iaitu, ‘Masa’, ‘Latihan’, ‘Sikap’ dan ‘Masalah Teknikal Yang Tidak Dapat Diselesaikan’. Untuk mengatasi keengganan dalam mengintegrasikan IWBT dalam bilik darjah sains, sebuah buku panduan instruksi IWBT untuk pengajaran dan pembelajaran sains berdasarkan topik yang diperhatikan semasa kajian telah disediakan. Buku panduan instruksi ini meliputi topik sains dari darjah 1 hingga darjah 6 dalam kurikulum sains sekolah rendah di Malaysia. Buku panduan instruksi IWBT mencadangkan idea untuk integrasi IWBT yang lebih berkesan dalam bilik darjah sains. Buku panduan instruksi ini membolehkan pengguna memilih fungsi IWBT mengikut aktiviti dan kerangka waktu seperti yang dicadangkan di dalam buku panduan. Keistimewaan buku panduan instruksi ini ialah pada masa yang sama kemahiran proses sains boleh diterapkkan. Akhir sekali, disebabkan data yang banyak telah dikumpulkan, sebuah rubrik dirumuskan untuk menilai unsur pengetahuan teknologi, pedagogi dan kandungan pelajaran (TPACK) guru sains. TPACK Model adalah kerangka teori kajian ini. Rubrik ini boleh menjadi instrumen di sekolah pada masa depan tetapi ujian yang lebih kerap adalah diperlukan dalam kajian lain. Implikasi kajian ini serta beberapa cadangan untuk penyelidikan selanjutnya telah dikemukakan.

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LIST OF ACRONYMS

IWBT	: Interactive Whiteboard Technology
IWB	: Interactive Whiteboard

Chapter 1: Introduction

Introduction

In response to the ongoing social changes and new educational goals, there is a realisation in many countries that education must prepare students with a new set of skills in order to succeed in the knowledge age. This has been ongoing for more than a decade. Different governments use different terminologies to describe these skills. The US calls them “21st century skills” (Partnership for 21st Century Learning, 2015) whereas New Zealand refers to these skills as “Essential Skills” (Barker, Hipkins, & Bartholomew, 2004). These skills such as information literacy, collaboration, problem solving and communication are found in the various 21st century skills frameworks (Barker, et al., 2004; Fong, Sidhu, & Fook, 2014; Partnership for 21st Century Learning, 2015)

According to the Malaysia Education Blueprint 2013-2025 (2014), it shows an initiative towards transforming our education system to meet high aspirations amidst an increasingly competitive global environment by lifting achievement for all students to meet the needs of the 21st century. In order to achieve such a high level of performance, it is necessary to further improve the dynamics of the teaching and learning process. It is proven that an information, communication and technology (ICT) learning environment provides positive advancements for educators and students in comparison to traditional methods (Barbalios, Ioannidou, Tzionas, & Paraskeuopoulos, 2013; Cheung & Slavin, 2013). Past research have highlighted virtual learning environments which have changed the role of teachers as the sole information provider and students become the active learners in the learning process (Bouta, Retalis, & Paraskeva, 2012; Crişan & Enache, 2013; Pedersen & Irby, 2014).

The students have access to interesting topics which engage them to work collaboratively and actively with their peers and this leads to the development and diversification of their competencies. Some researchers believe that 3D virtual environments provide novel learning opportunities, but careful design is necessary in order to realise their full potential (Bouta, Retalis & Paraskeva, 2012).

An increasing number of Computer-Supported Collaborative Learning (CSCL) environments is being reported in the literature (Alvarez, Salavati, Nussbaum, & Milrad, 2013; Singh & Mohamed, 2012; Warwick, Mercer, Kershner, & Staarman, 2010) in the strive for opportunities for learners to become active, collaborative and constructivist learners in the classroom. According to Alvarez et al. (2013), the use of interactive whiteboards in classrooms can foster the development of collective skills, distributed cognition and transmedia navigation in different knowledge domains. Students have fun and are motivated in such learning environments and thus enhance their learning in the classroom (Bakadam & Asiri, 2012; Singh & Mohamed, 2012; Warwick, Mercer, & Kershner, 2013).

Technology in Education

Today"s students need to be taught twenty-first century skills that they will need to thrive in the future. In general, twenty-first century skills are those skills that are required for “a successful life and well-functional society” (OECD, 2005). Some of these skills include digital literacy, inventive thinking, effective communication, teamwork, and the ability to create high-quality projects. In order to reach this lofty goal, educators need to focus technology on the key building blocks of student achievement. Those building blocks include assessment, alignment, accountability, access, and analysis (Lee, 2009).

Educators should know how their students learn best in order to consider the building blocks of students‟ achievement and thus plan and implement real authentic learning to enhance the teaching and support the learning. Driscoll (2002) argued that technology integration in education is not easy to achieve but it is necessary. She offered four broad principles as a framework for teachers as they think about how to integrate technology into their daily instruction. These four principles are as follows: 1) Learning occurs in context, 2) Learning is active, 3) Learning is social, and 4) Learning is reflective. It is important to remember that technology by itself will not guarantee true learning. However, the proper use of available technologies does have the power to enhance and transform education in today‟s classrooms.

The term “ICT” includes computers, the Internet, and electronic delivery systems, and is widely used in today's field of education. There is much evidence that there are benefits of using ICT in educational settings (Al-Qirim, 2011; Drigas, Kokkalia, & Lytras, 2015; Falloon & Khoo, 2014; Fisher, Lucas, & Galstyan, 2013; Neo, Neo, Lim, Tan, & Kwok, 2013). The use of ICT in teaching and learning can provide the learners with various benefits from academic, social and psychological perspectives. For instance, collaborative projects in mobile learning environments promote critical thinking through discussion and debates between the learners, improve the classroom results by promoting higher achievement and potentially improve the weak students‟ performances as they group with the higher achievement students (López-Yáñez, Yáñez-Márquez, Camacho-Nieto, Aldape-Pérez, & Argüelles-Cruz, 2015).

Furthermore, the use of ICT in teaching and learning also promises a new approach for collaborative learning for people with cognitive difficulties (Drigas et al., 2015), ease the way in assessing children who need special education with the support of ICT (Plowman, McPake, & Stephen, 2010), promotes learners collaborative learning as ICT be used in pairs (Fisher et al., 2013) and also promises the opportunities to raise the quality of students learning (Falloon & Khoo, 2014). In spite of that, Jacobson et al. (2010) in their research project elucidated that external constraints such as the nature of the assessment system, the extensive syllabus to be covered and school culture tend to strengthen more teacher-centered ICT uses rather than learner-centered ICT uses.

Neo, Neo, Lim, Tan and Kwok (2013) investigated the instructional relationships, created by the use of Web 2.0 and multimedia technologies using Laurillard‟s (1993) Conversational Framework, between the teacher, students and technology. Results showed that using Web 2.0 as a mediating component in the instructional process was interesting and effective for the student learning process and the Conversational Framework was successfully adapted in this learning environment. Students are motivated in such a learning environment, i.e. giving feedback to each other in web 2.0 and also face-to-face in the classroom and as a result they felt that learning is fun and become creative and active learners in accomplishing group work projects.

According to Ludvigsen and Mørch (2010), there are some general tendencies in complex computer-supported collaborative learning (CSCL) environments such as teachers and students need to engage deeply in specific problem-solving activities, and these deep engagements often involves disagreement, identifying problems and conflicting ideas that need to be resolved (problematizing). One of the aims of the CSCL is to improve such conditions in educational setting using scaffolding techniques for collaborative learning (Ludvigsen & Mørch, 2010).

CSCL environment students also learnt better due to the social interaction with peers for collaborative works. Kwon, Hong, and Laffey (2013) investigated the effects of a web-based group coordination tool based on metacognitive scaffolding principles with a total of 59 students formed into 20 groups based on the response rate to metacognitive prompts of the tool. Their study showed that group members who more actively used the coordination support tool established positive interdependence, engaged in positive interactions, and had enhanced group productivity. This study also showed that students were keen to study learning materials to enhance their confidence in order to contribute to the group that might perceive as helpful action to their peers.

In short, technology is abuzz in education and the impact of technology in education is into its third decade. Technology has the potential to transform the learning environment from teacher-centeredness to one of student-centeredness learning style. This transformation contributes to fostering 21st century skills. This present study will focus on one of the technologies available, which is the interactive whiteboard technology (IWBT).

Note: In this study, from this point, the following is applicable.

IWBT: Interactive Whiteboard Technology

IWB: Interactive Whiteboard

IWBs in the Science Classrooms

The IWBT is a branch of ICT that has played a huge part in transforming today‟s classrooms. The IWBT is sometimes referred to as an electronic whiteboard or SMART Board. In 1993, a pioneer company called SMART Technologies produced the first SMART Board IWBs (SMART Technologies, 2015). A number of researchers studied the use of IWBT by teachers in whole class settings (for example Alvarez et al., 2013; Bidaki & Mobasheri, 2013; Singh & Mohamed, 2012; Warwick et al., 2013, 2010). The IWBT includes a large touchable screen which is connected to a visualizer and/ or a laptop or computer with Internet access. The instructors or learners can perform a variety of different functions with the IWBT. For example, the users can write, erase and perform mouse functions with finger, a pen, a stylus or any other object that has a firm maneuverable surface. There is digital ink on the touchable screen that allows users to write with the pen without ink and erase with hand or pen over websites or other applications. The work on the screen can be saved and used again for future lessons or used in different software application (Bidaki & Mobasheri, 2013).

In many countries, the importance of the IWB is increasing (Hsieh, 2011; Nolan, 2016; Ormanci, Cepni, Deveci, & Aydin, 2015; Yakubova & Taber-Doughty, 2013). Teachers are the persons who make the pedagogical decisions whether to integrate the technological skills in the classrooms to present and deliver the content knowledge to increase student learning (Beauchamp & Kennewell, 2013; Díaz, Nussbaum, Ñopo, & Maldonado-carreño, Carolina, Corredor, 2015; Murcia, 2014). Teachers‟ Technological, Pedagogical and Content Knowledge (TPACK) may influence their pedagogical decisions in applying the IWBT in science classrooms (Jang & Tsai, 2012, 2013; Jang, 2010). The TPACK will be discussed further in greater detail in section 2.5.

In order to explore the relationship between the use of IWBT and Technological Pedagogical Content and Knowledge (TPACK) by teachers, Jang (2010) investigated the integration of the IWB and peer coaching in developing the TPACK among secondary science teachers. An IWBT-based peer coaching model was developed and was found useful in developing the TPACK of science teachers. Science teachers used IWBTs as instructional tools to present their content knowledge and to express students‟ understanding as well as help them to overcome teaching difficulties in the traditional classroom by implementing their representational repertoires and instructional strategies using the peer coaching model.

Murcia (2014) discovered that there are three types of teachers‟ interactive pedagogies which are technical interactivity, physical interactivity and conceptual interactivity in her case study research on how teachers and students use IWBT in primary science classrooms. The technical interactivity is controlled by teachers who can show videos and images, display text of the content and provide low level of closed questioning to students. On the other hand, physical interactivity involves students in manipulating objects on the IWBT by using the function of hide and reveal or drag and drop activities. Teacher can involve students in presentations and closed questioning by focusing students attention on the salient feature of the representation. By providing the conceptual interactivity, students are exposed to high-level open questioning and opportunities to generate new or re-representations of phenomena. In these IWBT environments, the classroom episodes demonstrate teachers‟ pedagogy on the interactive technology and also promote interactive students who actively participate and construct knowledge in the science learning process.

On the other hand, Warwick et al. (2010) investigated the vicarious presence of the teacher in pupils‟ learning of science in collaborative group activity at the IWB. These researchers strongly suggested that a consideration of grouping arrangements in the classroom and the development of activities and lessons not only lead to develop the use of group work and talk with positive interactions in pupils" groups, but also contribute to pupils" attainment in science. Teachers found that acting the role of task designers by using their knowledge of IWBT functionality and its affordances for learning in whole class settings to construct activities that might scaffold or mediate the learning activity of pupils" groups. The researchers found that pupils initially did not scrutinize the details of each page until they were persuaded by the group members. The pupils used the „external memory" of the IWBT to return to a previously completed task to change their original responses on the basis of further thinking. Besides, the use of the page sorter and page hyperlinks which is embedded within the activity by the teacher assisted pupils" learning.

Teachers can control the degree of freedom for pupils" action within the task using the IWBT and can either choose to lock down or free objects to be moved. The findings showed that pupils seemed to re-negotiate the task parameters which led to more discussion surrounding the topics and some interesting reasoning from the groups, articulated both in speech and through pointing and object manipulation (Warwick et al., 2010). In the study done by Warwick et al. (2010) it was found that pupils in all the case study classrooms demonstrated an active participation in their science learning as they would move objects, step back and consider their placement, reason and debate, and move objects to show alternatives.

Thus, IWBT presents a technological innovation with multidimensional features and options, however, teachers as deliverers or facilitators must utilise the technology available to enhance the learning process.

Problem Statement

In Malaysia, one of the objectives of science education is to foster creativity and innovation among students by facilitating them to master science and technology skills (Curriculum Development Centre, 2016) deemed needed in 21st century. The new Primary School Standard Curriculum (*Kurikulum Standard Sekolah Rendah*) or KSSR will empower students as well as the teachers and enrich them with the capabilities to increase their thinking skills and give them more room and freedom to exercise their creativity and innovation (Malaysia Education Blueprint 2013-2025, 2014). The Malaysian government has taken some initiatives to transform the education system. One of the examples in transforming the system is by leveraging ICT in delivering science lessons (Malaysia Education Blueprint 2013-2025, 2014, p.20).

Nevertheless, in schools, teachers are still applying traditional teaching methods in delivering the content knowledge to students (Low, personal communication, May 17, 2015; Schweisfurth, 2011). Schweisfurth (2011) stated that the classroom realities about the infrastructure, class size, teaching materials and teacher capacity as well as in-service offering to develop capacity are the barriers needed to overcome in order to implement the technology based learner centred education successfully. Schweisfurth (2011) also pointed out that some of the successful examples of the learner centred education implementation were due to the support among the teachers who were willing to learn new ways of teaching as well as the appropriateness of the conditions of classrooms. Teacher"s beliefs about the nature of knowledge and learning (epistemology), beliefs about effective ways of teaching (conceptions), and technology integration were positively correlated with one another (Kim, Kim, Lee, Spector, & DeMeester, 2013).

Past research has also shown that there is an apparent gap between the amount of technology available in today‟s classrooms and teachers‟ use of that technology for instructional purposes (Al-Qirim, 2011; Gray, Thomas & Lewis, 2010). Teachers are the crucial persons in utilising the technological tools in the classrooms in order to deliver the content knowledge and it has been found that the IWBT is under utilised (Bakadam & Asiri, 2012; Low, personal communication, May 17, 2015).

The focus of the present study is about IWBT. There are several research focal points in the use of IWBT technologies in the classroom for teaching and learning (Alvarez et al., 2013; Warwick et al., 2010). The major obstacle in integrating technology in the classroom proposed by Nikian, Nor, and Aziz (2013) is parallel with the findings by Kopcha (2012). They pointed out that the teacher‟s perception of time was consistently negative. Teachers always perceive integrating of technology is a burden of time because it interrupts the instruction; time is needed to find resources or planning and to undergo training. As such, there is a need to explore the integration of technologies such as the IWBT as well as to identify factors influencing the integration of the IWBT among the science teachers in the classrooms.

Bakadam and Asiri (2012) revealed that teachers‟ reluctance to utilize all of the available IWBT features stems from their limited knowledge of the use of IWBT in which the majority of teachers use the IWBT as an overhead projector and for internet research but do not make use of the many other advantageous features of the IWBT. This is in line with the informal conversation (Mei, 2015) of the researcher in her workplace where there are thirty-three classrooms equipped with the IWBT, the teachers fully utilise the visualizer and internet access but the use of the touchable screen of IWBT for writing and other techniques are at the minimum level. Thus, there is a need to look into the affordances of IWBT and identify the factors that influence the use of the IWBT by teachers.

Furthermore, Ormanci et al., (2015) stated that there is a need for further research concerning the use of IWBTs in science education in their thematic review of IWB use in science education because studies which are associated with the nature of science education are rare. Their findings showed that only five studies related to integrating IWB into science curriculum.

In Malaysia, IWBTs are relatively new. Singh and Mohamed (2012) suggested that both quantitative and qualitative research approaches are needed to give broader views and information of the use of IWBT and look deeper into the advantages and disadvantages of the use of IWBT. This may give ideas to schools regarding the cost incurred in the matter of the value of money to invest in such technology. Thus, the present study had three main purposes, namely, to explore the integration of the IWBT for science teaching and learning; to identify factors that may lead to the reluctance in the integration of IWBT for science teaching and learning and put forward emerging guidelines for more effective integration of IWBT in primary science classrooms.

Rationale of the Study

The central focus in this study is the integration of IWBT for teaching and learning in the science classroom in a selected Chinese school. Chinese schools in Malaysia have been built since the year 1819 by the Chinese community and until today there are more than 1300 Chinese schools in Malaysia from primary school until tertiary institution (Hu, 2010; Huang, 2012). Chinese primary schools in

Malaysia can be divided into two types which are national-type schools and private schools (UCSCAM, 2009). UCSCAM (2009) further mentioned that Chinese National-type schools are subsidised by the government but it is not enough to fully support daily conducive teaching and learning environment. Consequently, the Chinese community especially the Board of Directors and Parents Teachers Associations actively participate in contributing to upgrade the school buildings and various facilities by fund raising within the community (Hu, 2010; Huang, 2012; Overseas Chinese Affairs Office of the State Council, 2006; UCSCAM, 2009).

Since 2014, the researcher was given an opportunity to teach in one atypical government Chinese primary school which is equipped with IWBT in all classrooms. Even though all the schools teachers were given a basic two-hour training of the use of the IWBT twice in a year, the teachers still did not appear to show competent handling the IWBT for teaching and learning in the classroom. Through the researcher"s informal observations, most of the teachers only use the IWBT as a normal whiteboard but do not make use of the many other advantageous features of the IWBT. The teachers prefer to use the visualizer to display the textbooks or activity books when delivering the content knowledge to the students but did not fully use the functions of the IWBT such as use the stylus or finger to write on the IWB. The IWBT actually provides the space for students to physically contact with the board i.e. to write or discuss in groups on the board which allows them to engage in the learning process, to change from passive to active learners (Murcia, 2014; Warwick et al., 2013, 2010). However, the reality of the situation observed by the researcher was different. Generally, the researcher found that there was reluctance in the use of IWBT for teaching and learning purposes among colleagues. Thus, it can be said that the money invested in the technology may go to waste.

The main rationale of this present study is to investigate the factors of reluctance (Bakadam & Asiri, 2012) in integrating the IWBT in the science classroom and hopefully to offer a solution to overcome such a situation. In order to investigate the situation, the researcher explored the integration of IWBT among science teachers in a selected Chinese primary school which was the researcher‟s school, followed by identifying the factors that may lead to reluctance of the integration of IWBT in science teaching and learning.

Research Objectives

Based upon the problem put forward, the objectives of this study were:

1. To explore the integration of the IWBT for science teaching and learning in a selected fully equipped IWBT Chinese primary school.
2. To determine the factors that may lead to the reluctance in the integration of the IWBT for science teaching and learning in a selected fully equipped IWBT Chinese primary school.
3. To put forward an instructional guide for more effective integration of IWBT to overcome reluctance for science teaching and learning in a selected fully equipped IWBT Chinese primary school.

The original intent of this study was to achieve the above research objectives. However, as the study progressed, the researcher realised the data assimilated could formulate a rubric to assess science teachers‟ self-perception of their TPACK (the theoretical framework of the present study has been projected from the original TPACK framework) specifically in utilising the IWBT according to the theoretical framework based upon the observational and interview data of this study. Thus, a fourth objective emerged which was,

4. To identify the emerging TPACK elements to create a rubric to profile science teachers in the use of the IWBT.

Research Questions

In order to achieve the objectives above, the research questions of this study were:

1. How are science teachers‟ integration of IWBT for teaching and learning in a selected fully equipped IWBT Chinese primary school?
2. What are the factors that lead to reluctance in integrating IWBT for science teaching and learning in a selected fully equipped IWBT Chinese primary school?
3. What are the components of an instructional guide for more effective use of IWBT to overcome the reluctance in science teaching and learning in a selected fully equipped IWBT Chinese primary school?
4. What are the emerging TPACK elements to create a rubric to profile science teachers in the use of the IWBT?

Definitions of Terminologies

Interactive whiteboard technology (IWBT). In the context of the present study, IWBT consist of hardware (computer), related software, projector, visualizer, sensitive touchable screen and some stylus (pens without ink) which allow you to drag, click, copy, write and draw on the board and then save it to use again next time or to share them in various platforms.

Integration. Science teachers repurpose the IWBT for teaching and learning in the Chinese primary classrooms in this study. For example, a science teacher not only uses the IWBT to present the content knowledge, but he or she provides the pupils with collaborative work at the IWBT. They may use the features on the IWBT such as highlighting, screen-shading, spotlighting, annotating, capturing, recording, zooming and etc.

Reluctance. In the context of the present study, a situation where science teachers do not fully use the IWBT in a fully equipped IWBT science classroom specifically in the use of the features on the IWB is classified as reluctance. For instance, a science teacher writes on the IWB with a marker pen but not using the feature of "writing" which will allow him or her to write with a stylus or finger. This reluctance could mean that the teacher does not have the knowledge of the "writing" feature and hence uses the marker pen, or the teacher knows the "writing" feature but is not willing to use it due to the time constraints.

Engagement. In the context of the present study constructive interaction (Kwan, 2016) such as answering of questions, contribution of ideas, affective involvement (such as happiness and laughter) and/ or physical involvement (such as writing, drawing, erasing, drag and drop on the IWB) using all or part of the IWBT in the science classroom is the indication of engagement. Engagement was included as one of the TPACK elements in preparing guidelines for more effective integration of IWBT in science teaching and learning as well as in creating a rubric to profile science teachers.

Significance of the Study

This study explored the integration of the IWBT for science teaching and learning by science teachers in a selected Chinese primary school. The research findings of this study can offer useful data to various parties including the Ministry of Education, Board of Directors and Parent Teacher Associations in Chinese primary schools, Headmasters and Teachers, in deciding upon the investment of IWBT in the classrooms.

Furthermore, this study identified the factors influencing the reluctance of integrating IWBT among science teachers and perhaps could make recommendations as to how to address these barriers. Thus, it can perhaps also help to overcome the gap of reluctance in utilising the technologies available in the classrooms and their use of instructional purposes.

This study put forward a TPACK rubric grounded in the data. It may provide a clearer insight for educational technologies, administrators and decision-makers to understand what kind of professional development is needed for teachers in integrating IWBT in the science classrooms. Thus, administrators and decision-makers will have a clearer idea of how to implement professional development programmes for teachers‟ long term practices in science teaching and learning in the classroom using IWBT.

The vivid exemplars collected from this study were used in putting forward the instructional guide which can be used to encourage science teachers to fully utilise the IWBT more effectively in primary school classrooms in general and in particular Chinese primary school classroom where the IWBT is readily available.

Limitation of the Study

The central focus in this study is the integration of the IWBT for science teaching and learning. The selected sample was confined to a fully (computer or laptop, visualizer, interactive whiteboard, LCD projector, related software, and some stylus) equipped IWBT Chinese primary government school in every classroom. Therefore, the research findings might not represent a Chinese private school in

Malaysia or a Chinese primary government school in Malaysia which are partially equipped with technology (visualizer, LCD projector and a normal screen).

Time for data collection was only two weeks. Only six teachers volunteered who managed to cover limited number of topics. However, the researcher managed to obtain thirteen observations and five interviews so that as much data can be acquired to prepare the guidelines for more effective use of the IWBT.

Chapter Summary

Literature shows that in many cases, technology is available in classrooms but the frequency of use by teachers is few and far between. As such, this gap was investigated in this study by exploring the integration of the IWBT among science teachers in a selected Chinese school so as to identify factors influencing the reluctance of integrating the available IWBT in classrooms. In order to overcome the reluctance, the study findings also have led to the preparation of guidelines in teaching science using the IWBT. The findings of this study may shed some light on the fruitfulness of integrating technology in science classrooms and more specifically on the science teaching and learning using the IWBT in Malaysian school settings.

This chapter has described the foundation of this study, namely the problem statement, the objectives and research questions, the rationale of the study as well as the terms that have been used here. The following chapter contains a literature review of the studies on teaching and learning science within an ICT-supported learning context, the use of IWBT and a background review of the theoretical framework of this study.

Chapter 2: Literature Review

Introduction

Technology permeates our nation. IWBT is one of the specific technological tools used widely and globally. The implementation of the IWBT in many schools especially in developed countries has impacted the lives of many students. Some of the governments in developing countries are trying to implement such technologies into their educational settings. A broader look at technology and its impact on education helps place the IWBT into its proper context. Some may wonder how is the use of IWBT in Malaysian classrooms and its necessity or effectiveness. It was found that some schools in Malaysia are equipped with IWBT but is under utilised (Bakadam & Asiri, 2012; Mei, 2015).

This chapter discusses teaching and learning within ICT-supported learning contexts, pupils‟ engagement in technological enhanced learning environment, the use of IWBT in science teaching and learning, science process skills, authentic learning environment, guidelines for more effective integration of IWBT, technological, pedagogical and content knowledge (TPACK) framework, methodology of previous research and data collection methods.

Teaching and Learning within an ICT-Supported Learning Context

Lakkala and Ilomäki (2015) investigated a case study of developing ICT-supported pedagogy through a collegial practice transfer process in Finnish elementary schools to find new methods for in-service teachers‟ ICT training. In the project, a practice transfer model was applied, where experienced teachers supported their less-experienced colleagues in implementing digital technologies in their teaching through authentic examples and guidance. Their findings showed that less-experienced teachers gained self-confidence to use the ICT in the classrooms as they were provided with the flexible support from the more-experienced teachers. On the other hand, the results also showed that the tasks designed by the less-experienced teachers were less connected and weaker to support for pupils‟ collaboration, knowledge construction and metacognition than their more-experienced colleagues.

Lakkala and Ilomäki (2015) further suggested that teachers should strongly direct the discussion by providing authentic nature of the task but not unconnected exercises or teachers‟ ideas. The learning processes only will happen by the creation of pupils‟ own ideas and questions. The effectiveness of the process for promoting pedagogical change will increase if training or pedagogical guidelines for less-experienced teachers are provided to help them avoid focusing only on surface level phenomena, such as the digital tools. The school management can provide the teachers with different types of in-service training due to differences of competences in digital technology among the teachers in school.

Starkey (2010) presented the teachers‟ technology practice (TTP) measure as a tool to examine differences in technology-related teaching practice among subject areas. She examined the barriers and enablers that influenced the integration of digital technologies into teaching practice among six digitally able beginning teachers during their first year in New Zealand secondary schools using a complexity theoretical framework. Her findings showed that school context included policies and structure such as timetabling, room allocations, school curriculum and length of lesson which allow the access to digital technologies. These encourage the beginning teachers as they get support from mentors with relevant pedagogical content expertise which influences their ability to apply their knowledge and experience of digital technologies to their teaching practice. Overall, beginning teachers were innovative in overcoming the barriers of digital technologies in teaching and learning through appropriate access, support and mentoring. Thus, the context influences can be the key to successful implementation of technology in teaching and learning.

In 2015, Howard, Chan, Mozejko, and Caputi examined the correlation among five factors and three variables; the factors being Facilitate learning (FAL), Data and visualization (DAV), Working collaboratively (WCO), Online interaction and communication (OIC) and Preparation and delivery (PAD). Overall, these five factors encompassed the use of computer for teaching and learning and thus it is logical that results showed that teachers will think about how technology integration contributes to the social culture of the classroom, teaching and learning (p. 30). The three variables were: i) how often teachers use computers in the classroom, ii) if teachers think about how technology enhances learning when planning, and iii) teachers' perceptions regarding the importance of ICTs in teaching and learning were examined. The key variables were found to have good correlation with the five factors.

According to the suggestion by Kopcha (2012), the community of practice is a cost-effective alternative of mentoring in encouraging the changes in teachers‟ attitudes and practices with technology. Another research done by Kim, Kim, Lee, Spector and DeMeester (2013) is parallel with Kopcha (2012)‟s finding which showed that teacher‟s beliefs about the nature of knowledge and learning (epistemology), beliefs about effective ways of teaching (conceptions), and technology integration were positively correlated with one another.

On the other hand, Hew (2015) examined students‟ preference for peer or instructor facilitation of online discussion forums and found the reasons why most students preferred instructor facilitation compared to peer facilitation when it comes to online discussion, despite the reported benefits of peer facilitators in the literature. The reasons are: (a) to prevent the discussion from going off track, (b) to resolve conflicts in the discussion, (c) to provide information particularly when the topic of discussion is new, and (d) to motivate the discussion when students‟ participation wanes. The results of a comparative analysis across all three cases by Hew‟s (2015) study showed that only 35% of students preferred peer facilitation due to these reasons: (a) the participants desire greater freedom in voicing their own views, (b) the participants desire greater ownership in determining the direction of the discussion, and (c) the participants want actual hands-on-facilitation-experience.

Pupils' Engagement in a Technological Enhanced Learning Environment

In 2017, a study demonstrated the relationship between the impact of mobile technology on student attitudes, engagement and learning (Heflin, Shewmaker, & Nguyen, 2017). The study evaluated student learning in three different collaborative learning environments, both with and without mobile technology, to assess students' engagement, critical thinking, and attitudes towards collaborative learning. The results indicated that mobile technology is associated with positive student perceptions of collaborative learning but also with increased disengagement by some students during class. Students are engaged in collaborative learning environments as they were engaged through eye contact, speech, gesturing and posture. Meanwhile, students who are disengaged most often are found looking at technology, not making eye contact and posturing themselves in ways that are not participatory.

On the other hand, Morgan and Olivares (2012) found that the occurrence of interactions in a technological-integrated learning environment encourage students to assume some ownership of and control over the learning process as well as provide them with the realistic and relevant contexts which encourages them to explore from multiple perspectives. Students construct meanings rather than memorize the facts. The proper facilitation of the use of technology in the classroom can provide meaningful student-instructor, student-student and student-content interactions.

Rashid and Ashgar (2016) elucidated that the use of technology has a direct positive relationship between students‟ engagement and self-directed learning, however, no significant direct effect was found between technology use and academic performance. Their study is in line with Kwan (2016) who stated that engagements (cognitive, emotional and physical) appear to be increasing the interest of the students and teachers in pursuing their learning and teaching processes. She found that constructive interactions in a technological integrated learning environment promote engagement in learning among students in the classrooms.

Furthermore, according to Rashid and Ashgar (2016), there are a lot advantages if the empirically tested models of technology use are effectively channeled in the academic environments and incorporated in pedagogical strategies. The effective use of technology in classrooms can enhance not only the academic performance, student engagement and self-directed learning, but may also relieve the negative outcomes. Thus, technology should be used as an effective pedagogical and educational tool to promote academic achievement, student engagement and self-directed learning.

In Malaysia, the findings from Singh and Mohamed (2012) showed that students were more engaged in the learning process as they become active learners in the technological integrated classroom. Students felt that learning is fun and they have better understanding of the science content through the learning with IWBT.

Students also agreed with the use of interactive whiteboard as an environmental-friendly tool as it reduces the use of paper and ink. Students will engage in learning as they can write, draw or paint on the IWB as well as listen to the variety of sounds produced from the IWBT. Thus, the use of IWBT in classroom can increase the pupils‟ engagement in learning.

The Use of IWBT in Science Teaching and Learning

The features on IWBT not only assists the teachers to save the class time, but also helps the students to remember the previous lessons quickly (Al-Qirim, 2011; Bakadam & Asiri, 2012; Bidaki & Mobasheri, 2013). Thus, the affordances of the IWBT provide science teachers with great advantages for lesson planning and increase the pedagogical skills as well as afford students to view their work from home through the Internet. Thus, the general perception among the users of IWBT is that IWBT is suitable for all levels of schooling especially for primary schooling (Bidaki & Mobasheri, 2013).

Warwick et al. (2013) focused on the use of IWB as a cultural tool to support teachers for whole class teaching in primary science classrooms in the United Kingdom. They investigated how a teacher sets up a task on IWBs to facilitate the children‟s joint activities and how the use of discussion with children can train them for collaborative work at IWB. They also explored how children use exploratory talk to co-regulate their collective work and finally look for the links between all these aspects. Their findings showed that the IWB is a useful tool to scaffold a collective learning process.

In another similar research, the researchers Alvarez et al. (2013) from Sweden found that IWBT can support science teachers‟ role as mediators and facilitators in order to provide the students with constructivist problem solving activities. They used individual and collaborative work phases called Collboard that prompts active student participation and engagement, where students need to have their group discussion at the IWB. One of the research objectives was to ascertain the value of integrating digital pens and IWB in problem solving activities in the science classroom and their findings revealed that Collboard can be well integrated in the classroom and IWBT successfully provided the collaborative knowledge construction space. In Malaysia, Singh and Mohamed (2012) found that appropriate use of the IWBT increases the science classroom interactions whereas students are motivated to engage with the activities at the IWB as they felt the process of learning was easier and more interesting. They gauged the students" perspectives under four categories: Learning, Interaction, Motivation and Environment.

Murcia (2014) stated that the teacher is the critical agent in facilitating science learning in the classrooms by mediating effective use of the IWBT tools and substantive whole class discussion of science phenomena. Teachers can use IWBT to present different modes and represent scientific reasoning and findings to engage students in learning such as provide presentation of a short multimedia recording, snapshots of classroom action, whole class exploration talk based on the diagram presented and etc. (Beauchamp & Kennewell, 2013; Murcia, 2010, 2014).

There are five principles of practice which emerged from Murcia's (2014) ethnographic case study within the IWBT context and more specifically in exploring how do teachers intentionally use the IWBT in creating a social constructivist primary science classroom. The five principles were considered central to the intentional social constructivist design of IWBT which supported science learning and teaching experiences: 1) Engage and elicit students" prior knowledge through visually and conceptually appealing multimodal interactive displays; 2) Generate exploration and explanation opportunities that are rich in dialogic discourse about multimodal representations and re-representations of concepts; 3) Provide opportunities through higher-order questioning for students to transfer their learning to new or different contexts; 4) Create opportunities for students to generate their own representations and re-representations of concepts, and 5) Review learning by moving flexibly through an interactive learning sequence. Her findings also stated that the use of IWBT in intentional teaching can promote higher level thinking and conceptual engagement among students in which these IWBT environments encourage students‟ actively explored science concepts in multimodal formats.

On the other hand, the numbers of the pupils in every classroom varies and may affect the teachers‟ use of the IWBT. For instance, the number of the pupils may affect the group work dynamics using the IWBT as the science teachers use the IWBT for collective learning or collaborative learning in the classrooms (Alvarez et al., 2013; Warwick et al., 2013, 2010).

Warwick et al. (2010) concluded that the vicarious presence of teachers with the use at IWB is apparent with pupils‟ learning behavior. As such, teacher support, the technology and the learning tasks are merged to create a meaningful group talk and attainment of understanding during science lessons among primary school pupils. Their research further suggests the importance of teachers‟ skillful manipulation of the various uses of IWB to scaffold the environment that can lead to pupils‟ engagement, and success in the tasks they undertook to promote learning. Therefore, science teachers play a central role in leading productive collaborative work for pupils in groups and also a key role in the success of collaborative work at the IWB.

In an analyses of the effectiveness of the IWBT in teaching, Al-Qirim (2011) found that there were a lot of advantages using the IWBT in the classroom. The research showed that the IWB"s touchable and interactive features assisted teachers to deliver science content easily to students and further optimize the teacher"s time and resources. The large IWB display area and the ability to execute different applications at the same time also helped students to focus more on the teacher"s explanations and to participate in different discussions. The IWBT presents a new technological innovation with multifaceted and overwhelming features and options and thus challenge existing cognitive needs, teaching norms and practices of both teachers as deliverers and/ or facilitators and students as recipients and/ or involved in the learning process.

In Romania, Paragina, Paragina and Jipa (2010) conducted an opinion survey to identify the strengths and the weakness of the IWBT in teaching and learning. Their research elucidated that IWBT provides a quick glance of the topic, is attractive, provides more opportunities for students to write on the board and increase the students" involvement in the learning process. In contrast, the weaknesses of the IWBT included the problem of calibration, cost, time necessary for training to use the board and issues related to writing on the board.

However, there is increased emphasis nowadays on the role of a teacher, including science teachers to generate effective learning outcomes for students whereas teachers become facilitators rather than an instructor transmitting a set of knowledge (Levine & Marcus, 2010). According to Isotani et al. (2013), effective and pedagogically sound design of lessons by teachers can improve students" performance particularly the less knowledgeable ones in their overall performance throughout the school year. Thus, the teaching style is one of the important elements of successful teaching and learning in the classrooms. Students nowadays are from a technologically connected society and the teachers or instructor should always be aware about their students" experiences inside and outside the classrooms, particularly their way of accessing and manipulating the information. Thus, teachers" or instructors" pedagogy must evolve to meet the demand of teaching and learning environment in such a digital world.

Science Process Skills

In this present study, the researcher only considered the basic science process skills which consist of observing, classifying, measuring, using numbers, using space and time relationship, inferring, predicting, and communicating due to the sampling was only a primary school teachers and pupils (Kruea-In, Kruea-In, & Fakcharoenphol, 2015).

Kruea-In et al. (2015) developed an instrument called Understanding of Science Process Skill Test (USPST) corresponding to a Thai context to investigate Thai in-service and pre-service science teachers" understanding of science process skills. Their investigation revealed that there were no significant differences between in-service and pre-service science teachers" understanding of science process skills. They achieved good and excellent level in seven skills of USPST which were classifying, measuring, using numbers, communicating, predicting and interpreting. In contrast, their achievement was quite low in inferring skills because of the confusion about observation and inferring skills. In view of this, they suggested hands-on activities as guidelines to improve science teachers" understanding of science process skills. It was put forward that this objective can be achieved if the pedagogical content knowledge courses in the pre-service teachers" institutions would focus in both content and science process skills. On the other hand, hands-on activities can also promote authentic learning in science classrooms, as discussed in the section of Authentic learning environment below (p. 30).

Cigrik and Ozkan (2015) conducted fifty hands-on activities during their study to investigate the effect of visiting the Bursa Science and Technology Center on 6 grade students‟ scientific process skills. They found that schools could hardly help pupils acquire scientific process skills due to a lack of a highly interactive environment in the schools compared to science centres, which provided pupils with high level of meaningful relationship and development of science process skills during visits to the centres. Their findings are paralleled with Kruea-In et al.'s (2015) suggestions which elucidated that hands-on activities in classrooms can promote positively to the development of science process skills.

In Malaysia, Rahmani and Abbas (2014) investigated the influence of single-gender peer scaffolding in problem-based gaming on performance in double-loop learning and sub-dimensions of science process skills. They elucidated that girls were not suitable for single-gender peer scaffolding strategies but was partially effective for boys for enhancing science process skills. They suggested further studies should investigate the roles of motivation and experience in engaging in games for instructional purposes among genders.

Furthermore, Jeenthong, Ruenwongsa, and Sriwattanarothai (2014) agreed that learning science is to master the science process skills and to apply them in scientific investigation and not merely depending on memorizing the science content. They promoted integrated science process skills through betta-live science laboratory data and the results showed that students experiencing an intervention gained both a better understanding and experimental skills than the tradition. This was due to the students in the experimental group having hands-on activities of experiments in the science laboratories, whereas the control groups wrote their experimental reports based on the articles but did not have opportunities to have hands-on activities.

IWBT allows users to do hands-on activities on the IWBs. Past research in the United Kingdom investigated the use of IWB for group work among pupils in primary schools with the facilitation of science teachers. Pupils worked in groups at the IWB following their science teacher‟s instructions and guidance. The interesting findings from Warwick et.al (2010) is that the teachers spent less time with the groups at the IWB than they did with other working groups which were working without the IWBT. This was because, the science teacher had repurposed the IWBT technological tools that are not designed specifically to support collaboration to enhance the teaching and learning in the classrooms. Thus, the groups working with the IWBT were found to be more independent and the teacher could spend more time working with the groups without IWBT.

Authentic Learning Environment

With the help of the Internet and a variety of communication, visualization, and simulation technologies, students can reconstruct the past, observe phenomena using remote tools, and make valuable connections with people around the world. In an article entitled "Authentic Learning for the 21st Century", Lombardi, 2007 gave a few examples of how technology support today‟s authentic learning environment.

a) High-speed Internet connectivity for provision of multimedia information.
b) Communication and social networking tools for the support of teamwork, including collaborative online investigation, resource sharing, and knowledge construction.

c) Intelligent tutoring systems, virtual laboratories, and feedback mechanisms that capture rich information about student performance and help students transfer their learning to new situations.

d) Mobile devices for accessing and inputting data during field-based investigations (p. 7).

Instructors can engage students in learning using engaging activities supported by the proper scaffolding to develop expertise across all four domains of learning such as cognitive capacity to think, solve problems and create; affective capacity to value, appreciate and care; psychomotor capacity to move, perceive, and apply physical skills; conative capacity to act, decide and commit. Lombardi (2007) agreed that the emergence of a new set of technological tools, we can offer students a more authentic learning experience based on experimentation and action.

In dealing with the IWB, teachers can control the degree of freedom for pupils" action within the task at the IWB by either choosing to lock down or free objects to be moved. The findings from Warwick et.al (2010) showed that pupils seemed to re-negotiate the task parameters. As such, it led to more discussion surrounding the topics and some interesting reasoning from the groups, articulated both in speech and through pointing and object manipulation. Pupils in all the case study classrooms demonstrate an active participation in their science learning as they would move objects, step back and consider their placement, reason and debate, and move objects to show alternatives. Another interesting finding was that the teachers spent less time with the groups at the IWB than they did with other working groups. Thus, IWBT can support authentic learning as pupils have autonomy in their learning at IWB.

On the other hand, Warwick, Mercer and Kershner (2013) focused on how teachers may guide the children‟s collective leaning at the IWB through the scaffolding of collaborative activities and they revealed that learners can scaffold one another‟s learning related to the cognitive content of group dialogue and also metacognitive elements which included the procedural aspects of the group talk itself which may be stressed by their teacher in the beginning of the activity. Thus, teacher‟s facilitation in the group activity can produce authentic learning environment and productive collaborative situations to scaffold the learning in the classrooms.

As such, teacher support, the IWBT and the learning tasks can be merged to create a meaningful collaboration and attainment of science lessons among primary school pupils. Warwick et.al (2010) further suggested that the importance of teachers‟ skillful manipulation of the various uses of IWBT to scaffold the learning environment can lead to pupils‟ engagement with, and success in, the tasks they undertook to promote learning. Based on the literature reviews, authentic learning environments can be created with the proper use of IWBT with the presence of teachers who lead productive collaborative group work, scaffold learning and provide pupils with autonomy in their learning.

An Instructional Guide for More Effective Use of the IWBT in the Science Classroom

The IWBT is increasingly used in school classrooms but teachers have been found reluctant in utilising all of the available IWBT features stems. None of the past studies showed any kind of instructional guide for a more effectively use of IWBT in science teaching and learning.

In 2012, Kopcha concluded that providing a variety of professional development sessions over a period of time is a first crucial step in helping teachers make lasting changes and fully integrate technology in their instructional practices. The long term programme for professional development could be the key to support teachers with the knowledge and skills needed for technology based instructional practices. His statement is in line with the suggestion stated by Beauchamp and Kennewell (2013) which concerns about teachers‟ professional learning to build technical skills for integrating the IWBT in daily teaching and learning. As such, the instructional guide for more effectively use of the IWBT of this study can be used as the main sources to support science teachers‟ technical skills for integrating the IWBT in science classrooms. The following sections will discuss detail on science process skills, pupils‟ engagement in technological enhanced learning environment and authentic learning environment.

In this present study, an instructional guide has been prepared to overcome the reluctance of integrating the IWBT in science classrooms after consolidating the data collected from classroom observations and interviews. The researcher adopted the activities from classroom observations and created the guide that includes classroom activities, IWBT features guidelines, science process skills and duration of time in order to engage pupils physically, cognitively and affectively in an authentic learning environment.

Technological, Pedagogical and Content Knowledge (TPACK)

The Technological Pedagogical Content Knowledge (TPACK) framework has become a popular construct for examining the various types of teacher knowledge needed to achieve technology integration in the education community

(Cavanagh & Koehler, 2013; Rosenberg & Koehler, 2015; Wentworth, Graham, & Monroe, 2009). In 2013, Brantley-dias and Ertmer founded a new way to explain the teacher cognition needed for effective technology integration by providing a critical review of the TPACK construct and address the development, verification, usefulness, application, and appropriateness of TPACK. They found that the TPACK already has been redefined and conceptualized in multiple ways after it was formally introduced more than ten years ago. It will be the best instrument for measuring the TPACK if it could be able to capture how teachers actually use technology for instruction for specific content to particular students and also how that technology enables student learning of that same content.

Rosenberg and Koehler (2015) presented their reviews on context and technological pedagogical content knowledge (TPACK) to stress the importance of the context in educational research as they found that the specific meaning of context was unclear in the TPACK framework. Their research investigated the objectives were seeking among in journal articles that make use of the TPACK framework to find out whether context had been included when authors describe, explain, or operationalize TPACK; For the journal articles in which context was included, the aspects, as understood through a conceptual framework of context advanced by Porras-Hernandez and Salinas-Amescua (2013) with three levels (micro, meso, and macro) and two actors (teacher and student), as represented in Figure 2.1 was analysed. Micro factors are those in the classroom or learning environment, such as the design and layout of the room. Meso factors are those in the school or other settings in which the classroom or learning environment are found, such as a community centre or children‟s museum, and the availability of support staff. Macro factors are the societal conditions that affect teaching, learning, and the development of teachers and learners, such as state and national curricular standards (Rosenberg & Koehler, 2015, p. 189).

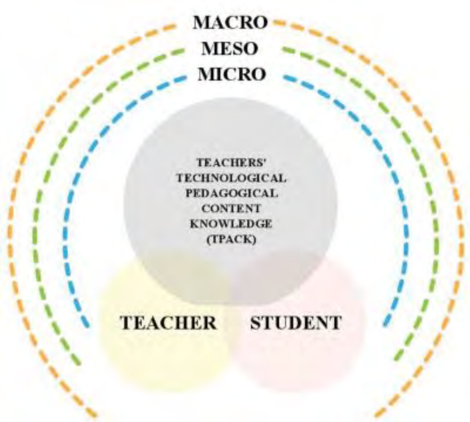


Figure 2.1. The conceptual framework for context as advanced by Porras-Hernandez & Salinas-Amescua (2013)

Rosenberg and Koehler (2015) reviewed 193 empirical journal articles and found that only 36% of the journal articles included the context whether as description, explanations or operationalization of TPACK. The factors which were included as the context were classrooms and school factors which are related to teachers followed by other factors related to students and society. Their findings stated that as the context was presented in a systematic and comprehensive way, it can facilitate the better understanding of the context around the teachers‟ TPACK.

Phillips (2016) provided an analysis to reveal how multiple perspectives of an individual‟s TPACK can lead to a more detailed understanding of their TPACK strengths and weaknesses that are enacted in different contexts. He offered two reminders as the summary of his findings. First, TPACK may be judged from a communal perspective as well as from an individual‟s perspective. Second, this understanding of the in-service teacher‟s practices and identity draws on his or her past participation and future aspirations, suggesting that TPACK is both knowledge used to support current practices and also knowledge in the making. Thus, it showed how TPACK development is an ongoing process that happens in the educational workplace rather than as an acquired end point of the instructional classrooms.

Furthermore, Phillips (2016) suggested the context shaping TPACK enactment should be considered as more than a physical location whereas the TPACK enactment may be better represented by adding the words „processes of identity development and practice‟ to the notion of „contexts‟ as factors influencing teachers‟ TPACK enactment in the classroom setting. The process of identity development is imagination, engagement, alignment and trajectory; the process of practice is mutual engagement, shared repertoire, joint enterprise and reification. The addition of practices and processes of identity formation to the commonly used TPACK diagram is illustrated in Figure 2.2.

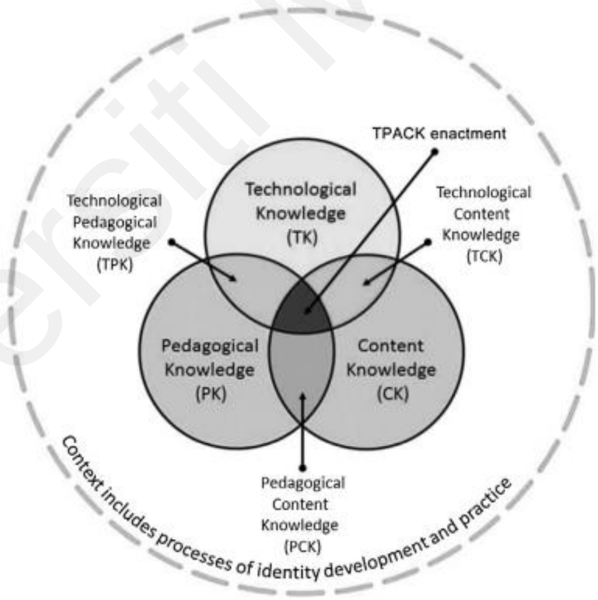


Figure 2.2. An elaborated representation of TPACK enactment in a community of practive (CoP) (Source: Phillips, 2016)

The research done by Phillips (2016) also provided some implications for the TPACK framework. First, context can be thought of as a series of processes grouped around practice and identity and these help to explain how TPACK development and enactment occurs in a workplace. Second, changes in TPACK can be considered as changes that occur in context, that is, TPACK may not change within an individual but the context in which it is situated may shape the way it is enacted among individuals. Third, one of the larger cases reveals that TPACK can be thought of as an aspect of trajectory that connects an individual‟s past participation in a community of practice with his or her current competence and anticipated future competence (p. 14).

In order to support researchers map out measurement principles and techniques that ensure reliable and valid measurement in TPACK research, Cavanagh and Koehler (2013) proposed seven-criterion lens for effective technology integration. They discussed about how to stimulate discussion about the validity of TPACK measures and measurement and also the use of contemporary validity theory as a framework to examine the principles and practices applied when dealing with validity issues in TPACK measurement. The found that the content and substantive aspects of validity evidence are challenging and researcher should be aware of these criteria when dealing with the TPACK research.

In 2012, Jang and Tsai exploring the TPACK of Taiwanese elementary mathematics and science teachers with respect to use of IWBs found that the TPACK scores of teachers who use IWBTs were significantly higher than those who did not use IWBTs. They also discovered that experienced teachers use more technology in the classroom compared with novice teachers. This phenomenon may be due to the fact that experienced teachers may have more opportunities and experiences teaching different content and applying numerous types of teaching strategies.

Jang and Tsai (2012) further explored the TPACK of Taiwanese secondary school science teachers using a new contextualized TPACK model by administrating a TPACK questionnaire. They stated that teaching experience and gender are the factors that influence the use of the IWBTs. Their findings showed that male science teachers valued their technology knowledge significantly higher than female teachers; experienced science teachers rated their content knowledge and pedagogical content knowledge in context significantly higher than the novice science teachers. Conversely, novice science teachers tended to rate their technology knowledge and technological content knowledge in context significantly higher than the experienced science teachers.

On the other hand, Wentworth, Graham, and Monroe (2009) investigated how technology should be appropriately used in active learning using TPACK as the framework during teacher development in teacher education program. They divided the teacher development in teacher education program into three stages and described each stage before investigating how the program has worked to improve technology understanding of among the candidates at Brigham Young University (BYU) in United State. They established a set of Principles of Effective Technology Integration (see Table 2.1) to evaluate each experience of the candidates creates technology that enhanced lesson plans using a rubric. These principles integrated ideas from the many cited works prior to the emergence of the TPACK framework which are showed a simpler, easy remember criteria that students could use the effectiveness of the technology integration they planned. The following questions were used to guide the evaluation of the technology experiences in each stage of the candidates‟ TPACK development:

i. Are teacher candidates translating the knowledge of technology integration (TPACK) experienced in the introductory course and TPACK Development in a Teacher Education Program methods courses into teaching practice as represented in the capstone assignment of Teacher Work Sample (TWS) in their final field experience?

ii. What factors have the greatest impact on student integration of technology into their TWS (modeling in methods classes, perception of technology availability, common criteria across experiences, linking technology to the inquiry process, etc.)?

iii. What are the barriers to improved transfer of TPACK to practice during pre-service teachers" field experiences? (p.826)

Table 2.1
BYU teacher work sample technology requirement instruction and rubric (Source: Wentworth et al., 2009)

Instructions				
Describe how you will improve student learning through student use of technology tools (word processing, spreadsheets, presentation software, Internet, simulations, science probes, etc). ***The technology should be used by the students*** in higher level thinking activities that would be difficult or impossible without technology. Student use of technology is not required in every lesson, but when it is used, thoughtfully plan for and describe its use. (You may include a description and rationale for using technology that is not available to you in your school setting.)				
Rubric				
	5 Exceeds Expectation	4-3 Meets Expectation	2-1 Partially Meets Expectation	0 Not Met / Missing Evidence
c. Technology	Student use of technology is integrated throughout the entire unit to promote higher level thinking activities.	Students use technology in learning activities that would be difficult without technology **OR** a strong rationale for not using technology is given.	Technology is used only in the production or presentation of learning activities **OR** a limited rationale for not using technology is given.	Technology is inappropriately used **OR** not used. Rationale for not using technology is weak.

Furthermore, Wentworth et al. (2009) found that during the technology integration course, the candidates effectively integrated technology into the technology-rich lessons with the students in completing the tasks. The success criteria used to evaluate the lessons and were focused on how the students learn and the use of technology to engage in active learning. Some candidates showed weak pedagogy as they integrated more than one technology that consumed too much time of the students to accomplish the task and this technology was not essential to the learning. As such, the technological and pedagogical skills and knowledge among the instructors or teachers in the classrooms are very important to ensure the content knowledge is well delivered to the students (Warwick et al., 2013; Wentworth et al., 2009).

In the present study, the TPACK was used as the foundational theoretical model. From the seven components of the model, namely, TK, CK, PK, PCK, TPK, TCK and TPACK, specific interaction components were projected between the teacher, pupils and the IWBT. These were TechTP, TechT, TechP, Tech, TP, T and P. These will be discussed further in Chapter 3.

Methodology of Previous Research

Different methodologies have been used in previous studies to explore the integration of the IWBT. The research design of these previous studies was reviewed and was used to justify the research design of the present study. Punch, 2014 defines qualitative research simply "… as empirical research where the data are not in the form of numbers" (p.3). It is common when using a qualitative approach that multiple methods are used to answer the questions or to identify the problem (Creswell, 2014). The diversity of qualitative research is higher than in quantitative approaches and therefore the possibility of combining methods is more complex (Punch, 2014). No matter what approach is used research can be seen as a tool for improving quality of education (Rolfe & Naughton, 2010).

The case study design has often been employed in previous studies to explore teacher and student use of IWBT (e.g. Murcia, 2014; Warwick et al., 2013, 2010). A case study is an appropriate method of exploring a complex problem in a bounded system. Based on Merriam's (2009) ideas, a research problem can be complex either because a problem can be understood in different ways, or because it can be solved by multiple solutions. Murcia (2014) used video capture and microanalysis techniques in her exploratory case study research to explore and documented teacher and student use of IWBT in two Western Australian primary science classrooms. Two science teachers were working with 25 year six (11 years old) students over a six-month period in a context of an independent boy‟s school in the Perth metropolitan area of Western Australia. These teachers had to critically reflect on their practice and the impact it had on their students‟ engagement with learning. The two teachers also had regular meetings at two to three-week intervals over a period of six months to establish common understanding and research protocol. Overall, the data gathered for this case study included semi-structured interviews, video-captured lessons, classroom observations field notes, student work samples and interactive notebooks produced by the teachers.

Warwick et al., (2013, 2010) applied a multiple case study approach to explore the collaborative group work for science lesson in the primary classrooms. Warwick et.al (2010) investigated the vicarious presence of the teacher in pupils‟ learning of science in collaborative group activity at the IWB. The sampling consisted twelve science teachers from three different schools in UK. Each of the teachers devised three science lessons based on their on-going schemes of work and the data were collected from total of thirty-six lessons. Data gathered from observational data included digital video-recordings and observational notes of the lessons in each classroom.

In another study, Al-Qirim (2010) conducted a case study to evaluate the effectiveness of the Interactive White Board Technology (IWBT) in teaching in Faculty of Information Technology (FIT) in UAE University. He adopts Yin‟s

(1994) case study design to answer how and what type of questions and using interviews to collect the data. The strength of a case study is its ability to capture a greater number of variables than is possible. This approach allows for qualitative interpretation and explanations from participant.

Meanwhile, Alvarez et al. (2013) used a mixed methods methodology to foster new media literacies in the classroom through collaborative problem solving supported by digital pens and IWBs. They used observations, pre- and post-tests, survey and interviews to collect the data. Observations were found appropriate in assessing the teachers" abilities to serve as mediators and facilitators of the learning process; Pre- and post-tests were used to seek for Collboard"s potential in improving academic performance and the grading process was done by two independent analysts for the first round of grading and afterwards only met for a consensus of the final grade for each test; Students were asked to undergo a paper-based survey to gauge their perception of Collboard and capture their thoughts and feelings about the participating in the Collboard activities.

In an exploratory mixed methods study, Kim, Kim, Lee, Spector, and DeMeester (2013) investigated how teacher beliefs were related to technology integration practices. The participants in this study were twenty-two teachers who have participated in a four-year professional development project funded by the U.S. Department of Education. Data collection were administered using questionnaire and survey to figure out the teacher beliefs about the nature of knowledge and learning (epistemology) and the effective ways of teaching (conceptions of teaching). The technology integration was investigated using classroom observations and teacher interviews. Pearson correlation coefficients were used to examine the relationships among the three variables.

However, there are a few limitations in the study done by Kim et al., (2013). First, the number of participants was small which limits the generalizability of the results of this study. Second, the chance of Type I error increased due the correlations computed. The differences of individual teachers were not examined in the technology integration practices. Forth, some researchers argue that teachers may not integrate technology in effective, efficient and engaging ways as they have different beliefs. Last, teacher beliefs should not be examined once because we only can gain better understanding with the changes in belief over time. Kim et al (2013) suggested future research ought to consider not only multi-time measurements but also the use of a multi-method approach including the examination of lesson planning materials, the reflection process, focus-group discussions, and so on to investigate teacher beliefs both quantitatively and qualitatively.

A survey research was done to gauge the reasons for using or not using IWBT from perspectives of Taiwanese elementary mathematics and science teachers (Jang & Tsai, 2012). The survey questionnaire using a 3-point rating scale from 1 (Disagree) to 3 (Agree) was sent to elementary school randomly selected across Taiwan. The questionnaire consisted of six closed-ended questions for teachers who were using the IWBT and one open-ended question for these teachers to provide other reasons. The questionnaire for teachers not using the IWBT consisted of five closed-ended questions. The data analyses involved participation of 650 mathematics and science teachers and the data were presented using independent samples t-test for the groups using IWBT and not using IWBT by teaching subjects and teacher gender, and ANOVA was performed for both groups according to teaching experience.

In another study, Hsieh (2011) also used survey research to investigate the pre-service teachers" attitudes towards teaching with IWBT, their teaching behaviours and pedagogical mistakes when using technologies in the classroom. The participants in this study were 44 senior students majoring in mathematics education or in science application and dissemination. Data were collected during March and early April, 2010 via a self-constructed survey. The instrument included two parts. The first part was a survey with twelve Likert-scale items that allow the participants to select their level of agreements based on their feelings and opinions (1 means strongly disagree and 5 means strongly agree) for each statement. The second part included three open-ended questions, asking for the advantages, disadvantages and suggestions regarding using IWBT with e-textbooks in the classroom.

Jang and Tsai (2012) used a quantitative methodology to examine Taiwanese elementary mathematics and science teachers" TPACK with respect to current use of IWBT. Questionnaire was developed to examine elementary teachers" use of IWBT and the TPACK of the teachers in two groups (i.e., use IWBT group versus not use IWBT group) and according to teaching subjects, gender and teaching experiences. The first part of questionnaire contained basic questions to gather participants" background information and one open-ended question was included in to gather more information about their use of other technologies. The second part of the questionnaire was developed to examine teachers" TPACK. The questionnaire was sent to elementary school across Taiwan. The total of 818 elementary teachers from 49 elementary schools responded to the questionnaire but only 614 teachers were finally selected due to the some of the questionnaires being incomplete and some of the questionnaires were answered by non-science and non-mathematics teachers.

To analyse the data, Jang and Tsai (2012) used an Independent Samples t-Test to compare two means and one-way ANOVA to compare more than two means according to the groups of variables. The Independent Samples t-Test was used to explore the significant differences of elementary mathematics and science teachers‟ TPACK in the two groups. Teachers‟ differences in teaching subjects and gender were examined with the t-test as well. ANOVA was performed to determine the differences between teachers‟ TPACK according to teaching experiences. Data from the one open-ended question was provided to understand what other technologies elementary teachers used in teaching mathematics and science.

In another eight-month case study done by Phillips (2016) to re-contextualise TPACK and exploring teachers‟ use of digital technology by examining the influence of teachers‟ socially mediated workplace settings on TPACK enactment. The study involved ten teachers in an Australian secondary school. Four cases are investigated in this study and the data generated from ethnographic observations and semi-structured interviews with the participants as well as from colleagues who had been invited by the teachers to participate in the study as their key professional learning colleagues. The importance of the theoretical connection between identity, practice and knowledge enactment (behavior) from a situated learning framework was highlighted by a core participant in this study and her TPACK perceptions were compared with the perceptions of her TPACK expressed by her colleagues.

A case study was investigated by Nordin, Davis, and Ariffin (2013) to find out pre-service teachers‟ technological, pedagogical and content knowledge mastery level. They used a mixed methods design which combined both quantitative and qualitative approaches for data collection and data analysis. The TPACK survey instruments with a five-point Likert-type scale were administered before and after their field experience to 107 pre-service teachers in New Zealand. Three student teachers were interviewed before starting field experience and after completing the field experience in different secondary schools. The pre- and post- survey scores were analyzed using a paired-samples t-test via SPSS. For qualitative data, they were employed case study analysis proposed by Yin (2009) to examine pre-service teachers pre-service teaches‟ development of TPACK level.

Data Collection Techniques

Creswell (2013) views the qualitative data collection as a series of activities that are interrelated which showed in Figure 2.3. He stated that the beginning of qualitative research was to find people or places to study and gaining access and making rapport is very important. In qualitative research, the typical approach to sampling is purposive, with the intention to generate insight and in-depth understanding on relatively small samples rather than empirical generalizations (Patton, 2002, p.230). The sampling design for qualitative study is different with the quantitative design in two ways. Firstly, there is no sample size in mind, instead the researcher collects data until the saturation point is reached which is the stage that no new information is emerging (Kumar, 2014). According to Strauss and Corbin (1998), at the stage of saturation, the sampling is stopped. They further suggested that there are no new relevant data emerging around the category and the relationships between the categories are created and validated (p.212). Secondly, the sampling design is guided by the researcher‟s judgements as who is likely to provide the „best‟ information (Kumar, 2014; Patton, 2002). The basic ideas behind the sampling strategies in qualitative research reflect the purposes and questions guiding the study (Punch, 2014).

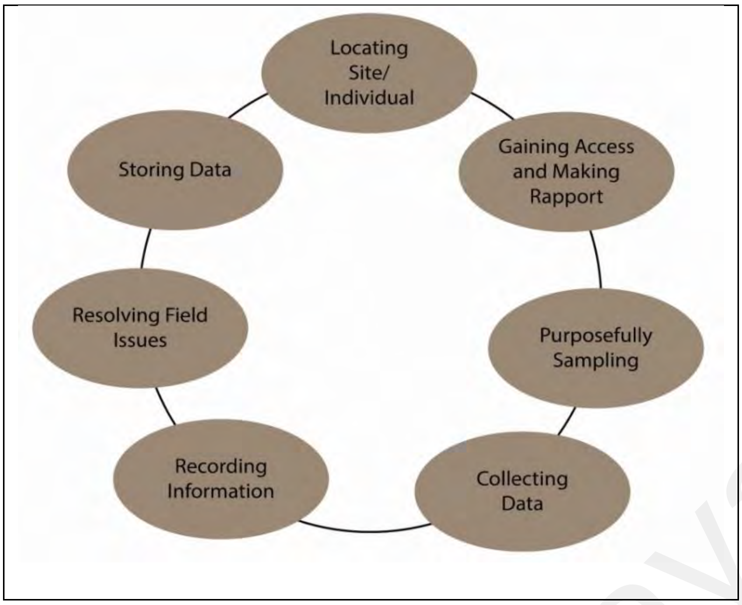


Figure 2.3. Data collection activities (Source: Creswell, 2013)

The most common technique for qualitative data collection is interviews (Merriam, 2009). In comparing standardized and qualitative interview, Braun and Clarke (2013) found that there are a few criteria that researcher need to understand in order to conduct successful qualitative interviews. Firstly, participants have particular own personal style and thus questions asked vary according to their responses. Secondly, good interviewers need to ask unanticipated issues and unplanned questions spontaneously even though an interview guide is ready in advance. In other words, the ideal of qualitative interview is flexible and responsive to the participants. Thirdly, open-ended questions are important to encourage participants to provide in-depth information. Fourthly, capturing the range and diversity of participants‟ responses in their own words is the goal of a qualitative interview. Lastly, it is impossible to minimize the interviewer‟s role as the interviewer who plays an active role in the interview, co-constructing meaning with the participants (p.79).

Another technique that is frequently uses in qualitative data collection was observations which can be produced in a particular context, by participants who come from, and are located within, that specific context. The process of observation begins with selecting a setting and gaining access to it, then starting with observation and recording (Punch, 1998). Researchers should refer to the research questions in order to decide what will be observed and, why (Creswell, 2013; Punch, 2014). The nature of the observation changes as the study progresses leading to ever clearer research questions which require more selected observations (Punch, 2014). The length of time of the observational data gathering depends on the purpose of the study and the questions being asked (Patton, 2002).

As such, there are five advantages of direct observations (Creswell, 2014). Firstly, the inquirer can get a holistic understanding the context through direct observation to capture the people in the setting; Secondly, the firsthand experience of being on-site allow the inquirer to be open, discovery oriented and inductive; Thirdly, the inquirer has the opportunity to observe the things that may routinely escape awareness among the people in the setting. Fourthly, the observer may have a chance to learn things that people would be unwilling to talk about in an interview; lastly, the firsthand experience allows the inquirer to draw on personal knowledge during the formal interpretation stage of analysis.

The data collection procedures will influence the quality of the data collected. The researcher given the response rates due to the importance in the data collection planning stage and administrate proper procedures to maximize the quality of the data. There are four sense common things suggested by Punch (2014) to ensure the quality of the data:

i. Think through the rationale and logistics of the proposed data collection, and plan carefully for data collection.
ii. Anticipate and simulate the data collection procedures; this will show the value of pilot testing any instruments (if appropriate) and the procedures for using them.
iii. When approaching people for data collection, ensure that the approach is both ethical and professional.
iv. Appreciate the role of training in preparing for data collection, both for ourselves and others. (p.160)

Based on the above review of previous methodology, the research of the present study conducted a case study to examine the integration of IWBT in an atypical Chinese primary school. Data were collected through the multiple sources of information, such as observations, interviews and documents.

Chapter Summary

This chapter began with an ICT-supported learning context for teaching and learning and followed by the review of the use of the IWBT in science teaching and learning and TPACK model or framework. Previous guidelines prepared by researchers were also discussed as well as science process skills, pupils‟ engagement in teaching and learning and authentic learning environment for more effective use of IWBT in science classrooms to overcome the reluctance of integration of IWBT for science teaching and learning. The methodology of previous research and the data collection techniques were also reviewed. The next chapter will discuss the conceptual and theoretical framework of this study.

Chapter 3: Conceptualisation of the study

Introduction

The focus of the present study is the integration of the IWBT in science classrooms. The case study explored teachers‟ integration of the IWBT in science teaching and learning and identified the factors that may lead to the reluctance in the integration of the IWBT for science teaching and learning. Based on the study findings, modules were put forward for more effective integration of IWBT to overcome the reluctance of integration of IWBT for science teaching and learning. In addition, based on the theoretical framework of the study, projected from the TPACK model, it was found that a rubric could be prepared grounded in data to gauge science teachers‟ TPACK components.

This chapter discusses the conceptual framework of the study to position the present study among previous studies, where the integration of the IWBT is defined using past literature. Lastly, the theoretical framework is also argued to support the integration of the IWBT in science classrooms in a selected Chinese primary school.

Conceptual framework

A conceptual framework is required to outline the relationship between the research interests of the present study and existing work of previous studies. Table 3.1 shows details of previous studies involving technology integration for educational purposes in five following categories: (1) Technology integration, (2) Perception of technology integration, (3) IWBT integration, (4) Perceptions of IWBT integration, and (5) Teachers‟ TPACK.

Table 3.2

Details of Previous Studies involving Technology Integration for Educational Purposes

Issues	Author(s)	Participants	Country	Data source(s)
Technology integration	Starkey (2010)	• secondary school • 6 young teachers Aged 23-35	New Zealand	• interviews
Technology integration	Jacobson et al. (2010)	Survey: • 1605 teachers • 51 schools • 0-20 years of service Interviews: • 8 principals, 2 vice-principals, 33 HODs, and 60 teachers • 1-23 teaching experiences • 5 primary schools & 3 secondary schools	Singapore	• survey • interviews • focus group discussion
Technology integration	Kwon et al. (2013)	• 69 students • 21 male & 48 female • 20 groups	USA	• team project • survey test consist of 10 multiple choice items
Technology integration	Lakkala & Ilomäki (2015)	• 2 more-experienced teachers • 2 less-experienced teachers	Finland	• interviews
Perceptions of IWBT integration	Hsieh (2011)	• 44 seniors students • Teaching practicum course	Taiwan	• teaching demonstration in group of 6 or 7
Perceptions of IWBT integration	Singh & Mohamed (2012)	• 12 Form Two classes • 14 years old • 3 public secondary schools	Malaysia	• interviews
Perceptions of IWBT integration	Bakadam & Asiri (2012)	• 50 teachers • A boys‟ school • Aged 30-39	Saudi Arabia	• questionnaire interviews
Perceptions of technology integration	Kopcha (2012)	• 18 elementary school teachers	USA	• survey • interviews • observations
Perceptions of technology integration	Kim et al. (2013)	• 22 teachers • rural K-8 schools	USA	• questionnaire • survey
Perceptions of IWBT integration	Bidaki & Mobasheri (2013)	• one of the council primary schools • 198 pupils • Seven classrooms	UK	• interviews • questionnaire
IWBT integration	Paragină, Paragină, & Jipa (2010)	• 54 teachers	Romania	• surveys •

Table 3.1 (ctd.)

Issues	Author(s)	Participants	Country	Data source(s)
IWBT integration	Warwick et al. (2010)	• 12 science teachers • 3 different schools • Aged 8-10	UK	• observation • documents related to the lessons
IWBT integration	Al-Qirim (2011)	• 6 teachers for pilot study • 25 teachers •	United Arab Emirates	• questionnaire • interviews
IWBT integration	Jang & Tsai (2012)	• 650 mathematics & science teachers • 52 elementary schools	Taiwan	• surveys
IWBT integration	Alvarez et al. (2013)	• 2 teachers • 12 mixed (male and female) students	Sweden	• observation • pre-and post-tests • survey • interviews
IWBT integration	Warwick et al. (2013)	• 12 teachers • Year 4 and 5 • Aged 8-10	UK	• observation • interviews • documents related to the lessons
IWBT integration	Murcia (2014)	• A boys" school • 2 teachers	Australia	• interviews • observation • documents related to the lessons
Teachers' TPACK	Jimoyiannis (2010)	• 6 science teacher • 10 to 25 years teaching experiences	Greece	• interviews
Teachers" TPACK	Nordin, Davis, & Ariffin (2013)	• 107 respondents • 62 females and 45 males (survey) • Aged 21-40 • 3 female pupils (interviews)	New Zealand & Malaysia	• survey • interviews
Teachers' TPACK	Ling Koh, Chai, & Tay (2014)	• 24 teachers • an elementary school • primary 1, 4 & 5	Singapore	• audio recordings 9 h and 50 min • Primary 1–2 h 58 min • Primary 4–2 h 3 min • Primary 5–4 h 49 min
Teachers' TPACK	Phillips (2016)	• 10 teachers • Australian secondary school	Australia	• observations • interviews
Teachers' TPACK	Jen, Yeh, Hsu, Wu, & Chen (2016)	• 52 pre-service • science teachers • 47 in-service high school science teachers	Taiwan	• questionnaire • interviews

Table 3.1 (ctd.)

Issues	Author(s)	Participants	Country	Data source(s)
Teachers" TPACK and IWBT integration	Jang (2010)	• 4 science teachers • Class size 28-32 students	Taiwan	• Written assignments • Reflective journals • interviews
Teachers" TPACK and IWBT integration	Jang & Tsai (2012)	• 334 elementary science & mathematics teachers • 5-26 years teaching experiences	Taiwan	• questionnaire

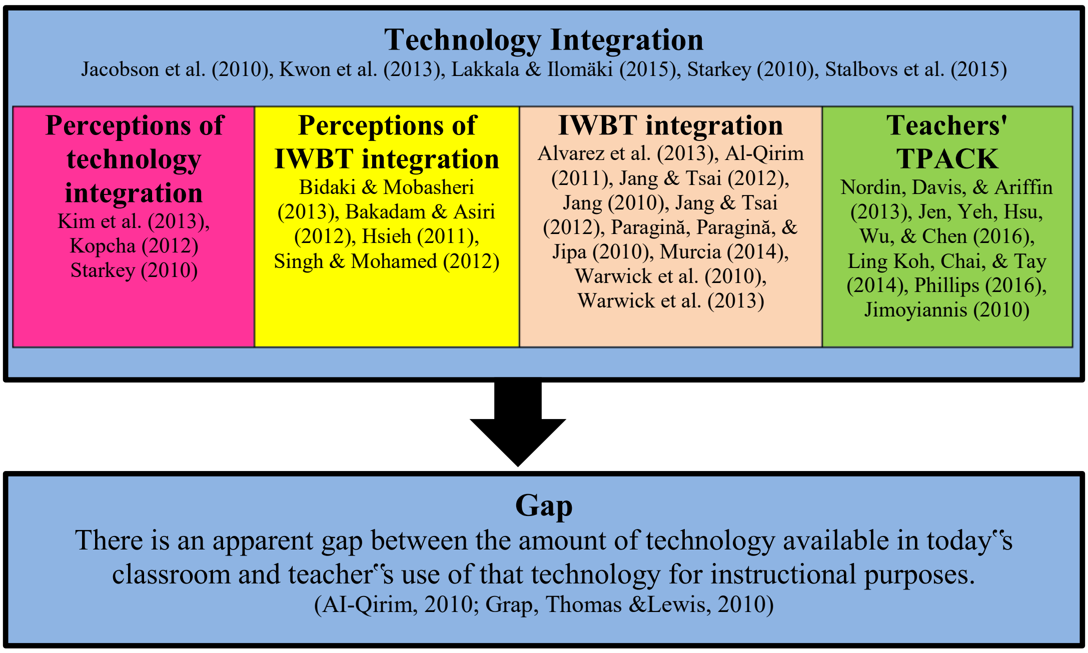
In 2010, Starkey examined the barriers and enablers that influenced the integration of digital technologies into teaching practice in New Zealand. Meanwhile, Jacobson et al. (2010) investigated the impact on pedagogical practices and technology use in Singapore schools. Furthermore, there are other researchers who have investigated technology integration for teaching and learning, such as Kwon et al. (2013) investigated the effects of a web-based group coordination tool based on the response rate to metacognitive prompts of the tool in USA. In Finland, Lakkala and Ilomaki (2015) applied a case study to develop ICT-supported pedagogy through a collegial practice transfer process and suggested that authentic examples and guidance could contribute to pupils" collaboration, knowledge construction and metacognition.

In addition, there were a number of researchers who have investigated the perceptions of technology integration and IWBT integration including Hsieh (2011) and Singh and Mohamed (2012), Bakadam and Asiri (2012), Kopcha (2012), Bidaki and Mobasheri (2013) and Kim et al. (2013). These researchers investigated the perceptions from teachers" perspective except Singh and Mohamed (2012) who studied from students" perspective. Singh and Mohamed identified the Malaysian secondary students" perspective on the use of the IWB for teaching and learning of science and suggested that both quantitative and qualitative research approaches are needed to give broader views and information of the use of IWBT and look deeper into the advantages and disadvantages of the use of IWBT. The scope of studies included the pre-service teachers‟ attitudes towards teaching with IWBT, their teaching behaviours and pedagogical mistakes when using technologies in the classroom (Hsieh, 2010); teachers‟ perceptions regarding the benefits of using the IWB (Bakadam & Asiri, 2012); teachers‟ perceptions of the barriers to technology integration and practices with technology under situated professional development (Kopcha, 2012); teachers‟ views of the effects of the IWB on teaching (Bidaki & Mobasheri, 2013); teacher beliefs and technology integration (Kim et al., 2013)

Furthermore, Warwick et al. (2010 & 2013), Parigina, Paragina and Jipa (2010), Al-Qirim (2011), Jang and Tsai (2012), Alvarez et al. (2013) and Murcia (2014) examined the IWBT integration in educational settings from different countries. Warwick et al. (2010 & 2013) and Murcia (2014) explored the teachers‟ roles in integrating IWBT for science teaching and learning. Warwick et al. (2010 & 2013) also suggested the use of the IWBT could provide pupils with collaborative science learning experiences. On the other hand, Alvarez et al. (2013) and Al-Qirim investigated the effectiveness of IWBT use for teaching and learning in classrooms. Jang and Tsai (2012) explored the TPACK of Taiwan science teachers with respect to the use of the IWBT.

The objectives of this present study were determined based on an apparent gap which appears between the amount of technology available in today‟s classrooms and teachers‟ use of that technology for instructional purposes (Al-Qirim, 2010; Bakadam & Asiri, 2012; Low, personal communication, May 17, 2015; Gray, Thomas & Lewis, 2010). Figure 3.1 shows the research gap of the present study. The research gap was identified based on previous studies carried out on technology integration including IWBT integration, perceptions of technology integration, perceptions on IWBT integration and teachers‟ TPACK for educational purposes. The research gap identified was that the factors leading to the reluctance of using IWBT has not been investigated in technological „rich‟ equipped science classrooms and how this reluctance may be overcome. This current study was a case study which tried to explore the integration of the IWBT in the science classrooms of a selected Chinese primary school and identify the factors that may lead to reluctance in integrating well equipped IWBT classrooms for science teaching and learning.

Figure 3.1 shows the conceptual framework of the present study which identifies the research gap of this present study. The identification of the gap led to the articulation of the problem and to the research objectives and research questions. The conceptual framework of the study is a vital component of this current study as it shows the reader the flow of the conceptualization of the study as to how the study was positioned against previous studies.



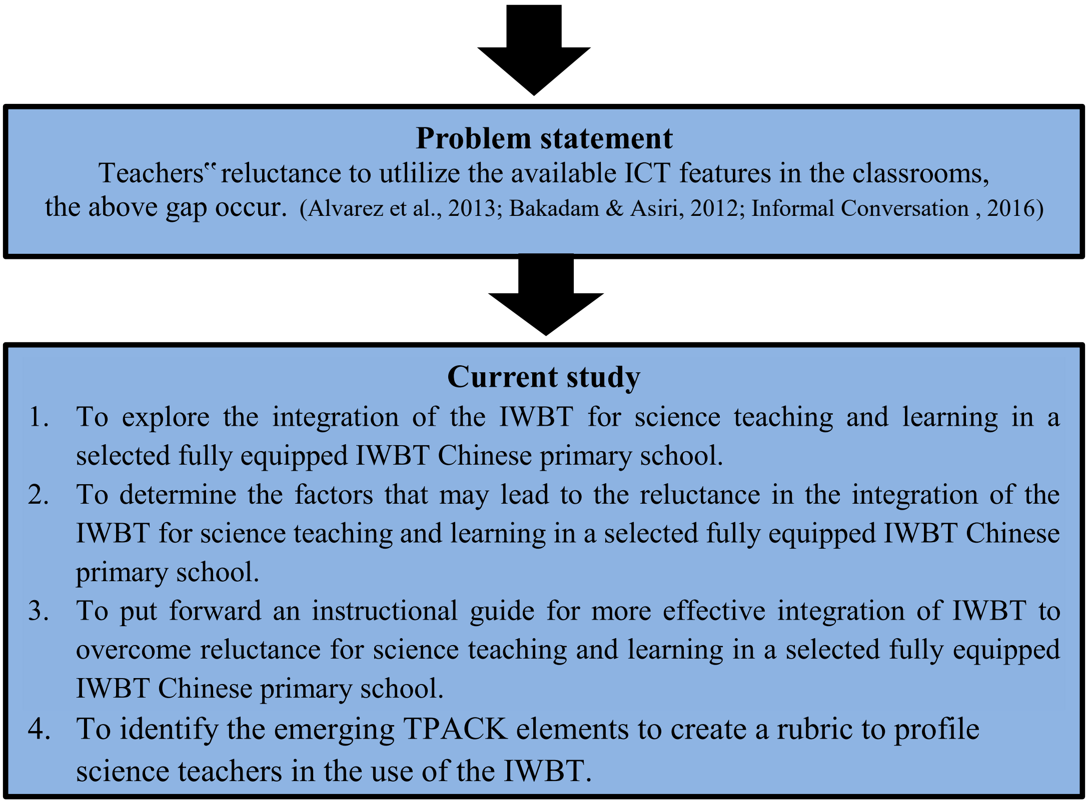


Figure 3.1. Implications of Past Studies Leading to the Research Gap and Defining of the Research Problem

Figure 3.2 shows the summary of the concepts investigated in the present study. The figure shows the reader how the main factors of the study interact and are being investigated.

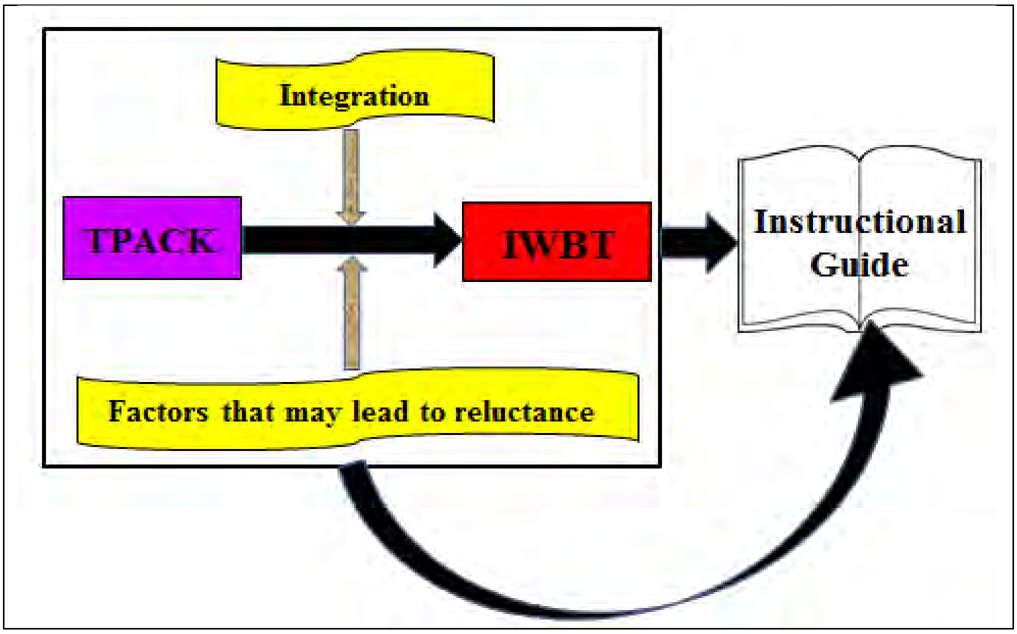


Figure 3.2. Summary of the Concepts Investigated in the Present Study

Studies that investigated the teachers‟ in pedagogical practices in the classroom using the IWBT indicate that such strategies can result in better instruction such as increase the students‟ attention, improve student skills (Bidaki & Mobasheri, 2013; Singh & Mohamed, 2012) and promote higher level thinking (Murcia, 2014) as well as provide effective content delivery to students and further optimize the teacher‟s time and resources (Al-Qirim, 2010). Other studies stressed the role of a teacher using the IWBT for lesson planning and increased pedagogical skills. It has also been shown that the IWBT was suitable for all levels of primary teaching and learning (Bidaki & Mobasheri, 2013; Murcia, 2014).

In this study, the process of integration of the IWBT among science teachers in the classroom was observed and interviews were done to explore how the integration of the IWBT was being carried out followed by identifying the factors that may lead to reluctance in integrating IWBT. This study also put forward guidelines for more effective use of the IWBT to overcome the factors of reluctance in integrating the IWBT in the science classrooms. As the study progressed and rich data emerged, a rubric was formulated to assess science teachers‟ TPACK specifically in integrating the IWBT according to the theoretical framework of this study.

Theoretical framework

In educational research, there is always a theory underpinning every study conducted. Theories are constructed in order to explain and predict a situation or phenomena. This study was guided by the framework of Technology, Pedagogical and Content Knowledge or TPACK model (refer to Figure 3.3). Technological, pedagogical and content knowledge (TPACK) have been used by hundreds of studies as a theoretical framework to explore teachers‟ technology use in classroom settings. As proposed by Koehler and Mishra (2009) for effective teaching with technology, the development of TPACK by teachers is the critical component. The theory of Pedagogical Content Knowledge (PCK) was at first introduced by Shulman (1986) and reconsidered by Mishra and Koehler (2006) to form the TPACK model. In this theory there are three main component of teachers‟ knowledge: content, pedagogy, and technology. The interactions between and among these bodies of knowledge, are represented as PCK (pedagogical content knowledge), TCK (technological content knowledge), TPK (technological pedagogical knowledge), and TPACK are equally important. All of the seven knowledge areas are considered within a particular contextual framework. In order to produce the types of flexible knowledge needed for successful technology integration into teaching, the interaction of these bodies of knowledge, both theoretically and in practice play the vital role.

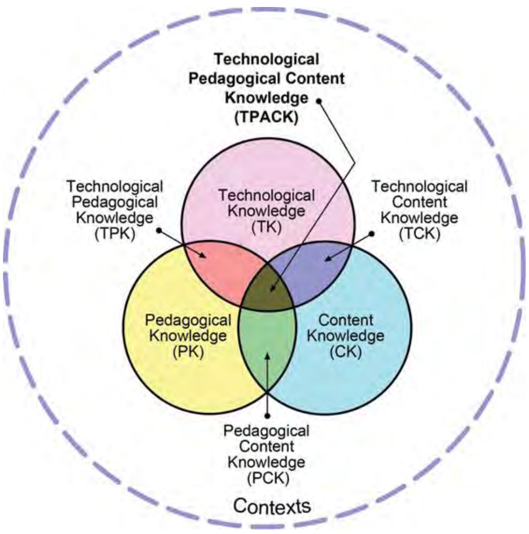
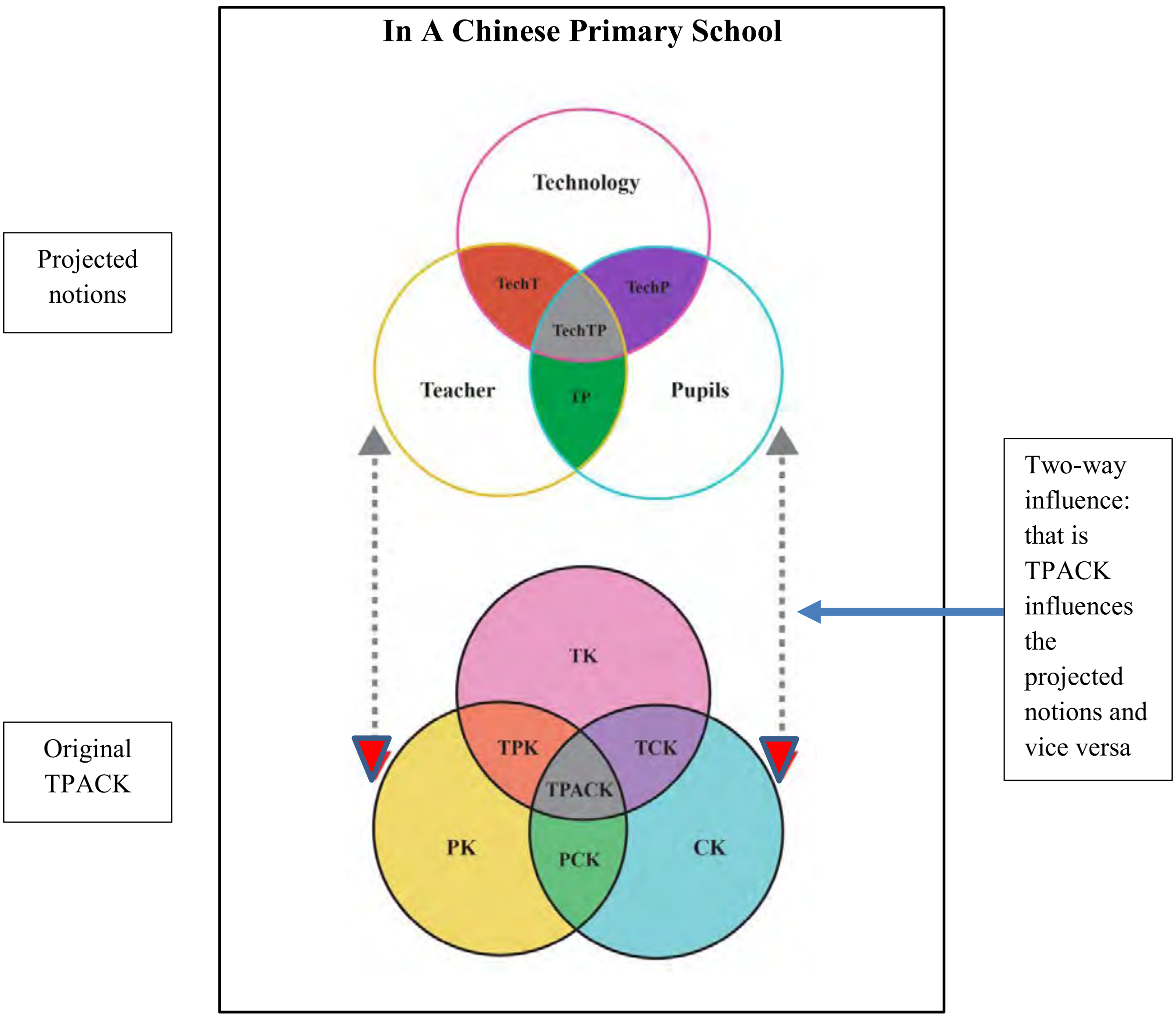


Figure 3.3.The TPACK framework from Koehler & Mishra (2009)

TPACK is a framework to understand and describe the knowledge areas needed by a teacher for effective pedagogical practice in a technology enhanced learning environment. The idea of pedagogical content knowledge (PCK) was first described by Shulman (1986) and TPACK builds on those core ideas through the inclusion of technology. Mishra and Koehler (2006) reconsidered Shulman‟s PCK framework and built TPACK framework in an attempt to understand how the increasing use of digital technologies in schools might impact on the development of teachers‟ professional knowledge.

The researcher considered the theoretical framework from Koehler & Mishra (2009) and the focus of the present study i.e. the integration of IWBT in a selected fully equipped IWBT Chinese primary school to construct the theoretical framework of this present study. The theoretical framework of the present study is illustrated in the Figure 3.4. The diagram shows the original framework from Koehler & Mishra (2009) and the projected notions of the scope of the present study.



Note.

Projection:

(a) TechTP means technology, teacher and pupils
(b) TechT means technology and teacher
(c) TechP means technology and pupils
(d) TP means teacher and pupils
(e) Technology means IWBT
(f) Teacher means Science Teacher in IWBT science classroom
(g) Pupils means pupils in IWBT science classroom

Original:

(a) TK means technological knowledge
(b) PK means pedagogical knowledge
(c) CK means content knowledge
(d) TPK means technological pedagogical knowledge
(e) TCK means technological content knowledge
(f) PCK means pedagogical content knowledge
(g) TPACK means technological pedagogical and content knowledge

Figure 3.4. Theoretical Framework of the Present Study

The specific technology under this present study was the IWBT and there were two actors in this study; they were science teachers and the pupils in the science classrooms. Science teachers" use of the IWBT related to their TPACK in science classrooms was explored, meaning, in this study it was assumed that science teachers" TPACK may influence their IWBT usage. Meanwhile, pupils" interaction with the IWBT was observed to triangulate the data. In this present study, the researcher observed and recorded the integration of IWBT during the teaching and learning among teacher and pupils in the science classroom. Figure 3.4 is further explained as follows in Table 3.2 below.

Table 3.2.
Explanation of the Projection Notions of the Theoretical Framework of the Present Study

No.	Projected Notions	Explanation
1.	TechTP	This notion TechTP is projected from the original TPACK where the teachers" technological, pedagogical and content knowledge interact in the delivery of lessons. TechTP is about how teachers" TPACK helps them to interact with their pupils through technology and the

No.	Projected Notions	Explanation
		pupils in turn are facilitated to interact with the Technology (IWBT in the present study).
2.	TechT	This notion TechT is projected from the original TPK where the teachers‟ technological and pedagogical knowledge interact in the delivery of lessons. TechT is about how teachers‟ TK influences them to utilise the IWBT in the delivery of their lessons
4.	TechP	This notion TechP is projected from the original TCK where the teachers‟ technological and content knowledge interact in the delivery of lessons which impacts the pupils. TechP is about how pupils interact with the technology (IWBT) and the content presented by the teachers.
4.	TP	This notion TP is projected from the original PCK where the teachers‟ pedagogical and content knowledge interact in the delivery of lessons. TP is about how teachers interact with their pupils without the influence of technology.
5.	Technology	This notion Technology is projected from the original TK where the knowledge about certain ways of working with the technology, tools and resources contributes to teaching and learning. Technology is about what are the components of IWBT (such as visualizer) and its affordances of each component and the teacher‟s knowledge about the equipment.
6.	Teacher	This notion Teacher is projected from the original PK where teachers‟ deep knowledge of the processes and practices or methods influence the teaching and learning. Teacher is about how the teacher teaches in the science classrooms without IWBT.

Technology keeps changing and offers new metaphors for understanding the world. Technology can constrain the types of possible presentations and also allow construction of varied ways of knowledge representation among the instructors. Furthermore, technological tools allow greater flexibility in navigation across these presentations. The only technology investigated in the present study was the IWBT. The usage of the components of the IWBT such as visualizer, LCD projector, and the IWB were observed (Figure 3.4 notion Technology). The double sided arrows in Figure 3.4 indicate that teachers‟ TPACK can influence their use of/ with the IWBT and how they facilitate their pupils to interact with the IWBT and vice versa (example Figure 3.4 notion TechTP).

The understanding of how science teaching and learning can change when the IWBT is used in particular ways is labeled as TechT in the theoretical framework of the present study. Science teachers need to have a deeper understanding of the constraints and affordances of the IWBT and contexts within which they function. The main focus of this present study was how the science teachers use the IWBT in their pedagogical approaches (Figure 3.4 notion TechT). TechT is about how teachers‟ TK helps them to utilise the IWBT in the delivery of their lessons. In order to achieve such goal, teachers need to be forward-looking, creative and open-minded seeking of technology use (Koehler & Mishra, 2009).

According to the theoretical framework proposed in the present study, teachers need to know how to repurpose the technology in the classrooms to deliver the subject-matter using the technology in the classrooms (Ling Koh et al., 2014). TechP is about how pupils interact with the technology (IWBT) and the content presented by the teachers who use their TCK. How then do pupils interact with the content through IWBT was investigated in this study (Figure 3.4 notion TechP).

Transference of content knowledge from a teacher to the students can occur as the teacher knows how to interpret the subject matter, find multiple ways to represent it and adapt the materials to address alternative conceptions and students‟ prior knowledge (Shulman, 1986). Thus, teacher‟s pedagogical decisions will affect how the content is delivered to the students (Figure 3.4 notion TP). In addition, in this present study, how a teacher teaches in the science classrooms without the IWBT (Figure 3.4 notion Teacher) was also investigated. Meanwhile, Pupils refer to how pupils interact with the science content knowledge delivered to them without IWBT (refer to Figure 3.4 notion Pupils).

In this study, even though the IWBT is the only technology observed, the control of the usage still depends on the science teachers in the classrooms. According to Koehler and Mishra (2009), teachers should creatively design or structure teaching when integrating the technology for any particular subject matter in specific classroom settings. Thus, there is no "one best way" to integrate technology into curriculum. In this study, the researcher entered the field of the study with an open mind to observe the integration of the IWBT as well as identify factors that lead to reluctance in integration of IWBT in the science classrooms.

Chapter summary

Conceptual frameworks are abstract representations, that pinpoint the research gap and connect the research objectives that direct the collection and analysis of data. The research gap is based on previous studies carried out on technology integration including IWBT integration, perceptions of technology integration, perceptions on IWBT integration and teachers‟ TPACK for educational purposes. The researcher of the present study argues that research related to teachers‟ reluctance to integrate all of the available features of the IWBT (Bakadam & Asiri, 2012; Mei, 2015) is a gap that needs investigation. Thus, the flow of the research gap was organised to answer the research objectives. Lastly, this study was guided by the framework of Technology, Pedagogical and Content Knowledge or TPACK model which was translated and projected into a framework for interaction between the technology used, the teacher and the pupils to explore the integration of the IWBT, in primary science teaching and learning.

Chapter 4: Methodology

Introduction

This study was designed to investigate the integration of IWBT in the science classroom, the reluctance in the integration of IWBT among science teachers of a selected fully IWBT equipped Chinese primary school and to put forward an instructional guide for more effective use of the available IWBT. The observational and interview data were the main sources of data gathered through observation notes and audio recordings of the science teachers in the classrooms. Documents related to the lesson were collected and interviews with teachers, pupils, and the e-classroom manager were conducted to provide alternative perspectives for the researcher to triangulate the data collected. This chapter describes in detail the research design, sampling, methods of data collection and data analysis of the study.

Feasibility Study

A feasibility study was conducted to see if the study can be carried out. The researcher walked around from one classroom to another (all 33 classrooms) for 30 minutes each day for 5 days. In addition the researcher talked informally with colleagues to learn more about the integration of the IWBT for science teaching and learning.

The outcomes of the feasibility study assisted the researcher to determine important aspects of the research. The main aspects that were uncovered are as follows:

(i) willingness of participants to be observed

(ii) number of appropriate participants

(iii) the need for an observation protocol and an interview protocol

(iv) analysing data

Based upon the feasibility study, the actual study was planned and executed.

The Research Design

In order to answer the research questions, the present study utilised a qualitative case study approach (Creswell, 2013; Yin, 2009). This present study is an in-depth description and analysis of a bounded system and it can be further defined by its special features. This embedded case was a selected Chinese primary government aided school which is located in Kuala Lumpur, Malaysia. This present study can be characterized as being particularistic, descriptive and heuristic (Merriam, 2009).

Particularistic. The case selected for the study was a, atypical Chinese government aided primary school where the researcher worked. This school was the bounded system investigated. Within this system, the board of directors sponsored the purchase of the IWBT for all the thirty-three classrooms in the school. The Parents and Teachers Association is responsible for the maintenance of these facilities. The learning software is also provided for the school learning system and all teachers in the school can access the software in every classroom and the staff room.

Within this case, the subunits purposively identified included four science teachers from level one and two science teachers from level 2. This strategy was found most suitable because the researcher believed that the sample chosen provided the „best" information to answer the research questions (Kumar, 2014). There were 6 science teachers who agreed and were willing to participate in the study. All 6 teachers were also qualified science teachers with at least one year experience. Table 4.1 shows the research participants in the classroom observations. Pseudo names are used.

Table 4.1
Research participants

Name (pseudonym)	Class	Teaching Science Experience	Observations
T1 Teacher Melissa	Y6	25	2
T2 Teacher Kang	Y5	1	3
T3 Teacher Won	Y3	1	2
	Y2		1
T4 Teacher Shirley	Y2	1	3
T5 Teacher Chua	Y1	20	1
T6 Teacher Nikki	Y1	3	1
		Total Observations	13

Note. No Year 4 science teachers volunteered.

Descriptive. This present study provides an in-depth understanding of the integration of IWBT in science teaching and learning. After classroom observations, the selected teachers and e-classroom manager were interviewed to elicit rich data. In addition, ten pupils were selected purposively for the focus group interview to triangulate the data. Through classrooms observations and followed by the interviews with teachers, pupils and the e-classroom manager, the real situation of reluctance in integrating the IWBT was explored.

Heuristic. This present study could illuminate the readers‟ understanding from three main perspectives which are the integration of IWBT, the factors that lead to reluctance in integrating the IWBT and the instructional guide for more effective integration of IWBT in science teaching and learning. Lastly, the emerging TPACK elements for profiling science teachers‟ use of their TPACK related to the IWBT were put forward.

Data Collection Techniques

This present study used multiple data collection techniques. The main data collection techniques were lesson observations and interviews. The documents related to the lessons were also collected to gain more understanding about the research and for triangulation purposes. All the data collected was in Mandarin and the researcher who is a qualified with double option of Chinese Language and English Language in teaching primary school translated the raw data into English. The translation of the data was verified by two experts in school who are also of the double option of the said language with the researcher. Next, the data was validated by another three experts from the private sector and tertiary level. The experts were a manager who was working in a unit curriculum of a kindergarten, a science lecturer in a private college and the researcher‟s supervisor. This section will discuss in detail about the lesson observations, interviews, documentary information related to the lessons and data collection processes and procedures.

Lesson observations. The researcher entered the field directly to observe the integration of IWBT for science teaching and learning in the classrooms so as to understand and capture the context holistically of the teachers‟ and pupils‟ interaction (Alvarez et. al., 2013; Patton, 2002; Warwick et.al, 2010; Warwick, Mercer, & Kershner, 2013). The researcher observed the natural settings by using the observation protocol that was prepared before entering the classrooms (Kumar, 2014, p.173). This present study applied non-participant observation as the researcher did not get involved in the activities of the lesson but remained as a passive observer (Kumar, 2014).

The researcher adapted The Framework of Observation Protocol (Marohaini et al., 2005) and developed an observation protocol. The researcher‟s supervisor gave feedback to recuperate the elements of TPACK theory (see Appendix B). After that, the Appendix B was verified by five experts from educational background. Firstly, the observation protocol was verified by a senior science teacher with more than fifteen-year of teaching experiences who was working in a same school with the researcher. Next, the researcher asked for verification from three postgraduate students who were a science lecturer and two science teachers. Lastly, the interview protocol was verified by researcher‟s supervisor. The experts verified this instrument with care and gave feedback in improving the language and the agreed with the appropriateness of the elements of the TPACK used.

In this present study, six science teachers participated voluntary for classroom observations. Three science teachers agreed to be observed three time times; a science teacher agreed to be observed twice; two science teachers agreed to be observed once. Pseudo names are used for the teachers in presenting the data collected. In total, thirteen observations were collected in this present study. An example of the verbatim transcript of the classroom discourse is shown in Appendix G. The researcher observed how the science teachers integrated the IWBT for science teaching and learning in the classrooms and followed up with interviews to gauge the factors that may lead to the reluctance in the integration of the IWBT for science teaching and learning. The researcher took precautions to avoid bias in her observation and did reflection after every observation session to increase the familiarity in writing the field notes during the observations in the classrooms

(Heath, Hindmarsh & Luff, 2010). The field notes taken by the researcher described interesting episodes or actions observed that were relevant to the objectives of the study. Field notes from lesson observations were produced and each teacher‟s lesson plan and pupils‟ work were collected in order to assist in the analysis. An example of the researcher‟s field notes is shown in Appendix H.

Interviews. Interviews are flexible, free and spontaneous in content and structured in a way that insight may emerge as the interview progresses (Gubrium & Holstein, 2002; Kumar, 2014). Meanwhile, the researcher read more past literature before designing a qualitative interview protocol in order to have a clearer picture on how to access to the participants and entering the research field to gain the best information on time (Gubrium & Holstein, 2002).

The main reason that the researcher used interviews in this present research was to explore the teachers‟ and pupils‟ perspectives (Creswell, 2014). The researcher interviewed the teachers who had agreed to further explore in-depth their integration of IWBT in the science classrooms to answer the first and second research questions. Table 4.2 shows the numbers of interviews conducted in this present study. since it was a qualitative research, the sample was collected until it reached saturation (Creswell, 2013; Yin, 2009).

Table 4.2
The numbers of interviews

Interviews	The numbers of Interviews
Semi-structured interview with science teachers	3
Semi-structured interview with e-classroom manager	1
Focus group interview	1

The researcher conducted two types of interviews which were semi-structured interviews and focus group interviews. After the end of class observations, the researcher conducted semi-structured interviews on a one-to-one basis with the teachers. There were three science teachers who participated in the interviews voluntarily among the six science teachers who agreed to allow classroom observations. An interview with the e-classroom manager was also recorded. The focus group interviews were conducted with ten pupils who were volunteers from the research classrooms to reflect on everything they had learnt throughout the process and to comment on the pedagogical strategies used by their teacher in teaching the science topic. The letters of consent were distributed to the pupils from different classrooms but only ten pupils managed to join the focus group interview during the recess time in school. The main purpose of conducting interviews with the pupils was to elicit their experiences with the IWBT in the science learning context for triangulation purposes. Through the pupils‟ interviews, the researcher described the nature of the learning process or the objects that were studied (Tierney & Dilley, 2002). Furthermore, in order to triangulate the data, the researcher conducted interviews with the e-classroom manager who entered the school weekly to supervise the operation of the e-classrooms. Thus, there were three interviews with three teachers, one interview with one e-manager and one focus group interview conducted with the pupils to collect the data.

The interview process started with the setting up of the interviewer‟s digital recorder amid friendly greetings, providing a specific social context for the interview conversation. The interview protocol was verified by five experts who were from an educational background, i.e. a chemistry lecturer, a secondary science teacher, two primary school science teachers and the researcher‟s supervisor. The interview protocol comprised three sections (see Appendix C, Appendix D, Appendix E and Appendix F) which are included five categories: (1) questions regarding technology integration, (2) questions regarding IWBT integration, (3) questions regarding perceptions of technology integration, (4) questions regarding perceptions of IWBT integration and (5) Teachers" TPACK. The interviews with the teachers and pupils were recorded with a digital recorder and later transcribed.

By using interviews, the researcher sought clarification from the teachers and pupils on the particular points in the lessons that the researcher may not understand. In short, the data collected from the interviews allowed the researcher to answer research questions one and two: „How are science teachers" integration of the IWBT for teaching and learning in a selected fully equipped IWBT Chinese primary school?" and „What are the factors that lead to reluctance in integrating the IWBT for science teaching and learning in a selected fully equipped IWBT Chinese primary school?"

Documents related to the lessons. In order to gain a comprehensive understanding of the curriculum context and design, this study also collected and examined a range of documents used during the lessons, including the curriculum materials, the worksheets given to the pupils, samples of student work and teachers" reflective notes (see Appendix N, Appendix O and Appendix P). Such documents allowed the researcher to triangulate the data collected. Due to the fact that the study was conducted in a Chinese primary government school, the data collected was in Mandarin. The researcher translated the data collected into English and asked for verification from two experts in schools. They are experienced teachers with double option in teaching English Language and Chinese Language. Next, the data was validated by another three experts from tertiary level.

Data collection processes and procedures. Before conducting the observations and interviews with the teachers and pupils, approval from the principal in the school for carrying out the study was obtained (refer to Appendix L); the consent letters from teachers and parents were acquired before collecting the data (refer to Appendix L2 and Appendix L3).

Before conducting the observations and observations, the researcher told the teacher and pupil participants about the purposes of the study. Both the teacher and pupil participants were required to give their full support by answering the questions honestly and trustfully. The observations and interviews were recorded and kept strictly confidential. This was to ensure the anonymity of the respondents and avoid any undesirable consequences. The duration for the collection of data was six weeks. The lesson observations and interviews were done in a three phase data collection process.

Phase I: preparation stage. This stage focused on collecting all the background information of the participating teachers. The researcher collected all of the supporting documents, such as the curriculum documents and lesson plans before the lesson observations in order to fully understand the objectives of the lesson as well as the content knowledge that will be applied during the lessons. In addition, the researcher collected the participating teachers‟ time tables to fix the period of observations and seek for approval from the school management because at the same time the researcher was also teaching in the same school. Furthermore, the researcher asked the participating teachers about the use of available resources with the school system before entering the classroom for observation in order to study the materials to get a clearer picture. The researcher printed out some relevant of the resources before entering the observation classrooms.

Phase II: main data collection stage. All of the classrooms observations were conducted to observe the integration of the IWBT for science teaching and learning in the selected fully equipped IWBT Chinese primary school. Six science teachers participated in the research study. In addition to lesson observations, the data collection process also included post-lesson interviews with the participating teachers to explore the factors that may lead to reluctance in the integration of the IWBT for science teaching and learning in the selected fully equipped IWBT Chinese primary school.

Phase III: project end stage. At the end of the all observations and interviews with teachers, the researcher elucidated other sources of data for triangulation purposes. For instance, a focus group interview with the pupils who were being observed was conducted. As previously noted, the researcher also collected samples of the pupils" work and relevant curriculum materials. Furthermore, interviews were conducted with the e-classroom manager to gauge her opinion and perspective in the integration of IWBT in the selected fully equipped IWBT Chinese primary school for triangulation purposes.

Table 4.3 summarizes the data collection process and Table 4.4 shows the data collection mapping of the present study to map out the data collection techniques and the number of data sources and related documents collected. There were six science teachers who participated voluntary in the classroom observations and the frequency of observations depended on the willingness of each participants. For instance, Teacher Won, Teacher Shirley and Teacher Gan agreed to be observed three times but Teacher Chua and Teacher Nikki only agreed to be observed once.

Table 4.3
Data Collection Processes for This Study

Phase I Preparation stage	Phase II Main data collection	Phase III Project end
1. Collect background information - class performances -teachers‟ background 2. Collect supporting documents - science textbooks - yearly scheme of work	1. Conduct lesson observations - field notes 2. Conduct interviews - teachers	1. Conduct interviews - pupils - e-classroom manager 2. Collect samples of pupils‟ work and related curriculum materials.

Table 4.4
Data collection mapping

	Frequency	Week
<u>Feasibility study</u>		0
Informal observation checklist	5	
Informal conversation with teachers	10	
<u>Actual study</u>		1 & 2
Phase I:		
Science teachers‟ background	6	
Teachers‟ timetables	6	
Available resources in the school system	6	
Science textbooks	6	
Yearly scheme of work	6	
Phase II:		3 & 4
Classroom observations	13	
Field notes	13	
Semi-structured interviews with teachers	3	
Phase III:		5 & 6
Semi-structured interview with e-classroom manager	1	
Focus group interview	1	

Pupils‟ work	13
Teachers‟ PowerPoint presentation	3

Data Analysis

The qualitative data were mainly collected from the classroom observations and interviews. The researcher started to analyse the qualitative data at the beginning of data collection, during and at the end of the data collection because a qualitative design is emergent (Creswell, 2014; Merriam, 2009). In this study, the researcher did not using software to analyse the data but analysed it manually.

Integration of IWBT and the factors that may lead to reluctance in integrating the IWBT in science teaching and learning. With the field notes, reflective summary and photos taken during the observation, the research wrote the observational transcripts (see Appendix G) after every classroom observation. On the other hand, three semi-structured interviews with science teachers, a semi-structured interview with an e-classroom manager and a focus group interview with pupils were recorded. After the interviews, the researcher prepared the interview transcripts (see Appendix I, Appendix J and Appendix K) before started to do the coding. In total, there were thirteen observations, four semi-structured interview and a focus group interview were recorded.

The source of data for this study is given in acronyms. For example in acronym, Teacher Melissa in the observation transcript labeled with (Observation 2, T1-2; O2L73-75), T1-2 means Teacher Melissa in second time observation in this study, O2 means second observation and L73-75 means from the 73^{rd} until 75^{th} line of the observation transcript data. The observation excerpt shows as below.

Teacher Melissa gives comments to each group and shows the best report to all pupils using the *visualizer*. She *zooms in and freezes* the report. Pupils are *required to* complete their reports. (Observation 2, T1-2; O2L73-75)

Meanwhile, the interview excerpt labeled with (EM, INT36-37), EM means e-classroom manager and INT36-37 means the 36th to 37th line of the interview transcript; the interview excerpt labeled with (FG, INT115-116), FG means focus group, and INT115-116 means the 115th to 116th line of the interview transcript. The excerpts were showed as below.

There are very few of them either *made e-log or asked for technical support*. Teachers seem don"t like to make e-log to our system. (EM, INT36-37)

(I"m) Too short and sometimes teacher calls me to the front but I"m *not tall enough to write*. (FG, INT115-116)

The interviews were transcribed and were written after each session (see Appendix I, Appendix J and Appendix K). The researcher listened to the audio recording of interview sessions and read the observational notes repeatedly before beginning to work on them (Marshall & Rossman, 2016). The researcher did the coding which is a process of putting tags, names or labels against pieces of the data (Marshall & Rossman, 2016; Punch, 2014). The researcher highlighted the key words with colour or different font style to do coding and then printed out the all the codes before started to cut them into pieces and categorised into different themes. Figure 4.1 shows an example of the process of categorizing.

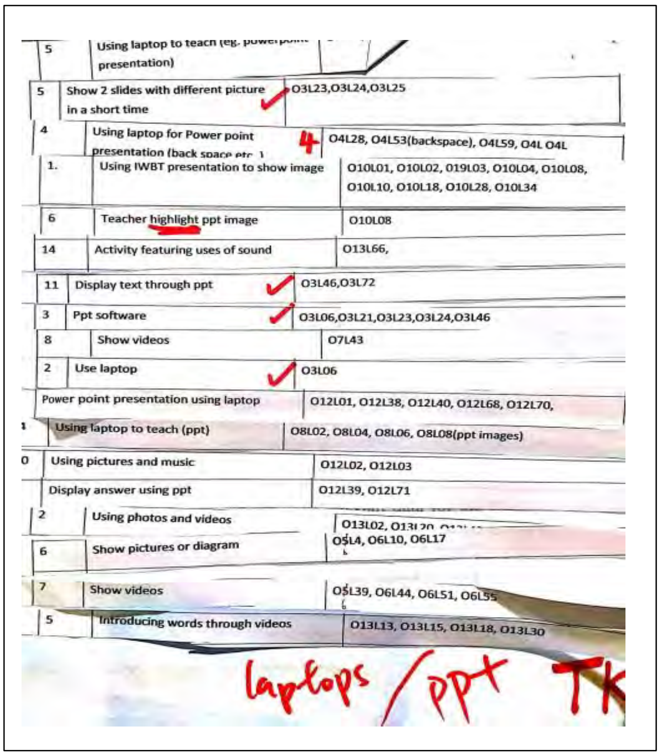


Figure 4.1. A Process of Categorising

New understanding emerged as researcher coded the data. After each of the transcripts was ready, the researcher started to do coding. Figure below shows an example of coding and condensing the codes in this present study.

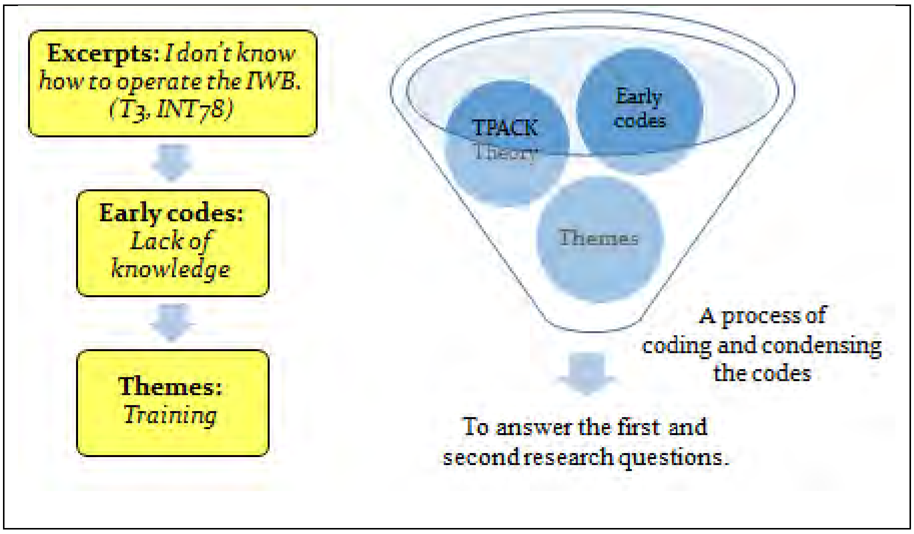


Figure 4.2. A Process of Coding and Condensing the Codes in This Present Study

With the earliest coding, the researcher did categorizing according the knowledge areas of the TPACK theory and the projection notions of the theoretical framework of the present study which was used to guide this study. For instance, „Using IWBT to present images‟ and „Teacher highlights ppt. image‟ were categorised under TechT (Technology and Teacher). Meanwhile, the codes such as „Teacher asks questions.‟ and „Pupils observe and differentiate.‟ were categorised under Teacher, Pupils and TP (Teacher and Pupils). After reducing the observation and interview data into themes through a process of coding and condensing the codes, the researcher finally presents the evidence to answer the first and second research questions (Creswell, 2013). Table 4.5 shows some examples of themes, early codes and the related excerpts from interview data.

Table 4.5
Some examples of themes, early codes and the related excerpts

Themes	Early Codes	Excerpts from interview data (audit trail)
Training	Lack of knowledge	I don‟t know how to operate the IWB. (T3, INT78) There are very few of them either made e-log or asked for technical support. Teachers seem don‟t like to make e-log to our system. (EM, INT36-37) (I‟m) Too short and sometimes teacher calls me to the front but I‟m not tall enough to write. (FG, INT115-116)
	Lack of practice	We need to explore by ourselves. (T2, INT56) The training that the school provided was the first day as we entered this school. At that time, we‟re not ready yet and we were not assigning to teach at that time. (T4, INT91-92) I think the training should provide from time to time, if not we‟ll forget. (T4, INT95-96)

This present study applied the constant comparative method of data analysis suggested by Merriam (2009) which is inductive and comparative. This method has been widely using in qualitative data analysis without building a grounded theory as first proposed by Glaser and Strauss (1967). Merriam (2009) suggested category construction is data analysis and she sees category the same as a theme, a pattern, a finding, or an answer to a research question.

Besides, the researcher triangulated the data to find agreement about core meanings or theme in text using different sources of information to verify a meaning or finding (Berg, 2001). Specifically, triangulation was conducted with research teachers‟ lesson plans, yearly scheme of work, pupils‟ work, interviews with pupils and the e-classrooms manager (see Appendix J, Appendix K, Appendix N, Appendix O and Appendix P). Hence, the researcher looked for convergence between the data generated from diverse sources as mentioned earlier and methods as a check on the validity of a statement or conclusion.

The researcher put forward the outcomes of this study by answering the third and fourth research questions. The IWBT science lesson plans were prepared based on the topics observed in the science classrooms. The IWBT instructional guide related to the IWBT for science teaching and learning were put forward according to the IWBT science lesson plans. Meanwhile, as the study progressed, the researcher noticed that rich emerging data of TPACK elements can be used to create a rubric to profile science teachers by considering the knowledge areas of technological, pedagogical and content that science teachers applied in the classrooms such as the use of the IWBT features, pupils‟ engagement, and science teaching activities, teaching-learning materials and so on. An initial test was administered using this IWBT Rubric in the selected fully equipped IWBT Chinese primary school. The

IWBT instructional guide and the rubric specific for the IWBT are discussed in detail in Chapter 5.

An Instructional Guide for the integration of IWBT. Based on the observational data, interview data and documents related to the lessons such as science yearly scheme of work, the researcher developed an instructional guide for more effective integration of IWBT to overcome reluctance for science teaching and learning. Firstly, the researcher referred to the observation data and developed IWBT science lesson plans according to the topic of science lessons observed. The elements of basic science processes skills and pupils" engagements were taken into account when reconstruct the lesson plans. The excerpts that contained the elements of engagement and science process skills were identified and classified in a table (refer to Appendix R). Three experts in the field verified the classification of the classroom observations. The experts were researcher"s supervisor, a science lecturer and a primary school science teacher.

At the earlier stage, the researcher suggested the utilising of the features of the IWBT upon the teacher reluctances found in the science classrooms after thirteen classroom observations. The researcher wrote down the reluctances found according to the TPACK components and the projection notions of the theoretical framework of the present study and then gave suggestions to overcome the reluctances in integrating IWBT for science teaching and learning. Table 4.6 shows some of the early suggestions for effective integration of the IWBT. The researcher developed the lesson plans and the IWBT instructional guide based upon the reluctances found in the observations and interview data for effective integration of the IWBT in primary science classroom.

Table 4.6

Early suggestions for the IWBT instructional guide

The Projected Notions	Reluctances found in the observation and interview data	Early suggestions for the IWBT instructional guide
Technology	The use of the IWB in science classrooms was mainly for projection purposes only. Most of the science teachers only managed to use 1-2 features of IWBT in the science classrooms. None of the features of IWB were used in science teaching and learning in the classrooms.	Provide an overview of the usefulness of the IWBT
Technology and Teacher (TechT)	The use of visualizers in the classrooms was mainly used to project the printed materials for explanation, discussion, reading and the homework to pupils. None of the features of the IWB were used to enhance the teaching and learning in the classroom. The IWB was used as a screen only. The main technology used was a whiteboard when applying questioning technique meanwhile the visualizer was the main technology during the revision class.	Match the science activities in the classrooms with the suitable features of the IWBT Incorporate science process skills and engagement in the IWBT instructional guide
Teachnology and Pupils (TechP)	Pupils wrote on the IWB with marker pens when they were called by their science teacher to answer the science questions which were projected on to the IWB. The pupils" height appeared to be a limitation when a teacher called them to the front to answer the questions on the IWB. This is because the teacher did not know that the IWB allows the scrolling up and down of the page on it.	Suggest the selection of the suitable IWBT features and provided the time frame needed for each of the use of the IWBT features for every science topic and activity in the instructional guide
Teacher; Pupils and Technology, Teacher and Pupils (TechTP)	Science teacher requested pupils to come to the front and draw, label, write or do corrections using marker pens on a whiteboard but not the IWB. Science teacher labeled a diagram on the whiteboard using marker pen. She did not write or label the diagram on the IWB. Science teachers tended to use questioning technique followed by explaining the theories of science and activities.	Develop the IWBT instructional guide

Table 4.6 (Ctd.)

	Pupils were engaged in the science learning physically, cognitively and affectively without the use of the IWBT. Science teachers were using static pictures, power point presentations; pages form textbook to deliver their content knowledge to pupils. Not all science process skills are taught in the science teaching and learning.

For instance, in the first classroom observation, Teacher Melissa requested pupils to come to the front and draw, label, write or do corrections using marker pens on a whiteboard but not the IWB. The researcher feels that the pupils could have been engaged not only cognitively but also engaged physically and affectively if Teacher Melissa had provided the pupils with the experience to write and draw on the IWB in her lesson. The lesson could be enhanced if the writing and drawing is saved and replayed either to provide pupils a chance to present their observation on the IWB or to recap the lesson during the closure. The below scenario described a reluctance in integrating the IWB in science classroom.

> T1: Do any of you know how to draw a pair of scissors? Could you draw on the whiteboard please? I would like to have two pupils at the front, draw.
> Two pupils *came to front to draw on whiteboard*. Teacher Melissa asked pupils to re-create their drawing in a bigger size. After they completed their drawing, she continued with more questions.
> T1: What are the differences between these two (pairs of scissors)?
> Pupils answered her questions by telling their teacher that one pair of scissors was opened and the other one was closed. Then, Teacher Melissa directed the attention of the class to the topic of the day which was „lever". Teacher Melissa wanted to elaborate her point further. So she walked to the middle of the class and requested another two pupils to label the pivot of both scissors.
> T1: Look, where is the pivot?
> *The two pupils started to label the picture of scissors.*
> T1: Then, label effort and load. Please don"t look at your book. You can always come back to do correction if you have made a mistake.
>
> (Observation 1, T1-1, 01L28-42)

In another classroom observation, Teacher Gan provided pupils with hands on activities by demonstrating under the visualizer and the IWB was used as a screen. However, the researcher suggested that hands on activities can be done using the visualizer with the recording feature on in order to replay if pupils cannot follow the steps of the activities or when teacher wants to give further explanation to pupils. Besides, Teacher Gan did not use the features on the IWB such as annotation on the screen which is the „write‟ feature of the IWB to label the direction of the light travelling.

On the other hand, Teacher Won let pupil hold up her hand phone after she switched on the function of the torchlight to project on to the IWB, pupil was engaged physically. She can use the available visualizer in the classroom to function as a torch light and shot the light to the IWB instead of using her hand phone but she did not use it. Besides, Teacher Won also asked questions followed by explanation and let pupils read aloud. Teacher Won then called pupils to write on the whiteboard but not the IWB. Pupils may have deeper physical engagement if their writing can be saved on the IWB. Both of the Teacher Won and Teacher Shirley did not use any of the features of the IWB and did not infuse science process skills. Part of the classroom observations had evidence of teachers infusing science process skills. Below is an excerpt which shows a teaching and learning activity in Teacher Won‟s lesson.

> Teacher Won asked pupils to recall all the source of light. She called out four pupils to come to the front and write on the whiteboard.
>
> (Observation 9, T4-1, 09L68-69)

In the 12th classroom observation, pupils were writing on the IWB with marker pens when they were called by their science teacher to answer the science questions which were projected on to the IWB. Writing on the IWB with marker pens may affect the cleanliness and the functionality of the board. In contrary, the IWB allows users to write on it using digital pens, fingers with variety of colours. On top of these, science lessons can be enhanced if science teachers could make use of the available features of the IWBT such as „searchlight‟ and „mask‟ to focus upon written facts on IWB. Besides, science teachers also can enrich their presentation immediately by writing and drawing on the IWB if they are able to use it.

Instead of using the mask feature of the IWB, Teacher Won used five circles to cover the pictures in Power Point presentation for pupils to guess objects during the lesson (see Figure 4.3). In actual fact, the five circles can be drawn using the features of the IWB. This showed that science teachers appeared reluctant in utilising all the available features of the IWB in classroom. It also revealed that science teachers need proper guidance in using IWBT.

Figure 4.3. The use of circles to cover the pictures instead of the mask features of the interactive whiteboard

Next, the researcher considered the classroom activities; a guide to the IWBT features, time and science process skills as the components of the instructional guide in helping and encouraging teachers to integrate the IWBT in primary science classrooms. For instance, a science teacher wants to show pictures of an animal (e.g.

cow and snake) to pupils using the IWB, he or she can refer to the instructional guide to choose the IWBT features suggested within a time frame i.e. use the search light to focus only on one of the observing objects among all in a single page (0.5min) or use the digital pen to circle on the IWB (1 min). Furthermore, the instructional guide also suggests the science process skills involved such as observation and classifying. The time frame was estimated and presented for each of the IWBT features needed for instruction as well as for the overall activity. The instructional guide was validated by five experts in this field. The instructional guide will be discussed in more detail in chapter 5.

A rubric specific for the IWBT. The base underpinning theory of the present study is the TPACK model from which projected notions specific for IWBT was made. Hence, as indicated by the double-sided arrows in Figure 3.4 (p.60) teachers" TPACK can influence their use of/ with the IWBT and how they facilitate their pupils to interact with the IWBT and vice versa.

As the study progressed, the researcher realized that the data assimilated could formulate a rubric to profile science teachers" use of their technological pedagogical and content knowledge (TPACK) related to IWBT. Therefore, the researcher considered the theoretical framework as well as the observation and interviews data of the present study, an IWBT Rubric was assembled to profile science teachers" use of their TPACK related to the IWBT for science teaching and learning. In putting forward the IWBT Rubric, the researcher considered the knowledge areas of technological, pedagogical and content that science teachers applied in the classrooms such as the use of IWBT features, pupils" engagement, and science teaching activities, teaching-learning materials and so on. There were two parts of this rubric which were Part A and Part B. The profiles of respondents were obtained from Part A while Part B is the IWBT Rubric. There were seven components and four levels in the present IWBT Rubric. The seven components were adapted from TPACK theory i.e. technological knowledge (TK), technological pedagogical knowledge (TPK), technological content knowledge (TCK), technological pedagogical and content knowledge (TPACK), pedagogical knowledge (PK), content knowledge (CK) and pedagogical content knowledge (PCK). Furthermore, there are four levels in each component of TPACK i.e. 1) Beginner Level, 2) Intermediate Level, 3) Proficient Level and 4) Mastery Level. The levels were created based on the observational and interviews data and further discussions with the peers and experts in the field. All the peers are master holder educators and the experts are the researcher‟s supervisor and the technical support team from the IWBT field, a private company.

From the observation data, it showed that all the participants tried to engage pupils by using only 1 to 2 features of the IWBT in the primary science teaching activities. The following observational excerpts support this;

> Teacher Melissa walked to the visualizer and used the function of *zoom in* to visualize the table to the biggest size. (Observation 2, T1-2; O2L43-44)
>
> She showed her activity book by putting it on the visualizer. She *zoomed in* the page. She explained the instructions on the page to the pupils. (Observation 9, T3-1; O9L102-104)
>
> Teacher Gan walked to the podium in front of the pupils and focus question number eleven using „*zoom in*‟ function to make the question looks bigger. Then, he „*freeze*‟ the question and walked to the screen. He used his finger to point at the question and started explaining the question to all pupils. (Observation 5, T2-3; O5L19-22)

There were three teachers who managed to use both the laptop and visualizer in one period of science lesson among six teachers observed but one of the teachers did not know how to set up the visualizer and laptop at once. Thus, she kept changing the connectors to change the use of the visualizer to laptop and vice versa three times in a lesson. She did not use the features of the IWB at all. The following observational excerpts support this;

> After that, Teacher Shirley *changes the connector at the laptop to visualizer*. She uses „zoom in‟ feature to enlarge textbook page 95.
> (Observation 6, T4-1; O6L20-21)

> Teacher Shirley *changes the connector from visualizer to laptop*. She shows pupils a video clip of jellyfish. (Observation 6, T4-1; O6L38-39)

> Teacher Shirley *changes the connector to visualizer again* as she needs to show page 97 from the textbook. (Observation 6, T4-1; O6L56-57)

Thus, in the TK element, the Beginner Level is put forward as: "I am only beginning to learn to use 1-2 features of the IWBT into primary science teaching activities and I am not able to solve problems with the IWBT." Meanwhile, the Intermediate Level for TK is put forward as: "I am only able to use 3-5 features of the IWBT into primary science teaching activities and would need help with the IWBT if there are problems" (see Appendix M). This instrument was verified by five experts from an educational background who were three primary school senior science teachers, a chemistry lecturer and the researcher‟s supervisor. The researcher analysed the observational and interview data guided by TPACK Theory and found that all the emerging data can be assembled to form a rubric specific for IWBT to profile science teachers‟ use of their TPACK related to the IWBT for science teaching and learning. Table 4.7 shows a sample of early themes and excerpts from observational and interview data guided by TPACK Theory. In this present study, the technological knowledge is the main focus of the study. Thus, the analysis was conducted based upon four of the domains of Koehlar and Mishra (2009), namely technological knowledge (TK), technological pedagogical knowledge (TPK), technological content knowledge (TCK) and technological pedagogical content knowledge (TPACK). Thus, the notion of pedagogical knowledge (PK) was grouped with the TPK; the notion of the content knowledge (CK) was grouped with the TCK; the notion of the pedagogical content knowledge (PCK) was grouped with the TPACK. The integration of IWBT in science classrooms is discussed in detail in Chapter 5.

Table 4.7
Sample of Early Themes and Excerpts from Observational and Interview Data Related to Rubric to Profile Science Teachers‟ Use of Their TPACK in Integrating the IWBT for Science Teaching and Learning

Early Themes	Excerpts from observational and interview data (audit trail)
Technological knowledge (TK) (Projection notion: Technology)	Teacher Shirley changes the connector from visualizer to laptop. She shows pupils a video clip of jellyfish. (Observation 6, T4-1; O6L38-39) Teacher Shirley changes the connector to visualizer again as she needs to show page 97 from the textbook. (Observation 6, T4-1; O6L56-57) She shows the root of a plant using Microsoft PowerPoint. She highlighted the root in advance on following slide and talks to pupils about the slides. (Observation 10, T3-2; O10L08-09)
Pedagogical knowledge (PK) and Technological pedagogical knowledge (TPK) (Projection notion: Technology)	Teacher Melissa gives comments to each group and shows the best report to all pupils using the visualizer. She zooms in and freezes the report. Pupils are required to complete their reports. (Observation 2, T1-2; O2L73-75) She uses visualizer to zoom in textbook page 95 and starts to give explanation for that page. She points on the book and asks pupils to read aloud. She asks her pupils to imagine certain scenarios. (Observation 7, T4-2; O7L21-23)
Content knowledge (CK) and Technological content knowledge (TCK) (Projection notion: Pupils & TechP)	Teacher Nikki now played *soft sounds* and *louder sounds* coming from a *shaker*. T6: Does a musical party also have soft sounds and louder sounds? P3: Yes. T6: Can you all make sound of „miaw‟ softly and loudly. Ready? We start with a kitten sound. P4: Miaw. T6: How is a big cat making its sound? P5: Miaw (louder sound) T6: Which part of body help you listen to all these sounds.

Table 4.7 (Ctd.)

	P7: Ears. (Observation 13, T6-1; O13L43-52) Before letting pupils proceed with hands-on activity, Teacher Gan demonstrates how to roll up the paper and what to observe. The goal of the activity was to see the light from the lamp on a table through rolled up paper in the classroom. T2: Can you see (observe) the light (using the roll up paper) from the lamp? Who can"t see (the light from the roll up paper)? P2: Yes, I can. (Observation 3, T2-1, 03L52-57)
Pedagogical content knowledge (PCK) and Technological pedagogical and content knowledge (TPACK) (Projection notion: Pupils & TechP)	Teacher Shirley shows second video clip of jellyfish and requests pupils to observe silently. She asks pupils a question and provides with an answer. T4: Why do jellyfish sparkle under the sea? It is a way they protect themselves because in the dark they needed to sparkle. The class is slightly noisy and some of the pupils are either discussing with their classmates about some important issues or sharing information about jellyfish. (Observation 6-1; O6L44-51) R: Did your science teacher call you to write on the IWB? P10: We always put up hands but teacher not call us to the front to write. R: I"m so sorry to hear that. P10: Teacher, I know Oliver is not tall enough. R: Did you teacher pull down the pictures, exercise or pages to match your height and let you write? P8: Huh, how? R: The teacher can let you write according to your height. P8: Never. We don"t know. (FGI-71-79)

An initial test was administered using this IWBT Rubric in the selected fully equipped IWBT Chinese primary school. Since this was an emergent finding, the sample was sought from the same school used in the present study to pilot test the instrument. There were sixteen option and non-option science teachers ranging from one year to more than fifteen years of experience in teaching science. This sample included the six teachers who participated in the study. These teachers participated voluntarily to gauge their TPACK related to IWBT for science teaching and learning.

After the science teachers gauged themselves individually using the IWBT Rubric, the researcher approached them face-to-face to further clarify the data given and wrote down the information given by the participants straight after the meetings. The data which emerged allowed the researcher to fine tune the instrument. Figure 4.4 shows how the data assimilated is used to create the final IWBT rubric.

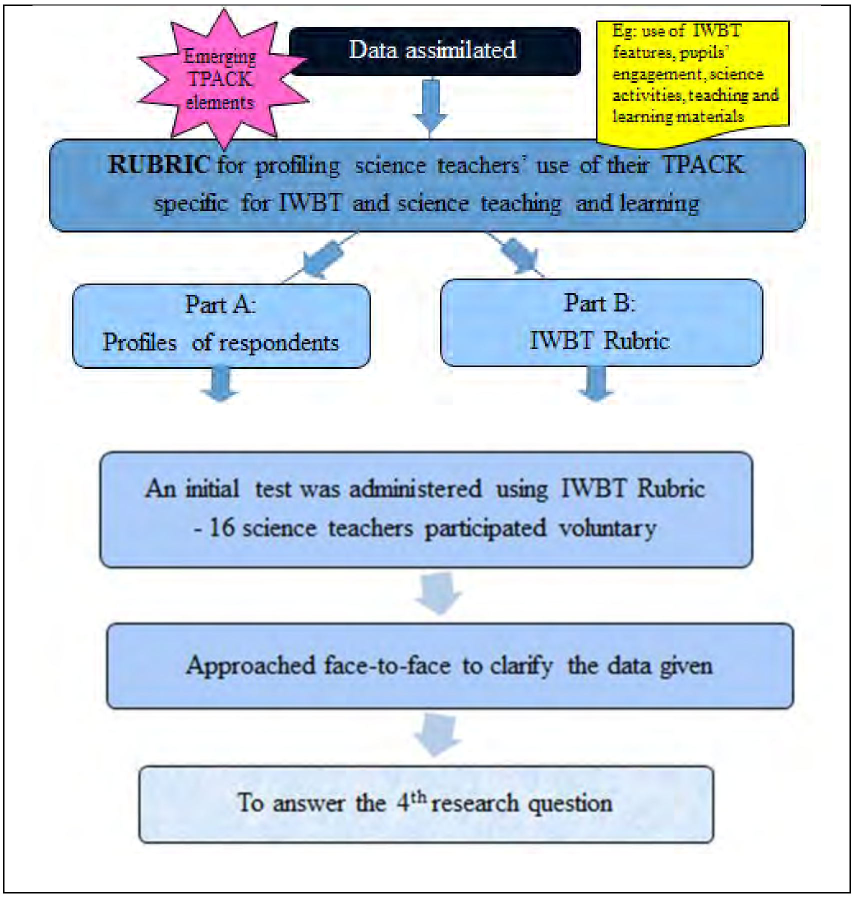


Figure 4.4. The Process of Creating the IWBT Rubric from the Data Assimilated

Chapter Summary

This study utilised qualitative research methodology due to the nature the study aimed to explore a case in a primary Chinese school. The sampling was purposive in order to provide the most relevant data for the findings. The main data collection methods were observations in the science classrooms and interviews with the science teachers. Documentary information related to the lessons collected and interviews with ten pupils and e-classrooms manager provided alternative perspectives to triangulate the data. A feasibility study was implemented as a preparation to go into the field and to ease the real data collection. Constant comparative analysis was applied to analyse the qualitative data in this present study. Based on the rich data collected from observations and interviews, the researcher prepared science lesson plans and put forward an instructional guide for more effective integration of IWBT to overcome reluctance for science teaching and learning. The instructional guide for more effective integration of IWBT is discussed in detailed in Chapter 5.

Chapter 5: Findings and Discussion

Introduction

This chapter organizes the collected data and their analyses according to the research questions. Findings from the observations, interviews and documentary information related to the lessons were interpreted simultaneously for the flow of the ideas. The researcher looked deeply into the science teachers‟ integration of the IWBT and the factors that probably had led to reluctance in integrating the IWBT for science teaching and learning.

Integration of IWBT in Science Teaching and Learning

This section discusses about the integration of IWBT from the seven perspectives or notions of the theoretical framework projected for the present study, i.e technology, teacher, pupils, teacher and pupils (TP), technology and teacher (TechT), technology and pupils (TechP) and technology, teacher and pupils (TechTP).

Technology. According to classroom observations, the use of the IWB in science classrooms was mainly for projection purposes only. The laptop was the most popular technology among all the technologies in the classrooms (Table 5.1). Most of the science teachers only managed to use 1-2 features of IWBT in their teaching and learning activities in the classrooms. The most frequently used was the „freeze‟ and „zoom in‟ of the visualizer but not the IWB at all.

The data collected showed that science teachers used the laptop for Power Point presentations and for showing videos from the internet and teaching resources provided in the school learning system (Murcia, 2014). Furthermore, there were two science teachers who played music and sound while using the laptop to project videos downloaded from YouTube and the teaching and learning software provided in the school system. When using the laptop, the science teachers used the enter button to move the slides forward and backspace button to go back to the previous pages but none of the teachers used the remote controller for moving the slides forward or backward. This meant that science teachers were standing at the front left of the classrooms which were at the podium in front of a laptop to control his or her slides.

Table 5.1
The Use of IWBT in the Classrooms

			IWBT Technologies		
Name (pseudonym)	Standard	Topic	The use of visualizer	The use of IWB	The use of laptop
T1 Teacher Melissa	Y6	Simple Machines	0	0	0
	Y4	Measurement	√	√*	0
T2 Teacher Gan	Y5	Light	√	√*	√
	Y5	Light	0	√*	√
	Y5	Light	√	√*	0
T3 Teacher Won	Y2	Light and darkness	√	√*	√
	Y3	Reproduction of Plants	0	√*	√
	Y2	Light and darkness	√	√*	√
T4 Teacher Shirley	Y2	Light and darkness	√	√*	√
	Y2	Light and darkness	√	√*	√
	Y2	Light and darkness	√	√*	√
T5 Teacher Chua	Y1	My Senses	0	√*	√
T6 Teacher Nikki	Y1	Types of Sounds	0	√*	√

Note. * The √* indicates the use of the IWB as a screen only. No statistics is involved

Neither a computer nor a laptop is provided in the classroom. Thus, teachers need to bring along their laptops if they want to use the laptop for their classes. Among the six teachers observed, there were three teachers who managed to use both the laptop and visualizer in one period of science lesson and they seem to have acquired the basic knowledge of installation of the IWBT in order to connect to the visualizer followed by the laptop and vice versa. The following observational excerpts support this;

After that, Teacher Shirley *changes the connector at the laptop to visualizer*. She uses „zoom in" feature to enlarge textbook page 95.
(Observation 6, T4-1; O6L20-21)

Teacher Shirley *changes the connector from visualizer to laptop*. She shows pupils a video clip of jellyfish. (Observation 6, T4-1; O6L38-39)

Teacher Shirley *changes the connector to visualizer again* as she needs to show page 97 from the textbook. (Observation 6, T4-1; O6L56-57)

Teacher Shirley, a young first year graduate female teacher, did not know how to set up the visualizer and laptop at once. Thus, she kept changing the connectors to change the use of the visualizer to laptop and vice versa three times in a lesson. She did not use the features of the IWB at all. On the other hand, Teacher Melissa, who is a female senior science teacher, only managed to use the visualizer for the teaching and learning in the classroom. Both of them did not use any of the features of the IWB at all. When interviewed, Teacher Melissa mentioned that she was rushing to complete the syllabus as the class was a standard six class. Teacher Melissa had also hardly mastered the use of the IWB due to certain reasons. She appeared resistant in using the IWBT and she repeatedly mentioned she cannot remember or memorize. The excerpt below indicates this;

R : What do you think about the installation of IWBT in the science classroom?

T5 : I think it"s good. It attracts pupils" attention in learning. For some topics such as animals, plants and the universe, we need the IWBT to help teachers to teach in classroom. But, as time flies, pupils will be used to it and it may be hardly capture pupils" attention. Young teachers use the IWBT more frequent than elderly teachers. For me, *I hardly memorized the steps to set up the IWBT and how to use it*.

R : Can you share with me your own experiences with the use of IWBT in science classrooms?

T5 : I only know how to use the visualizer to project the pages on textbook to the screen. I hope I manage to use the IWBT but *cannot remember the steps* that I learnt in the training. May be was lack of hands-on activities during the training in school. (T5, INT 3-12)

The findings from the Technology perspective suggested that the science teachers were at the beginning level of their knowledge of the IWBT. Hence, science teachers showed reluctance in utilising the available features of IWBT, more specifically, none of the features of IWB were used in science teaching and learning in the classrooms.

Technology and the Teacher (TechT). In this present study, science teachers used the technology in classroom to deliver the science content knowledge. How did the science teachers‟ deliver the science content knowledge with the use of the IWBT? In the fully equipped IWBT classrooms, it was found that the use of visualizers in the classrooms was mainly used to project the printed materials for explanation, discussion, reading and giving the homework to pupils; When using the visualizer, the science teachers usually zoomed into the page that he or she wanted to project to pupils followed by freezing the page. Then, the teacher usually gave instructions to the pupils. None of the teachers used the features of the IWB. For example, teacher Melissa used the „zoom‟ and „freeze‟ function of the visualizer to explain the theory of science but the IWB was only used as a screen. The excerpt below demonstrates this:

> Teacher Melissa gives comments to each group and shows the best report to all pupils using the *visualizer*. She *zooms in and freezes* the report. Pupils are *required to* complete their reports. (Observation 2, T1-2; O2L73-75)

These findings were parallel with the findings of Schweisfurth (2011) which revealed that the classroom realities are the barriers which need be overcome in order to enhance technology based learner centred education.

In this present study, the IWB was only used for projection purposes most of the time. Besides, not all science process skills were taught in the science classrooms.

Table 5.2 shows the engagement and science process skills in relation to the IWBT in science classrooms. In delivering science content knowledge, the most frequent science process skills observed in the science classroom are observational and communication skills, where the science teachers provided the opportunities for pupils to observe the science phenomenon and communicate what they observed in order to share the learning experiences. In contrast, science process skills such as measuring and predicting were observed at a minimum level among all of the science process skills (refer to Appendix R).

Table 5.2
Engagement and Science Process Skills in relation to the IWBT

Topic	Engagement			Science Process Skills
	Physical*[1]	Cognitive*[2]	Affective*[3]	
Simple Machines	√	√	√	Observation Communicating
Measurement	√	√	×	Classifying Measuring Communicating
Characteristic of Light	√	√	√	Observation Communicating Inferring
Characteristic of Light	√	√	√	Observation Communicating Inferring
Characteristic of Light	×	√	×	Observation
Light and darkness	√	√	√	Observation
Reproduction of Plants	√	√	√	Observation Communicating
Light and darkness	√	√	√	Observation Classifying Communicating
Light and darkness	√	√	√	Observation Classifying Communicating Inferring
Light and darkness	√	√	×	Observation Classifying Communicating
Light and darkness	√	√	√	Communicating Inferring
My Senses	√	√	×	Classifying
Types of Sounds	√	√	√	Observation Inferring

Note. √ Yes × No
*1/ *2/ *3 In relation with the use of visualizer, laptop and the IWB as a projection screen.

On the other hand, some of the science teachers used the slides they had created for presentation before the lesson or used videos which they have browsed using the internet to give explanations and instructions for teaching and learning activities in the classrooms. Usually, the slides were projected on to the IWB and pupils were required to look at the screen while listening to teachers‟ explanations and afterwards pupils were instructed to read aloud. None of the features of the IWB were used to enhance the teaching and learning in the classroom. The IWB was used as a screen only. For example, teacher Chua only used Power Point presentations to deliver her content, although she was familiar with setting up the laptop with the IWB before she started the lesson.

> *Teacher Chua sets up her laptop and ready with her PowerPoint presentation*. She shows a picture of a boy with an instruction on the top of the picture while she is showing the *pictures, music* flows out from her laptop. (Observation 12, T5-1, 12L01-03)

For teacher Shirley, the main technology was the whiteboard when applying questioning technique and the visualizer was the main technology while doing revision in class. Teacher Gan also used none of the features of the IWB and the interactive board was only used as a normal whiteboard. Some excerpts recorded were as below.

> T4: Please discuss on the differences between light and darkness. Not the source of light.
> Teacher Shirley walks to the front and points towards the title written on the *whiteboard* to remind her pupils the topic of the day and goal of their group works. (Observation 8, T4-3; O8L35-37)

> Teacher Shirley used the function of „zoom in‟ of the *visualizer* to show pupils textbook page. She started giving explanation for that page. She pointed towards the page and asked pupils to read aloud. Next, she asked her pupils to imagine certain scenarios.
> T4: If we switch off all of the lights, *what will happen?*
> P5: Cannot see clearly.
> T4: *How about we switch on the light?*
> P6: We can see clearly. (Observation 7, T4-2; O7L20-27)

P10: Is this Tomb-Sweeping Day (Qing Ming Festival)!
P11: No, is mid-autumn festival.
T4 : Is mid-autumn festival.
T4 : *What are the things that people (Chinese) hang during mid-autumn festival?*
P10: They hang the lanterns.
Teacher Shirley talked briefly about the picture on that page. Then, she asked the pupils to put their activity book on the table and searched for page 61. She placed her activity book on the textbook under the *visualizer.*
(Observation 7, T4-2; O7L56-63)

Teacher Gan uses power point presentation (ppt) to show the title of the lesson. The IWB is empty other than the text "Refraction of light".
T2: What is the meaning of „refraction of light?
After asking his question, he moves to the next ppt slide showing the answer of his question. He explains the meaning to the pupils by *writing it down on the whiteboard*. He refers to the experiment previously to explain the refraction of light better. (Observation 4, T2-2; O4L12-18)

Teacher Won used the torchlight function to project on the IWB. However, she also used the IWB as a screen for projection purpose only. Below are some excerpts.

She requests a pupil to hold up her hand phone with torchlight function on. The pupil holds the hone up making sure the torchlight is directed towards the screen as instructed by Teacher Won. Teacher Won then starts gesturing with her hand to make shadows on the screen. (Observation 9, T4-1, 09L05-09)

Teacher Won shows a new presentation slide with three names of the sources of light two pictures. Those pictures included: table lamp, torch and stove light. She requests the pupils to read aloud. (Observation 9, T4-1, 09L82-84)

Teacher Nikki integrated IWBT by using the educational software provided in the school learning management system to teach sound in the standard 1 classroom. She used only a laptop and projected the teaching software on the IWB without using any features of the IWB. The IWB was used as a screen. Meanwhile, the software provided in the school system contains colourful pictures, sounds, music, statements, photos and exercises and teachers need to log in and play the content of the lesson. The excerpt recorded is as below.

> *Teacher Nikki* switched on the IWBT. She used the school learning system to start her lesson. The *video* starts with a musical party, all sort of music made by all type of musical instruments. Before the music starts, the audience is quiet. The sound of music is loud and follows by soft music and vice versa. *Teacher Nikki pause the video*. (Observation 13, T6-1, 13L05-08)

Technology and Pupils (TechP). Learning is dependent on the pedagogical approaches teachers use in the classroom (Schweisfurth, 2011). There were many interesting observations made in the present study in relation to how the pupils interacted with the technology used to present the content. For instance, teacher Chua used Power Point presentations projected through the IWB. Nevertheless, pupils were asked to use marker pens to circle the right answers when questions were projected through the IWB (Figure 5.1). Teacher Chua, did not seem to realise that improper use of the IWB as a normal whiteboard (using marker pens to circle the answers) would damage the board.

Figure 5.1. Using marker pens will damage the surface of the IWB

In addition, the pupils" height appeared to be a limitation when teacher Chua called them to the front to answer the questions on the IWB. This is because teacher

Chua did not know that the IWB allows the scrolling up and down of the page on it. Below is the evidence of the height limitation.

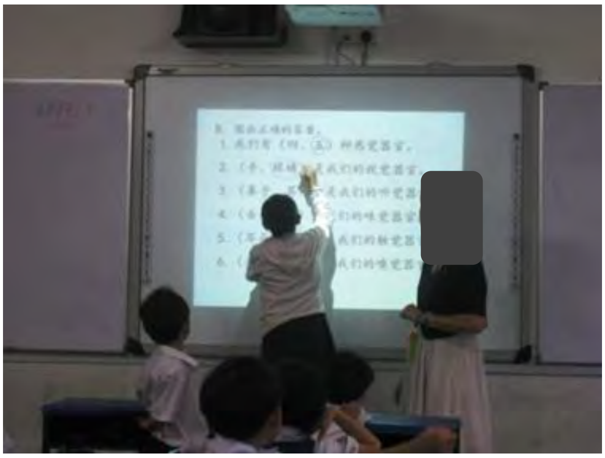


Figure 5.2. Classroom Observation
Note. A pupil not tall enough to write on the board and he needed a chair to answer a question on the board.

Most of the teachers did not know that the IWB could be adjusted to pupil‟s height and thus accommodating to shorter pupils. Some excerpts from focus group interviews showed the evidence:

> R: Did your science teacher call you to write on the IWB?
> P10: We always put up hands but teacher not call us to the front to write.
> R: I‟m so sorry to hear that.
> P10: Teacher, I know Oliver is not tall enough.
> R: Did you teacher pull down the pictures, exercise or pages to match your height and let you write?
> P8: Huh, how?
> R: The teacher can let you write according to your height.
> P8: Never. We don‟t know. (FGI-71-79)

Hence, the interaction of the pupils with the IWBT technology and the content presented in teacher Chua‟s class was not at a desired level that can be obtained is more of the features had been utilized.

Teacher Shirley on the other hand mentioned that that as she could not log in to the school learning system to access relevant content (as she claimed she did not know the username and the password), the content knowledge that presented by this teacher to the pupils was solely prepared by her and the ready resources in the school learning system was not utilised. An excerpt of the interview data showed this situation.

R : Do you use the school learning system provided?
T4 : I want to use it but *I don"t have the username and password*. I can"t log in.
R : Oh! It"s very simple. You just put any numbers after a „T". It can be „T7, T8" and so on.
T4 : Huh? How about the password?
R : 1234567.
T4 : Huh? I don"t know… Okay, I"ll use then. I never use before. I thought is the same username and password with our school management system. (Interview, T4; I04L70-77)

Teacher Shirley showed preference in using Power Point presentations to show pupils photos, asked pupils questions regarding the photos and then proceeded to explain to pupils. She pointed to each word on the IWB using a pointer or her finger for pupils to read aloud. Pupils were engaged physically as they read following Teacher Shirley"s pointing finger. The IWB was used as a screen only. Again, pupil interaction with the IWBT and content was just looking at the screen and reading. The excerpts were recorded as below.

Teacher Shirley shows more presentation slides. First, she shows a slide with a photo of a bedroom with light on and follows by another slide of a switched on torch light.
T4: What type of energy?
P2: Light energy.
T4: What are the sources of light?
P3: Lamp post.
P4: The sun.
T4: Ok, can you all give me more examples?
Teacher Shirley presents another slide with image of lighted candles.
She gives some explanation to pupils and introduces the topic of the day– „Light and darkness" and asks pupils to look at textbook page 95.
(Observation 6, T3-1, 03L09-19)

Teacher Shirley was using YouTube videos to give examples for pupils while explaining the theory. In one of her observations, she downloaded the videos before the lesson started and another observation, she used the internet to play the YouTube videos. Both of the videos presented involved sounds and music. She did not write and drew on the IWB using the digital pen or finger. They were still using old technology, i.e whiteboard and marker pens to write and draw. Again, the IWB was only used as a screen for projection purpose. The pupils could only respond and discuss from their seats without physically interacting with the IWBT - passively interaction with the IWBT. The excerpts recorded were as below. Figure 5.3 is one of these classroom scenarios.

> After explaining the theory, Teacher Gan moved on to next slide to show a diagram of refraction of light. He walked to the screen and pointed at the diagram while he explained to the pupils. He told them about the line of the light, the air and glass as according to the medium in the diagram. Then, he used a torch light to show light to pupils. He used the pointer of the IWB to point at the line of the light and gave explanation to the pupils.
>
> (Observation 4, T2-2, 04L30-33)

> Teacher Gan walked to the podium in front of the pupils and focus question number eleven using zoom in function to make the question looks bigger. Then, he „freeze" the question and walked to the screen. He used his finger to point at the question and started explaining the question to all pupils.
>
> (Observation 5, T2-3, 05L19-22)

Note: None of the participating teachers appeared to draw and write on the IWB.

Figure 5.3. Passive pupil interaction with the IWB and Whiteboard

Teacher (T); Pupils (P) and Teacher and Pupils (TP). This section will discuss the last three dimensions of the projected theoretical framework which does not involve the integration IWBT. As stated earlier, although all classrooms in the school were fully equipped with IWBT, as can be seen from the above discussion, the integration was minimum with much of the features of the IWB unused. The reluctance to use the technology was clear, as much of the time, lessons were carried out without the integration of the available technology. Nonetheless, the teaching-learning process went on without much technology, to which the discussion now turns.

Classroom observation data showed that pupils were engaged in the science learning physically, cognitively and affectively without the use of the IWBT. An example from teacher Melissa‟s classroom is captured as below.

> She proceeded to request two pupils to write "lever" on the whiteboard. Two pupils *wrote on the whiteboard* and only one of them wrote correctly.
> T1: Please come forward to rewrite if there‟s any mistake.
> After that, Teacher Melissa requested pupils to take two brooms and two dustpans to the front but the pupil only brought a broom and two dustpans.
> T1: How come you all so stingy that only can share one broom here?
> She made a joke with them and *all pupils laugh*.
> (Observation 1, T1-1, 01L55-61)

Teacher Melissa managed to present concepts in a logical sequence through hands-on activities without the help of technology. The excerpts are given below:

> Teacher Melissa asked three pupils to *demonstrate floor-sweeping*. She then requested the whole class to *observe the demonstration* and come up with their conclusion.
> T1: Who sweeps the floor better? What are your inferences? What are your reasons?
> Teacher Melissa lets pupils choose the best sweeper among the three pupils by casting votes. Most of the pupils choose Pupil A, five choose Pupil C and none choose Pupil B. She requests Pupil A to *repeat the demonstration* and requests pupils to observe the type of force applied to different parts of broom.
> T1: Please look again! Let me know where is the load? Pupil A, you could stop and go back to your seat now, thank you.
> Pupils A go back to her seat. (Observation 1, T1-1, 01L62-66)

Another example from her class shows that science teachers tended to use questioning technique followed by explaining the theories of science and activities.

After asking questions and explaining, she proceeded to request pupils to come to the front and draw, label, write or do corrections using marker pens on a whiteboard but not the IWB. Some excerpts recorded were as below.

> T1: Do any of you know how to draw a pair of scissors? Could you draw on the whiteboard please? I would like to have two pupils at the front, draw.
> Two pupils *came to front to draw on whiteboard*. Teacher Melissa asked pupils to re-create their drawing in a bigger size. After they completed their drawing, she continued with more questions.
> T1: What are the differences between these two (pairs of scissors)?
> Pupils answered her questions by telling their teacher that one pair of scissors was opened and the other one was closed. Then, Teacher Melissa directed the attention of the class to the topic of the day which was „lever". Teacher Melissa wanted to elaborate her point further. So, she walked to the middle of the class and requested another two pupils to label the pivot of both scissors.
> T1: Look, where is the pivot?
> *The two pupils started to label the picture of scissors.*
> T1: Then, label effort and load. Please don"t look at your book. You can always come back to do correction if you have made a mistake.
> (Observation 1, T1-1, 01L28-42)

> T1: Today is a revision lesson. Everyone please come to the front and sit on the floor.
> All the pupils move to the front and sat on the floor. Teacher Melissa starts her class by asking a questions and then explaining her answers.
> T1: How to draw a data table? Firstly, you need to know your dependent and independent variables. Please do not open your textbook.
> Teacher Melissa draws a data table on the left side of whiteboard as a sample. And she starts explaining the basic structure to form a data table.
> (Observation 2, T1-2, 02L01-09)

Other examples were found in teacher Gan"s classes for the topic of light and revision class. No IWBT was involved.

> Before letting pupils proceed with hands-on activity, Teacher Gan *demonstrates how to roll up the paper and what to observe*. The goal of the activity was to see the light from the lamp on a table through rolled up paper in the classroom.
> T2: *Can you see (observe)* the light (using the roll up paper) from the lamp? Who can"t see (the light from the roll up paper)?
> P2: Yes, I can. (Observation 3, T2-1, 03L52-57)

> Teacher Gan walks round the classroom to help his pupils with their works and observes how his pupils are doing their works. After five minutes, Teacher Gan requests his pupils to look at the question number eleven.
> P3: I know. The answer is C.
> P4: No, the answer is A.

P5: I know the answer.
T2: Let‟s look at number eleven. (Observation 5, T2-3, 05L12-18)

The above classroom scenarios also appeared in Teacher Shirley‟s classes for the topic of „Light and Darkness‟. The excerpts were recorded as below.

Teacher Shirley drew on the whiteboard using marker pen and showed the pupils where to write the title of task. Pupils responded accordingly.
T4: Please follow me.
All pupils followed accordingly. (Observation 8, T4-3, 08L22-25)

Pupils bring their whiteboard cards and walk to the front to present their group works yet most of them are lack of confident. They hide their works by only showing the back of the whiteboard cards. Once Teacher Shirley goes through their works, she starts commenting on each group work. She only managed to go through three group works with all the pupils. She then starts to read the group work from the first group.
(Observation 8, T4-3, 08L44-49)

Overall, the findings from this present study showed that pupils engaged affectively with the integration of technology in the classrooms, even if it was at the most minimum level. The interaction with technology, make pupils happy even when teachers did not use all the features of the IWBT but only the bare minimum. Pupils enjoy through learning with the aid of technology, as shown in the excerpt below.

R: How was your feeling writing on the IWB?
P1: It‟s fun and I enjoy it very much.
R: Janson, how about you? What kind of science lesson you like?
P2: Using computer.
R: What did you all do with the computer?
P2: Got pictures and using computer.
R: What did teacher do with the pictures and computer?
P2: She just teaches us and we listen to her. (FGI-14-21)

Factors that Lead to Reluctance in Integration the IWBT for Science Teaching and Learning

The researcher found that there are four main factors that lead to reluctance in integrating the IWBT for science teaching and learning. The main factors are Time, Training, Attitude and Unsolved Technical Problems which emerged from the data collected. A sample of themes for these factors is shown as below.

Table 5.3

Sample of Themes of the Factors that Lead to Reluctance in Integration the IWBT for Science Teaching and Learning

Themes	Early Codes	Excerpts from interview data
Time	Lack of time	Too much papers work (admin work) until I cannot totally concentrate in preparing my lessons. (T2, INT85-86) The only problem is the technical part that when it happens, it really wasted my time.(T4, INT12-13)
	Time wasting	Using this thing (IWBT) really time consuming. (T4, INT106) First, it‟s really burden. You need to connect here and there before start to use it.(T4, INT103-104) Sometimes the board shows that: „The board is disconnected.‟ As this happen, it‟s really wasting the time. (T4, INT 53-54)
Training	Lack of knowledge	I seldom use because I‟m not familiar with the use of this board. (T2, INT28) Not enough (training). Through my observations, a lot of teachers only use visualizer. Very less teachers use videos or other multimedia to teach. (T2, INT52-53) I don‟t know how to operate the IWB. (T3, INT78) There are very few of them either made e-log or asked for technical support. Teachers seem don‟t like to make e-log to our system. (EM, INT36-37) (I‟m) Too short and sometimes teacher calls me to the front but I‟m not tall enough to write. (FG, INT115-116)
	Lack of practice	We need to explore by ourselves. (T2, INT56) The training that the school provided was the first day as we entered this school. At that time, we‟re not ready yet and we were not assigning to teach at that time. (T4, INT91-92) I think the training should provide from time to time, if not we‟ll forget. (T4, INT95-96)

Table 5.3 (Ctd.)

Attitude	Ready sources	Now, we only invented the syllabus for three main languages. It is Bahasa Malaysia, Inggeris and Mandarin. (EM, INT56-57) I want to use it but I don"t have the username and password. I can"t log in. (T4, INT59)
Unsolved Technical Problems	IWB screen	I don"t why the screen becomes blurring and the image is not in the place. (T3, INT81-82)
	Connections	I don"t know what the problem is and why sometimes the school learning system is hanging. It can"t move. I"m not sure is due to my laptop or the line (internet itself). (T3, INT55-56) First, it"s really burden. You need to connect here and there before start to use it.(T4, INT103-104) When it was hanging, I have to switch off the Chrome and reopen again. (T3, INT58) Mainly, they refuse to connect the laptop and worry about the installation. (EM, INT10-11)
	Calibration	The feedbacks that I got from them is the calibration depends on how frequent use of the IWB. If the IWB is not been use for a long time, it needs calibration. (EM, INT69-71)
	Installation	This kind of set up really depends on teachers" knowledge of IWBT. They really need to know how to set up the IWBT in order to use this technology. (EM, INT3-4)

Time. According to the e-classroom manager, the setting of the e-classroom in the school was different from other schools that equipped with IWBT because the school headmaster wanted teachers to take more responsibilities in handling the installation of the IWBT. With this kind of setting, teachers can bring home their laptop to prepare the content of teaching outside the classrooms. Thus, she said that it may need more time in setting up the IWBT before using it in the classroom and the reason that lead to reluctance as the excerpt shown as below.

> *"Burden. It can be the main reason."* (EM, INT64)

Setting up IWBT is time-consuming and teachers whom are older, were not skillful enough or not familiar with IWBT or do not possess the mastery to use it. Teacher considered the IWBT is very difficult to use, it is a burden given how time-consuming it is to set it up. Teachers need to install personal laptop with the classroom IWBT before using it. Teacher also claimed that unsolved technical problems were time-consuming as well. The finding of the factor of time lead to teachers" reluctance in integrating the IWBT in science teaching and learning is parallel with the previous research that have been done (Kopcha, 2012; Nikian, Nor & Aziz, 2013). Excerpts from teachers" interview data have clearer explanation about time in integrating the IWBT in classrooms.

> *"Using this thing (IWBT) really time consuming".* (T4, INT106)

> *"First, it"s really burden. You need to connect here and there before start to use it."* (T4, INT103-104)

> *"The only problem is the technical part that when it happens, it really wasted my time."* (T4, INT12-13)

> *"Sometimes the board shows that: „The board is disconnected." As this happen, it"s really wasting the time."* (T4, INT 53-54)

On the other hand, if the IWB is not been using quite sometimes, teachers need to do calibration before starts to write on the interactive board and it takes some times to set up the IWB. Again, it was time-consuming before starting of the teaching and learning in the classrooms. Some interview data revealed that teachers" lack of knowledge causing them spending extra time to resolve this technical problem.

> *"Yes, every time before I use, I do the calibration."* (T4, INT20)

Young teacher agreed that teaching with technology are fun and it needed to spend more times because teachers need to prepare and practice with the technology before the lesson begins. In contrast, another teacher elucidated that increasing admin work distracted her in well preparing the lesson with technology even she is enjoying teaching with technology. Some excerpts had shown as below.

> *"If you want to make your lesson fun, of course you need to spend more times."* (T2, INT64-65)

> *"Too much papers work (admin work) until I cannot totally concentrate in preparing my lessons."* (T2, INT85-86)

Training. The focus group interview with pupils had showed evidence that teachers were lack of technological knowledge and the final themes appeared as training (Bakadam & Asiri, 2012). Teachers need trainings to gain technological knowledge in utilising IWB appropriately. The interview data elucidated that pupils feel fun, enjoyable and happy to be able to write on IWB or even to touch the screen and some pupils claimed, the infrequency of using IWB heighten the whole learning experience when teacher do use IWB. Unfortunately, a small fraction of pupils never did have the chance to try out IWB; this specific group of pupils expresses their wish to try out IWB in the near future. One of the most frequently heard reason is the height of pupil. Pupils are too short to reach and write on the IWB as most teachers did not know that IWB could be adjusted to pupil"s height and thus accommodating to shorter pupils. An interview excerpt from Focus Group Interview revealed the height of pupils restricting the learning opportunities at IWB.

> *"(I"m) Too short and sometimes teacher calls me to the front but I'm not tall enough to write."* (FG, INT115-116)

> *"Teacher always calls the first row. I"msitting at the back."* (FG, INT121)

> *"Teacher, I know Oliver is not tall enough."* (FG, INT74)

Other reasons including the seating position as pupils claimed that teachers would preferred to call out pupils sitting at the front and back row, so sitting in the middle row reduces pupils chance at being call out to experiment with IWB and also the intensity of competition as too many pupils raised out their hands wanting to be call out. The IWBs can allow a few users to use at the same time and none of the classrooms has evidence of group work or collaboration work using IWBT.

Teachers were not familiar with most of the features of IWBT making it hard for them to use it. One of the teacher claimed that the digital pens was missing; teachers could not use IWBT with incomplete tools. All teachers agreed that the training provided was not enough to support teaching and learning using IWBT. After the training, teachers were able to use visualizer successfully but not IWB at all. Teacher commented that, training was only given when they first entered school, and there are no laptop provided to practice with so teachers would like to suggest that training should be provided from time to time. Excerpts from teachers" interviews data had shown as below.

> *"Not enough (training). Through my observations, a lot of teachers only use visualizer. Very less teachers use videos or other multimedia to teach."* (T2, INT52-53)

> *"May be we also felt it"s difficult to operate and we don"t want to use it."* (T3, INT71)

> *"I don"t know how to operate the IWB."* (T3, INT78)

Teachers elucidated that they hoped to attend the training again in order to improve their knowledge regarding the use of IWBT in classrooms. Besides, they also explained that lack of practice restricted them excel in operating IWBT. After the training, they seldom or never use the IWB and solely depended on the use of visualizer in their teaching and learning in the classrooms. Teacher claimed that if the trainings are provided from time to time, they will have chances to practice more frequently. Furthermore, the e-classrooms manager revealed that teachers seldom make e-log as they facing technical problem in classrooms which was taught in the teachers‟ training. Interview excerpts from teachers and e-classrooms manager revealed a clearer explanation of the factor of training based on the early code of „Lack of practice‟.

> *"We need to explore by ourselves."* (T2, INT56)
>
> *"May be we also felt it‟s difficult to operate and we don‟t want to use it."* (T3, INT71)
>
> *"The training that the school provided was the first day as we entered this school. At that time, we‟re not ready yet and we were not assigning to teach at that time."* (T4, INT91-92)
>
> *"I think the training should provide from time to time, if not we‟ll forget."* (T4, INT95-96)
>
> *"There are very few of them either made e-log or asked for technical support. Teachers seem don‟t like to make e-log to our system."* (EM, INT36-37)

Furthermore, it is also very time-consuming to connect to IWB and the lesser the frequency of using IWBT, the more time it takes to connect it as teacher cannot recall back how to connect it which is discussed under the section of Time. The excerpts of interview data had clearer elucidated the trainings provided in school are not enough to support teachers‟ knowledge in utilising the IWBT that lead to reluctance of utilising the IWBT. The factor of „Training‟ is due to „Lack of knowledge‟ and „Lack of practice‟ among the science teachers in this study.

Attitude. The school learning system provides teachers with software as teachers log in to choose the subject and topic to support the teaching and learning in the classrooms. Teachers also can use Internet access to explore the sources to support the teaching and learning in the classrooms. Somehow, due to the new curriculum in 2017, the company in service is still progressing with the new software for teaching and learning in the classrooms. Teachers should aware about the progressing of the software, incomplete of the content of the software and they shall prepare the teaching and learning sources by themselves. An excerpt of conversation with Teacher Chua recorded after a classroom observation as below.

> *"I prepared power point presentation today because no more teaching software in our school learning system. If you visit my class one month earlier, I still can show you more interesting teaching style."* (FN, T5-O12)

Below is evidence from e-classroom manager stated that incomplete software provided for school.

> *"Now, we only invented the syllabus for three main languages. It is Bahasa Malaysia, Inggeris and Mandarin."* (EM, INT56-57)

A new teacher elucidated that she did not have the username and password to log in this system. As researcher"s experiences in this school, the username and password is ready for all teachers in school. Teachers" attitudes to gain the ready resources and overcome such undelivered information are importance to provide pupils with the authentic learning experiences in classroom. An excerpt was shown a teacher"s attitude in assessing the ready sources in classroom.

> *"I want to use the school learning system but I don"thave the username and password. I can"t log in."* (T4, INT59)

From the focus group interview with pupils elucidated that all pupils preferred the involvement of computer in lesson, as teachers show videos, pictures and letting pupils write on the IWB either using digital pen or pupil"s finger. All these interaction with technology, make pupils happy even when teachers did not use other features but choose to teach with traditional (asking/explanation verbally) method, pupils feel exhilaration through learning with the aid of technology. Thus, the factor of attitude restricted the use of ready sources in classroom is one of the factors that lead to reluctance in integrating the IWBT in classrooms (Murcia, 2014; Warwick et al., 2010).

Unsolved technical problems. Teachers complained a few technical problems arising when they used the IWBT in classrooms. Sometimes, the screen colour of IWB has issues, school learning system is hang, board disconnected and thus it was wasting teacher"s time. This finding of the present study is parallel with the previous research done by Paragina, Paragina and Jipa (2010). Below are some excerpts that explained the technical problem of IWB screen.

> *"Until now, the colour of the screen still is blurring."* (T2, INT45)

> *"I don"twhy the screen becomes blurring and the image is not in the place."* (T3, INT81-82)

Besides, the problems of connections between laptop, visualizer and IWB were lead to reluctance in integrating IWBT among teachers revealed from interview data with teachers. Some teachers keen to use the board either solely as projections or writing board but the connections was lost and they cannot solve this problem. Another factor is unwillingness among teachers to connect the IWBT in classroom which was due to the setting of IWBT in classroom proposed by the headmaster in implementing the IWBT for this school. He wanted teachers to hold more responsibilities in utilising the IWBT in classrooms. Below are some excerpts related to the problems of connections in e-classrooms.

> *"Sometimes the board shows that: „The board is disconnected." As this happen, it"s really wasting the time."* (T4, INT 53-54)

> *"First, it"sreally burden. You need to connect here and there before start to use it."* (T4, INT103-104)

"The setting here is totally difference from other school"s e-classrooms. In other school, everything is fixed there and teachers only need to switch on before use it. Here, the headmaster wants all teachers take more responsible in using IWBT." (EM, INT5-7)

"Mainly, they refuse to connect the laptop and worry about the installation." (EM, INT10-11)

Furthermore, the software provided in school system seems to be unstable and teacher complained that it was hanging sometimes when she wanted to use it. The excerpts below provided clearer explanation of unsolved technical problems arise in the science classrooms.

"The Donview software is disconnected and I can"t use the board." (T4, INT75)

"I don"t know what the problem is and why sometimes the school learning system is hanging. It can"t move. I"m not sure is due to my laptop or the line (internet itself)." (T3, INT55-56)

Due to the setting of the IWBT in classrooms, teachers need to do calibration before start to use it but most of them unaware about this step and this is categorized as unsolved technical problem in this study which is consistent with the finding of undelivered information and training need discussed in previous section. The image and writing will only in place if the calibration is settled before the use of the IWB. Lacking technological knowledge and practice of calibration are shown in below excerpts.

"This kind of set up really depends on teachers" knowledge of IWBT. They really need to know how to set up the IWBT in order to use this technology." (EM, INT3-4)
"I don"t why the screen becomes blurring and the image is not in the place." (T3, INT81-82)

"The feedbacks that I got from them is the calibration depends on how frequent use of the IWB. If the IWB is not been use for a long time, it needs calibration." (EM, INT69-71)

Interestingly, the data collected from interview with e-classroom manager revealed that teachers did not seek for further help to solve technical problems arise in their classrooms. This is congruent with the data analysis of attitude as discussed in the section of „Attitude‟ as one of the factors that leads to reluctance in utilising the IWBT in science classrooms. Interviews data showed that teachers tried to restart or reopen the page that was hanging in the way of trying resolve the technical problem that they were facing. Below are some evidences.

> *"Mainly, they refuse to connect the laptop and worry about the installation."* (EM, INT10-11)

> *"When it was hanging, I have to switch off the Chrome and reopen again."* (T3, INT58)

IWBT Instructional Guide for More Effective Integration of IWBT to Overcome the Reluctance in Science Teaching and Learning

The researcher prepared the IWBT science lesson plans based on the topics observed in the science classrooms. The instructional guide covered topics from Year 1 until Year 6 of Primary Science in government schools in Malaysia. The instructional guide proposes the IWBT science lesson plans for more effective integration of the IWBT in the science classrooms. The novelty of the instructional guide is that it allows the users or science teachers to select the IWBT features according to classroom activities and time frame as proposed in the instructional guide. Thus, science teachers can engage the pupils while infusing science process skills in IWBT equipped science classrooms within an estimated time as proposed in the instructional guide.

The IWBT instructional guide was verified by five experts with an education background i.e. the researcher‟s supervisor, two senior science teachers, a young science teacher and the e-classroom manager. After the first draft of the instructional guide were prepared, the researcher sought for verification from two colleagues with more than 15-years teaching experience and a young science teacher with one-year teaching experience. They were excited with the IWBT science lessons instructional guide and gave the researcher some positive feedback on content and pedagogical aspects.

Meanwhile, the researcher also asked for verification from the e-classroom manager for the technological aspect specifically on the integration of IWBT in science teaching and learning. The e-classroom manager gave encouraging feedback as she hoped to share such useful materials with other instructors. She verified and improved the most useful features of the IWBT from ten features to twelve features to consolidate the instructional guide (see Appendix Q). Table 5.4 shows the feedback and discussion with the peers and the experts.

Table 5.4
Feedback and Discussion with Peers and the Experts

Factors that lead to reluctance	Evidence from observational and interview data	Feedbacks and discussion with the peers and the experts
Time	Using this thing (IWBT) really time consuming. (T4, INT106) Too much papers work (admin work) until I cannot totally concentrate in preparing my lessons. (T2, INT85-86)	Provide time frame for the use of each feature of the IWBT Suggest authentic learning environment and science process skills in the IWBT instructional guide
Training	“ (I‟m) Too short and sometimes teacher calls me to the front but I‟m not tall enough to write.” (FG, INT115-116) “Teacher, I know Oliver is not tall enough.” (FG, INT74) Most of the science teachers only managed to use 1-2 features of IWBT in their teaching and learning activities in the classrooms. The most frequently used was the „freeze‟ and „zoom in‟ of the visualizer but not the IWB at all (see Table 5.1).	Match the science activities with the use of suitable features of the IWBT Suggest the most useful features of the IWBT

Table 5.4 (Ctd.)		
Attitude	" I prepared power point presentation today because no more teaching software in our school learning system. If you visit my class one month earlier, I still can show you more interesting teaching style." (FN, T5-O12) "I want to use the school learning system but I don"t have the username and password. I can"t log in." (T4, INT59)	Prepare sample of the IWBT instructional guide Annotate the elements of authentic learning in the IWBT instructional guide
Unsolved technical problems	First, it"s really burden. You need to connect here and there before start to use it.(T4, INT103-104) When it was hanging, I have to switch off the Chrome and reopen again. (T3, INT58) Mainly, they refuse to connect the laptop and worry about the installation. (EM, INT10-11)	Prepare sample of the IWBT instructional guide. Explain the use of the suggested features in the instructional guide

The feedback and discussion with the peers and experts were considered to establish the elements of the IWBT instructional guide. The duration of time for each of the science lesson and classroom activity (for the IWBT Science Lessons Module) as well as the time frame needed for each of the IWBT features are provided in the booklet to overcome the factor of Time in integrating the IWBT for science teaching and learning.

Furthermore, in order to overcome the factor of Training which could be due to lack of knowledge and lack of practice, the most useful features of the IWBT were suggested. For instances, visual feedback, zoom, writing, drawing and erasing, mask, search light, annotating text and record the lesson. These related IWBT features were highlighted with red in the IWBT instructional guide and specifically shown as one of the columns in the instructional guide that matched with the classroom activities.

The findings of the present study showed that science teachers were unaware of the ready sources provided in the school learning system which is categorized under the theme of Attitude. In order to overcome the factor of Attitude, the IWBT instructional guide put forward the element of authentic learning environment by the peers and the experts to consolidate the science teaching and learning experiences in a fully equipped IWBT classroom. This element is highlighted in blue in the IWBT instructional guide and shown as one of the columns that matches with the classroom activities.

Lastly, the solution to overcome the factors of Unsolved Technical Problems included the IWB screen, connections, calibration and installation were put forward in the booklet. Figure 5.4 shows how the process of putting forward the IWBT instructional guide was done. A step-by-step instruction was developed to guide the user to install the IWBT and calibrate the IWBT screen. The speed of Internet is suggested in the booklet for better connection. Besides, the general troubleshooting was prepared to help the user to overcome the unsolved technical problem in integrating the IWBT in teaching and learning science. Table 5.6 shows the emerging solutions to overcome the factors of reluctance in integrating IWBT for science teaching and learning.

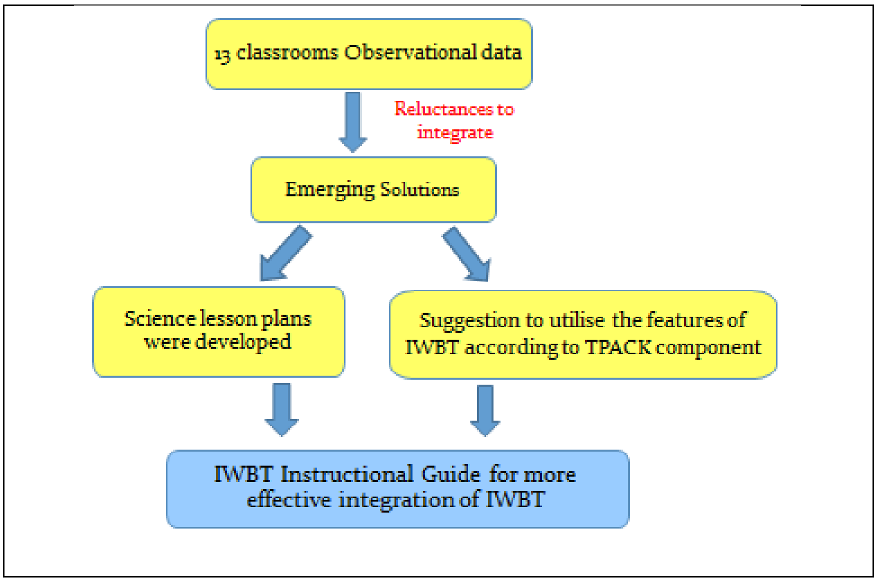


Figure 5.4. The Process of Putting Forward the IWBT Instrucional Guide

Table 5.5
The Emerging Solutions to Overcome the Factors that Lead to Reluctance in Integrating the IWBT for Science Teaching and Learning

Factors that lead to reluctance	Excerpts from interview data	The emerging solutions
Time: Lack of time	Too much papers work (admin work) until I cannot totally concentrate in preparing my lessons. (T2, INT85-86) The only problem is the technical part that when it happens, it really wasted my time.(T4, INT12-13)	• Provide the duration of time for each of the science lesson and classroom activity. • Provide the time frame needed for each of the IWBT features • General troubleshooting is prepared. • The installation tips are provided.
Time: Time wasting	Using this thing (IWBT) really time consuming. (T4, INT106) First, it‟s really burden. You need to connect here and there before start to use it.(T4, INT103-104) Sometimes the board shows that: „The board is disconnected.‟ As this happen, it‟s really wasting the time. (T4, INT 53-54)	
Training: Lack of knowledge	I seldom use because I‟m not familiar with the use of this board. (T2, INT28) Not enough (training). Through my	• The installation tips are provided. • Suggest the most useful features of the IWBT.

Table 5.5 (Ctd.)

	observations, a lot of teachers only use visualizer. Very less teachers use videos or other multimedia to teach. (T2, INT52-53) I don‟t know how to operate the IWB. (T3, INT78)	• The related IWBT features were highlighted with red in the IWBT and specifically showed as one of the columns that matches with the classroom activities.
	There are very few of them either made e-log or asked for technical support. Teachers seem don‟t like to make e-log to our system. (EM, INT36-37) (I‟m) Too short and sometimes teacher calls me to the front but I‟m not tall enough to write. (FG, INT115-116)	
Training: Lack of practice	We need to explore by ourselves. (T2, INT56) The training that the school provided was the first day as we entered this school. At that time, we‟re not ready yet and we were not assigning to teach at that time. (T4, INT91-92) I think the training should provide from time to time, if not we‟ll forget. (T4, INT95-96)	
Attitude: Ready sources	Now, we only invented the syllabus for three main languages. It is Bahasa Malaysia, Inggeris and Mandarin. (EM, INT56-57) I want to use it but I don‟t have the username and password. I can‟t log in. (T4, INT59)	• The sample of the IWBT was prepared.
Unsolved technical problems: IWB screen	I don‟t why the screen becomes blurring and the image is not in the place. (T3, INT81-82)	• The suitable speed of the Internet for better connection is suggested. • The installation tips are provided.

Table 5.5 (Ctd.)		
Unsolved technical problems: Connections	I don"t know what the problem is and why sometimes the school learning system is hanging. It can"t move. I"m not sure is due to my laptop or the line (internet itself). (T3, INT55-56)	• General Troubleshooting is prepared.
Unsolved technical problems: Calibration	The feedbacks that I got from them is the calibration depends on how frequent use of the IWB. If the IWB is not been use for a long time, it needs calibration. (EM, INT69-71)	
Unsolved technical problems: Installation	This kind of set up really depends on teachers" knowledge of IWBT. They really need to know how to set up the IWBT in order to use this technology. (EM, INT3-4)	

After the verification from the researcher"s supervisor and the experts, the researcher prepared the instructional guide as a booklet that contains the IWBT science lessons for science teaching and learning. The booklet has been created for the convenience of the users and as a support to teachers to integrate the IWBT more effectively in primary science classrooms. A sample of IWBT Science Lesson Plan is as below.

IWBT Science Lesson Plan (Year 1)

YEAR **:** One

THEME **:** Human

TIME **:** 60 minutes

CONTENT STANDARD **:** 4.1 Human Senses

LEARNING STANDARD **:** 4.1.1

LEARNING OBJECTIVES **:** At the end of the lesson, pupils will be able to state the parts of the human body and relate the parts with its sense.

SCIENCE PROCESS SKILLS: Observing, Classifying

PROCEDURES:

1. **Set Induction**
   a) Call a pupil to the front and blindfold him or her with a piece of cloth. Ask the pupils to walk around in the class.

b) Teacher asks: Can your classmate walk easily around in the class? Why?

2. Presentation

a) Teacher input

Today we will be learning about our five senses, which are sight, hearing, touch, taste, and smell. The senses of the body are the brain's link to the world that we live in. Everyone has the potential to use their five senses and this makes us all the same. Whether we are a boy or a girl, tall or short, shy or outgoing, we all are alike through our senses and the body parts that produce them. All of the five senses don't always work well. Some people may not be able to see, but they are able to hear, taste, touch, and smell. Some people are not able to hear, but they can see, taste, touch, and smell. They use their other senses to make up for the one(s) that they lost or don't have. This way, they experience what other people experience, just in a different way. We all have eyes that allow us to see, taste buds that allow us to taste, fingers that help us touch, ears that allow us to hear, and a nose that allows us to smell. Whether these senses work well or not, we all have the body parts that go along with the senses, which provides the potential to see, hear, taste, touch, and smell. This makes us similar to one another.

b) IWBT teaching and learning

Teacher plays a short video to provide pupils with the real life experiences with our five senses.

3. Modelling: IWBT teaching and learning

a) Teacher projects two pictures of animals (reptile and a bird) and guides pupils to **circle** the differences of the human body and animals.

b) Teacher projects a picture of a boy and introduces the parts of the human body and relates the parts with the appropriate senses.

c) Teacher guides pupils to **annotate/ label** the parts of the human body and their senses on the interactive whiteboard.

a) Teacher **records the pages** that played on the screen.

4. Guided practice: IWBT teaching and learning

a) Pupils are asked to observe their own body and compare with their friends.

b) Teacher **snaps a photo** of a pupil in the classroom and projects it on the screen.

c) Teacher facilitates pupils to **annotate/ label** the parts of the body on the screen in groups.

5. **Independent practice**
    a) Teacher provides pupils with exercise books.
    b) Pupils can practice after school.
6. **Closure: Checking for Understanding**
    a) The teacher asks the pupils some questions: Which body parts produce sight/ smell/ taste/ hearing/ touch?
    b) Guide pupils to say aloud the importance of their senses.
    c) Teacher plays the pages that recorded and gives a conclusion

REFLECTION:

Figure 5.5. Example of IWBT Science Lesson Plan (Year 1)

Table 5.6
Related use of IWBT Features (Year 1 My Senses)

Year/ Topic Area	Classroom Activities	IWBT Features Guidelines/ Time (minutes)	Science Process Skills that can be infused	Duration of Time (minutes)
Year 1 Human Senses	**Activity 1**: 1. Teacher shows two pictures of animal (e.g. cow and snake) to pupils using the IWB. 2. Teacher asks: (a) Name the parts of the animals shown. (b) Circle the parts of animals that you do not have on the IWB.	Using IWB features a) Searchlight to focus only on one of the observing objects among all in a single page (0.5min). b) Use the digital pen to circle on the IWB (1 min).	Observation Classifying	30 min
	Activity 2: 1. Pupils are asked to observe their own body and compare with their friends. 2. Teacher snaps a photo of a pupil in the classroom and projects it on the screen.	Using IWB features a) Zoom in/ out to resize the objects before or during the observations (0.5 min). b) Snap a photo of a pupil (1 min).	Observation Classifying Communication	30 minutes
	3. Teacher facilitates pupils to annotate/ label the parts of the body on the screen in groups.	c) Searchlight to focus each part of the body (0.5 min). d) Use digital pen to write or label on the IWB (2 min)		
	Activity 3: Identify and classify the objects according to characteristic of the objects.	Using IWB features a) Drag and drop to fill in the blanks (1 min).	Observation	60 minutes

Table 5.6 (Ctd.)

	b)	Use digital pen to write on the IWB (2 min).	Classifying Communication

Profiling of the use of the IWBT features by science teachers

This section addresses the fourth objective of this study, which is, identifying the emerging TPACK elements to create a rubric to profile science teachers. The theoretical framework of this study is based on the TPACK framework from which projections were made to put forward the dimensions of TecTP, TechT, TechP, TP, Technology, Teacher and Pupils. The projected dimensions were used to guide the exploration of the integration of the IWBT for science teaching and learning in a selected fully equipped IWBT Chinese primary school. This was followed by development of the IWBT instructional guide for more effective integration of the IWBT to overcome reluctance for science teaching and learning.

As the study progressed, the researcher realized that rich emerging data although analysed within the projected dimensions, also reflected the original TPACK elements that can be used to create a rubric to profile science teachers. For instance, the features of the IWBT, science teaching activities and dependency of technical problem solving are the elements found in the data related to the original TPACK framework. As such, in developing the IWBT Rubric, the researcher considered the knowledge areas of technological, pedagogical and content that science teachers applied in the classrooms such as the use of the IWBT features, pupils" engagement, and science teaching activities, teaching-learning materials and so on.

An initial test was administered using this rubric specific for IWBT in the selected fully equipped IWBT Chinese primary school. There are two parts in this rubric, i.e. Part A and Part B. Part A contains science teachers‟ demographic information and Part B contains a table that assesses science teachers by levels and components of TPACK related to IWBT. The levels of the rubric are Beginner Level, Intermediary Level, Proficient Level and Mastery Level; the components of the rubric are TK, PK, CK, TPK, TCK, PCK and TPACK. For instance, at the beginner level of TK is related to 1-2 features of the IWBT with teaching activities and the capability of solving problem related to IWBT.

Appendix M is the IWBT rubric for profiling science teachers‟ use of their TPACK related to IWBT for science teaching and learning. Science teachers also can use this instrument to do self-assessments to know their self-perception of their TPACK related to the IWBT in science teaching and learning. A pilot test was carried out to test this rubric in the field. This instrument can be used in primary school science classrooms with IWBT equipment but this is not the scope of this study. This rubric appears to be a future tool that can be used in school though more testing is needed in another study. Below are discussions about science teachers‟ profiling of the use of the TPACK related to the IWBT for science teaching and learning.

More than 15 years science teaching experiences teachers. Teacher A, Teacher B and Teacher C shared similarities in TK, PK, CK and PCK. They showed low TK but higher PK, CK and PCK. They had lack knowledge about IWBT and were at the beginner level in integrating IWBT in science classrooms but they were very familiar with the science content knowledge and able to engage pupils physically, cognitively and affectively in creating authentic learning environment.

Teacher A showed highest PK, CK and PCK among three teachers in this group but she was low in all technological knowledge areas which were TK, TPK, TCK and TPACK. These results were congruent with the data observation in classroom as she was one of the research teachers. The only technology used in her classroom was visualizer and the IWB was used as projection screen. Teacher A"s use of her TPACK shown in radar chart as below.

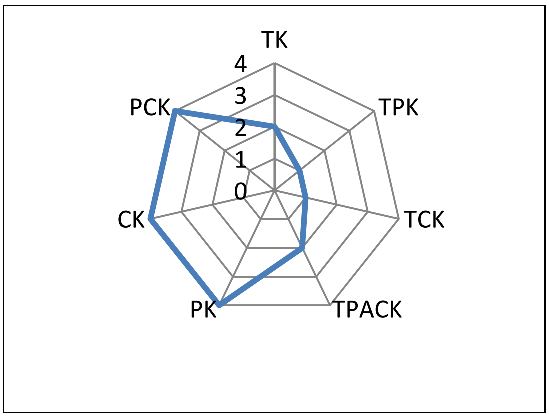


Figure 5.6. Teacher A"s use of her TPACK related to the IWBT

Meanwhile, Teacher B was showed all knowledge areas at proficient level except her TK was in intermediate level and PCK was in mastery level. She agreed with the integration of IWBT in science classroom can promote pupils" learning interest but sometimes she needs help with the IWBT if there are problems. Furthermore, she stated that there is still a room for her to improve her science content knowledge. In spite of this, she had high confident in her PCK and she stated that she was more experiences in teaching science. Teacher B"s IWBT Rubric data shown in radar chart as below.

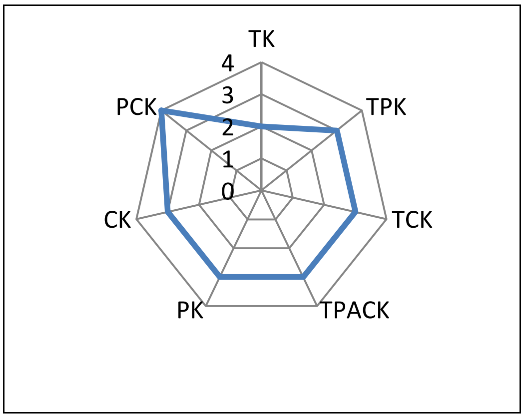


Figure 5.7. Teacher B‟s use of her TPACK related to the IWBT

Teacher C use of her technological knowledge related to the IWBT was very low. She mentioned that she had difficulties in learning to use the technologies in classroom due to her older age and she hardly remembered the procedures of using the IWBT. Since she was a most experiences teachers in school, her perception of her PCK is high. Teacher C‟s use of her TPACK related to IWBT shown in radar chart as below.

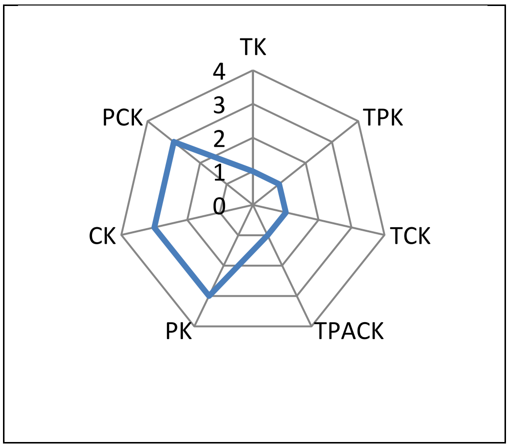


Figure 5.8. Teacher C‟s use of her TPACK related to the IWBT

5 to 15 years science teaching experiences teachers. Teacher D and Teacher E‟s knowledge about all the seven components of knowledge were at or above intermediate level. Teacher D had higher TK, TPK and PCK than Teacher E. Teacher D stated that she used the visualizer to teach with textbook and exercise books and the learning software provided in school learning system while Teacher E stated that her TK still need to improve and she needed help with IWBT if there are problems. Both of the teachers were at the mastery level of their PK whereas they used static pictures, PowerPoint presentation, videos, internet in their science teaching. Figure 5.9 shows the use of their TPACK related to the IWBT.

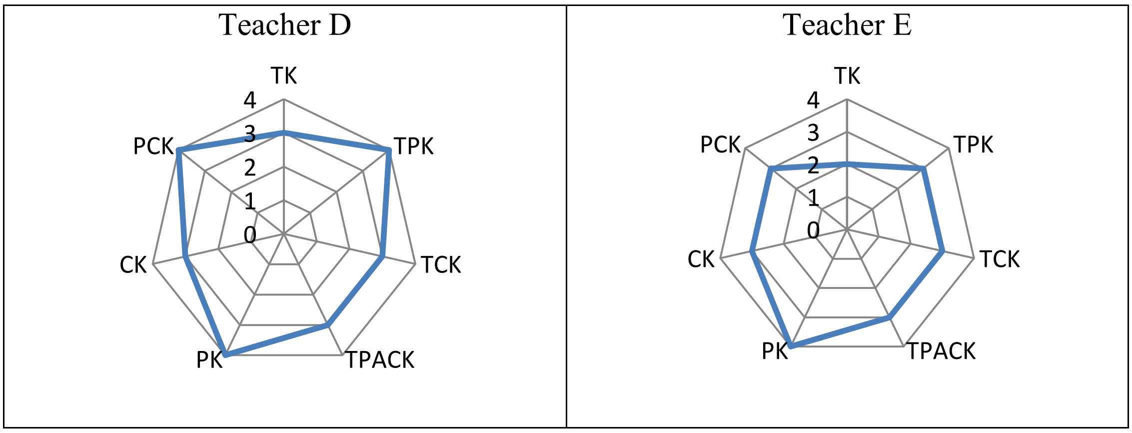


Figure 5.9. Teacher D‟s and Teacher E‟s use of their TPACK related to the IWBT

Teacher D had showed a mastery level for TPK, PK and PCK and proficient level for TK, TCK, TPACK and CK. She gave feedback that the IWB could not allow all pupils to write and draw at the same time but she showed her favour in using the learning software in school learning system.

On the other hand, the only knowledge area that showed mastery level from Teacher E‟s data was PK. The other knowledge areas were at the proficient level except TK was at the intermediate level. She mentioned that she still have rooms to improve her technological knowledge.

Below 5 years science teaching experiences teachers. There were eleven science teachers with below 5 years of science teaching experiences participated in this rubric assessment. Three of the science teachers (Teacher F, Teacher G and

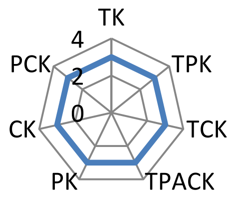
Teacher H) showed similarities in their use of their TPACK in the areas of TK, TPACK, PK, CK and PCK which were at proficient level.

In comparing the use of TPACK related to the IWBT, it was found that only a knowledge area difference between Teacher G and Teacher H which was TPK. Teacher H showed one level higher of TPK than Teacher F. Teacher F"s had proficient level of all seven components of knowledge area. On the other hand, teacher G showed one level lower of TCK compared with Teacher F and Teacher G. This may due to Teacher F and Teacher H were degree holder qualifications but Teacher G only possessed Diploma in Education.

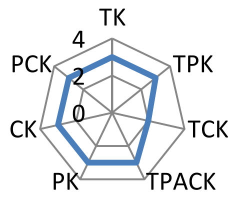
Furthermore, Teacher F mentioned that the use of IWBT in science classroom provided pupils with virtual learning experiences and eased teaching and learning. He also stated that IWBT can arouse pupils" interest in learning but he showed worry about vandalism of the IWBT among pupils. Teacher H stated that her perception on TK was at proficient level but not at the mastery level because of the sensitivity of the IWB that led her reluctance in using it. She further mentioned that she used learning software frequently but not at mastery level. She judged her TPK to be at mastery level because pupils favoured in using the IWBT. She always provided her pupils to do exercises on the IWB.

Besides, Teacher G stated that she needs help with the IWB if there are problems but she enjoyed using the IWBT in the teaching. She mentioned that the learning materials provided by school are convenience to use. She also stated that she managed to engage pupils physically, cognitively and affectively most of the time in integrating technology based teaching-learning materials. This finding is congruent with classroom observation data collected whereas she used PowerPoint presentation prepared by her to teach science content knowledge. Her classroom observation showed that there is a need to improve her technological knowledge as pupils still using marker pen to write on IWB on Teacher G‟ PowerPoint slide but not digital pen of the IWB. The radar charts below indicate these;

Teacher F



Teacher G



Teacher H

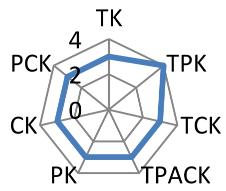


Figure 5.10. Teacher F‟s, Teacher G‟s and Teacher H‟s use of their TPACK related to the IWBT

Out of eight teachers, there was only two teachers‟ use of their TK is slightly low comparing to the other teachers. These two teachers are Teacher J and Teacher M. Both of them explained that they were not familiar with the IWBT in the classrooms due to only exposed to one lesson of IWBT training before they went to the field to use this technology. This indicated that trainings are needed to overcome the reluctance in integrating IWBT in classroom. Additionally, Teacher J‟s CK, PCK and TCK are one level higher than Teacher M. She mentioned that lesson preparation before class was important as it increased her familiarity about the science content and thus she judged her CK at a mastery level. This findings is parallel with the findings of the past researches which elucidated that teachers‟ attitude influenced the teaching pedagogies in the science classrooms (Murcia, 2014; Warwick et al., 2010). Meanwhile, Teacher M revealed that this was her first year of teaching and she cannot control her pupils well and she needed help with the IWB if there are problems. Thus, she rated her PCK and TCK at intermediate level. Teacher J‟s and Teacher M‟s use of their TPACK related to IWBT were as below.

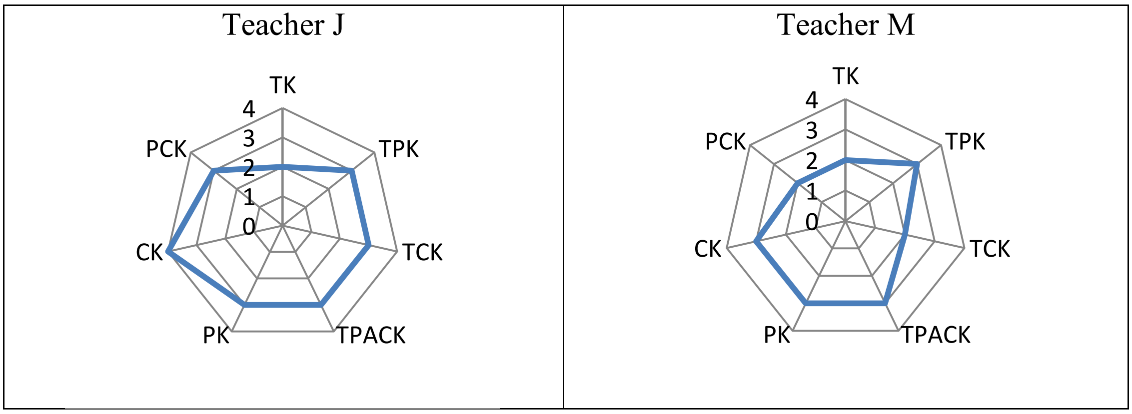


Figure 5.11. Teacher J‟s and Teacher M‟s use of their TPACK related to the IWBT

On the other hand, there were four teachers‟ CK were low among this group of teachers. They were Teacher I, Teacher K, Teacher L and Teacher O. Teacher I stated that there were some rooms for her to improve her PK. She judged her CK, PCK, PK and TPACK at intermediate level but her TK, TPK and TCK is slightly higher which were at proficient level. Meanwhile, Teacher K‟s seven components of knowledge areas were at proficient level but her CK and TPK were slightly lower which were at intermediate level. Likewise, she indicated there are trainings needed to improve her knowledge in integrating IWBT. Moreover, Teacher O‟s knowledge areas were one level higher than Teacher L except her CK. Teacher O‟s CK was at beginner level but Teacher L‟s CK was at intermediate level. Both of them showed the same level of TK, TPK, TPACK and PK which were at proficient level. The findings revealed that IWBT eased the teaching and learning in the classroom and they showed preferable in using visualizer and the features of zooming in their presentation in classroom but seldom provide pupils with the opportunities to use the IWB. Similar to Teacher J and Teacher M, Teacher L‟s and Teacher O‟s findings indicated that there were trainings are needed to overcome the reluctance in integrating IWBT in classroom. Teacher I‟s, Teacher K‟s, Teacher L‟s and Teacher O‟s use of their TPACK related to IWBT were as below.

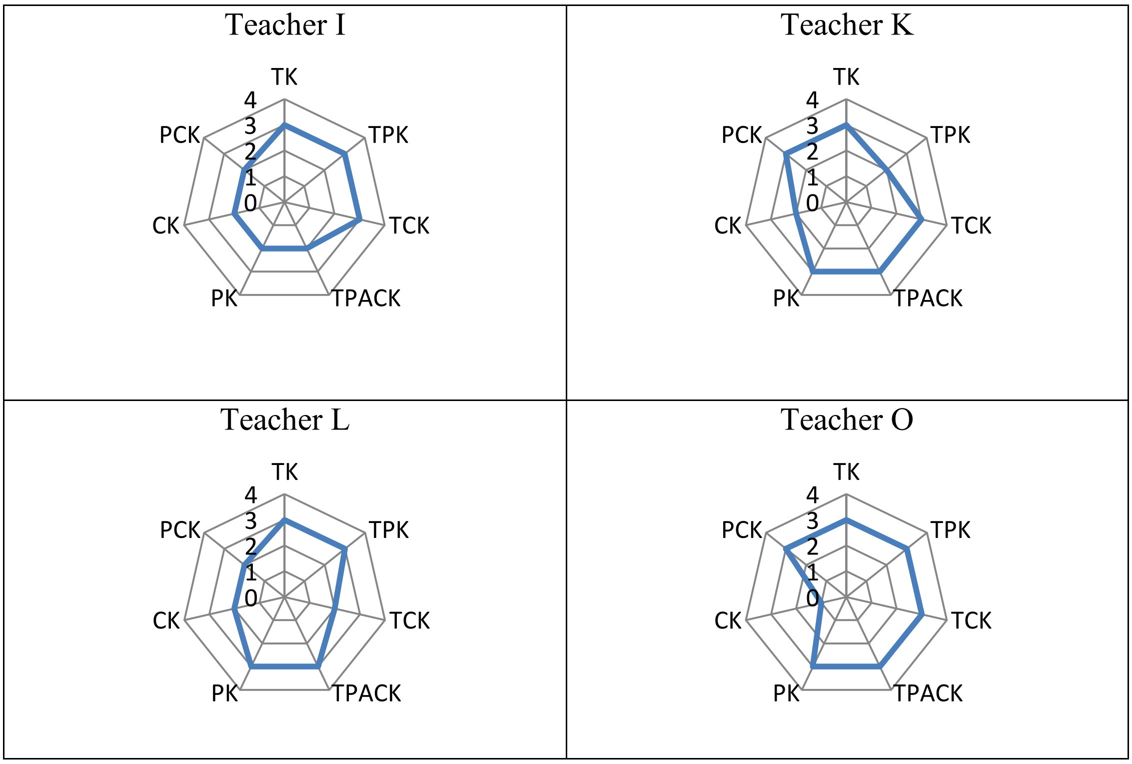


Figure 5.12. Teacher I‟s, Teacher K‟‟s, Teacher L‟s and Teacher O‟‟s use of their TPACK related to the IWBT

Teacher N‟s and Teacher P‟‟s use of their TPACK related to IWBT were almost same as showed in radar chart below. The findings indicated that was only difference in their PCK. Teacher P‟‟s PCK was at mastery level while Teacher N‟‟ PCK was at proficient level. Both of them mentioned that they can engage their pupils in learning by explaining the whole structure and process of primary science subject matter due to their familiarity with the science content. On top of that, Teacher F and Teacher N showed similar of their use of the TPACK related to IWBT as their radar charts were similar. Figure 5.13 and Figure 5.14 show their radar charts.

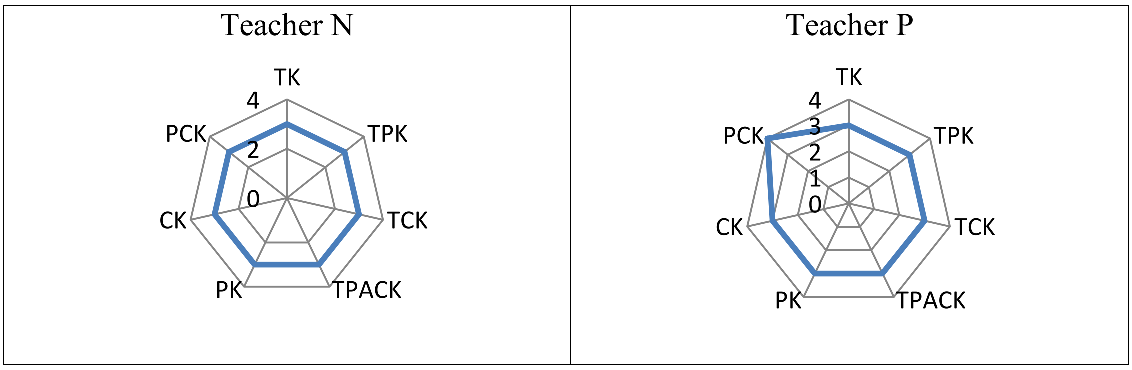


Figure 5.13. Teacher N‟s and Teacher P‟s use of their TPACK related to the IWBT

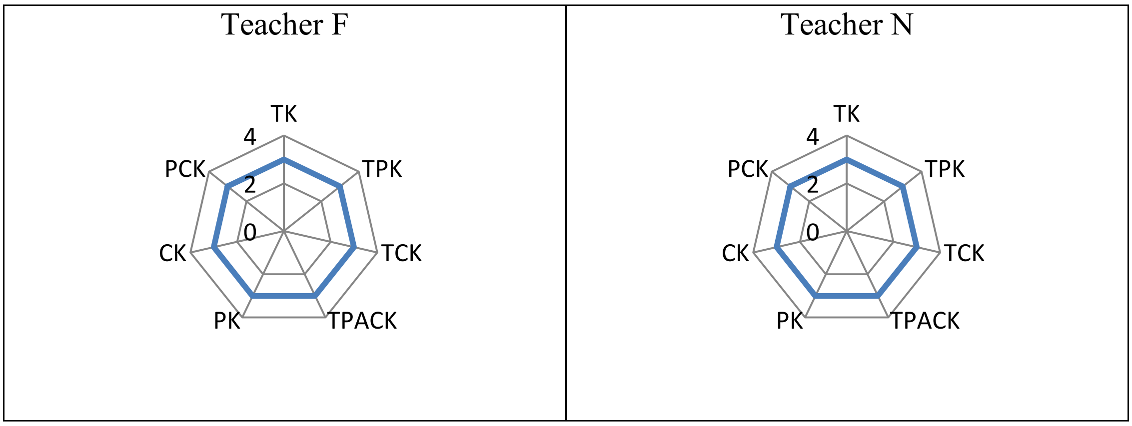


Figure 5.14. Teacher F‟s and Teacher N‟s use of their TPACK related to the IWBT

Chapter Summary

In this chapter, integration of IWBT in science teaching learning is discussed in details from the perspective of TPACK theory as the underpinning model for the projected notions. The reluctance of using the entire IWBT showed that science teachers‟ preferable in using laptops and visualizers but none of the features of IWB, i.e. the IWBs were only used for projection purposes.

The main factors that led to reluctance in integration of the IWBT are Time, Training, Attitude and Unsolved Technical Problems which emerged from the data collected. Earlier codes were identified before the emerging of the final codes from the emerging data. The researcher has proposed the IWBT instructional guide for more effective integration of IWBT in the science classrooms and suggests the usefulness of the IWBT in a booklet to allow the users or science teachers to select the IWBT features according to classroom activities and time frame as proposed in the IWBT instructional guide.

Furthermore, the rich emerging data of TPACK elements was used to create a rubric to profile science teachers. The researcher considered the knowledge areas of technological, pedagogical and content that science teachers applied in the classrooms such as the use of the IWBT features, pupils" engagement, and science teaching activities, teaching-learning materials and so on in developing the IWBT Rubric.

Chapter 6: Summary, Implications and Conclusion

Introduction

The general objective of the present study was to investigate the factors of reluctance in the integration of IWBT among science teachers in order to put forward an instructional guide for more effective integration of IWBT to overcome the reluctance for science teaching and learning in a selected fully IWBT equipped Chinese primary school. Using TPACK theory (Mishra & Koehler, 2006; Mishra & Koehler, 2009), researcher"s intention to explore in-depth the factors that lead to reluctance and gaining science teachers" valuable opinions and suggestions to overcome the reluctance of integration IWBT available in classrooms were achieved. Findings of science teachers" use of their TPACK related to the integration of the IWBT had strengthened the novelty of the present study whereas the IWBT Instructional Guide were developed to help science teachers to overcome the reluctance in integrating the IWBT in classrooms.

Summary

This present study has successfully achieved its four objectives and answered four research questions. The findings of the four research questions are summarized and presented in following section.

Integration of the IWBT in science teaching and learning. The findings about the integration of IWBT in science classrooms were presented in seven perspectives of knowledge areas of the projection notions of the TPACK theory (Mishra & Koehler, 2006; Mishra & Koehler, 2009). This present study revealed that science teaches‟ technological knowledge was at the beginning level as the multifunction IWB was used for projection purpose. All of the science teachers were familiar with the use of visualizer, laptop and played the learning software in classrooms but do not familiar with the connection of the visualizer or laptop to the use of the multi features of the IWB and thus most of them only managed to use 1-2 features of the IWBT into their teaching and learning activities in the classrooms. The most frequently used was the „freeze‟ and „zoom in‟ of the visualizer but not the IWB at all. The IWB was used for projection purpose.

Science teachers used the visualizer in the classrooms to project the printed materials for explanation, discussion, reading and the assigning homework to pupils. None of the science teachers used the available features of the IWB. The IWB was only used as a projection screen. Furthermore, science teachers used the computer or laptop to display Power Point presentation or the ready teaching and learning sources in the school learning system and the IWB was only used as a screen.

There were evidences showed that science teachers incorporated the science process skills and engage pupils physically, cognitively and affectively in science classrooms with the use of the IWBT (Kwan, 2016; Warwick et al., 2013, 2010). However, this present study revealed that science teachers were reluctance in integrating the IWBT to the fullest in the fully equipped IWBT classrooms (Al-Qirim, 2011; Gray et al., 2010; Low, personal communication, May 17, 2015). Science teachers elucidated that they need help in integrating the IWBT in science teaching and learning.

Factors that lead to reluctance in integrating IWBT for science teaching and learning. There are four main factors that lead to reluctance in integrating the

IWBT for science teaching and learning. The main factors are time, training, undelivered information and unsolved technical problems which emerged from the data collected. Firstly, the findings of this present study revealed that science teachers lacked of time due to the burden of works until she or he did not have much time to spend on learning or preparing the lesson to integrate the IWBT in her lessons (Kopcha, 2012; Nikian, Nor & Aziz, 2013). Furthermore, the findings suggested that using IWBT in science classrooms were time consuming due to the setting up of the IWBT specifically setting up the laptop and the IWB, and also lack of practice restricted them excel in operating the IWBT.

The second factor is training which emerged from categories of „lack of knowledge" and „lack of practice". Science teachers were not familiar with most of the features of IWBT restricted them to use the IWBT in classrooms. All of the science teachers revealed that training provided in school was not enough to support the teaching and learning in classrooms. They further demonstrated a need to attend trainings to improve their knowledge about the use of the IWBT in classrooms.

Thirdly, science teachers" attitude is one of the factors that lead to reluctance in integrating the IWBT for science teaching and learning (Murcia, 2014; Warwick et al., 2010). Science teachers complained the problem of login the school learning system and incomplete of school learning materials. These were due to undelivered information among teachers about the ready sources and the login protocol in school.

The forth factor that lead to reluctance in integrating IWBT for science teaching and learning is unsolved technical problems which was due to IWB screen, connections, calibration and installation of IWBT. In this present study, science teachers elucidated that they faced various problems with this technology and they need help to solve the problems. They mentioned that sometimes the screen colour has issue, disconnect between the laptop and the IWB, unstable of the learning software provided and time-consuming calibration needed before start to use the IWB were problems that lead to reluctances in integrating the IWBT among science teachers.

IWBT Instructional Guide for more effective use of IWBT to overcome the reluctance in science teaching and learning. The elements of the IWBT were established to put forward the IWBT Science Lesson Plans and the IWBT Instructional Guide which included the classroom activities, IWBT features, science process skills and the duration of time. The IWBT Instructional Guide were developed upon referring to the classroom activities that proposed in the IWBT science lesson plans for more effective integration of IWBT in science classrooms. The novelty of the guidelines was that they allow the science teachers to select the IWBT features according to classroom activities and time frame that proposed in the guidelines. Furthermore, science teachers can connect their pupils with engagement while applying science process skills in the IWBT science classrooms within an estimated time proposed in the guidelines. The Installation Tips, General Troubleshooting, the IWBT Science Lesson Plans, the IWBT Instructional Guide and The Usefulness of the IWBT were assembled in a booklet for more effective integration of the IWBT and help science teachers to overcome the reluctance for science teaching and learning in selected fully equipped IWBT classrooms.

Science teaches' use of their TPACK related to the integration of IWBT for science teaching and learning. More than 15 years of science teaching experiences teachers showed low technological knowledge in comparing with the other two groups of teachers which were 5 to 15 years or less than 5 years of science teaching experiences teachers. They had lack knowledge about IWBT but they were very familiar with the science content knowledge in comparing with less than 5 years of science teaching experiences teachers.

On the other hand, teachers with 5 to 15 years of science teaching experiences showed higher knowledge areas in TK, TPK, TCK, TPACK and PK comparing with more than 15 years of science teaching experiences teachers. Their CK and PCK appeared similar comparing with more than 15 years of science teaching experiences teachers.

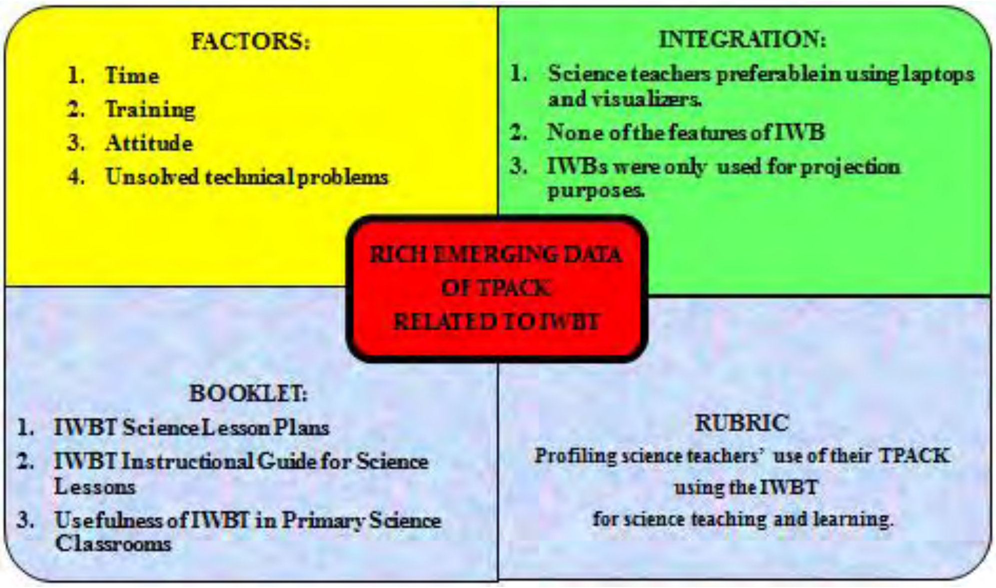


Figure 6.1. Key findings of the present study

Meanwhile, below 5 years science teaching experiences teachers‟ profile of the use of TPACK related to the IWBT shows that the qualifications of science teachers influence teachers‟ TCK. Science teachers with degree holder qualifications showed higher TCK compared with the science teacher possessed Diploma in Education. Furthermore, below 5 years science teaching experiences teachers‟ profile of the use of TPACK related to the IWBT also elucidated that they need training to improve their TK and CK. This present study also found that science teachers" attitudes influence their TK in integrating the IWBT in science teaching and learning (Murcia, 2014; Warwick et al., 2010). Figure 6.1 shows the key findings of this present study.

Implications of the Study

Several implications for stakeholders (e.g., scholars, teachers, school authorities, Board of Directors, Parent Teacher Association) are given based on the findings presented in the present study.

Firstly, there are several implications for IWBT research. Due to its significant contribution to teaching and learning in classrooms, research related to IWBT has been overwhelming in the past decade. Although there has been much research related to IWBT, there is as yet a lack of investigation of IWBT using TPACK theory especially in Chinese primary school in Malaysia. In this present study, the researcher observed IWBT integration from seven domains of knowledge areas as suggested by Koehler and Mishra (2009). Hence this present study had contributed by providing a different dimension of understanding about the integration of IWBT in Chinese primary school in Malaysia.

Secondly, teachers should be aware of the use of IWBT features in science classrooms. In this present study, when the researcher interviewed teachers about the integration of IWBT in science classroom, none of the teachers could explained the features of IWBT explicitly although they have had training. In spite of that, none of the classroom observations showed that science teachers using the digital pen or finger to write on the IWB but there was a science teacher used marker pen to write on the IWB when she was guiding pupils to answer the questions. This indicates that teachers need a proper guideline to help them to use the features of IWBT in daily instruction. Teachers knew the features of IWBT but were not aware of how to use them appropriately. The present study provides science teachers a useful guideline for science teaching and learning. Teachers can refer to the booklet created by researcher before or during the science lesson as refer to the science activities and the related features of the IWBT in the guideline.

Thirdly, the school leadership must continuously upgrade themselves on knowledge of IWBT. School leadership has to play an active role in leading and supporting their teachers in integrating IWBT in classrooms. When the school authorities have the relevant knowledge, they would decide what kind of training teachers needed to overcome the reluctance in integrating the IWBT in classrooms. In the present study, researcher revealed that the factors that lead to reluctance in integrating IWBT in science classrooms were time, training, attitude and unsolved technical problems. School leadership should know clearly about the factors of reluctance in integrating IWBT among school teachers when they plan for professional development for teachers, invite experts on IWBT to conduct workshops that would support their teachers in daily instructions. Thus, school leadership will have a clearer idea of how to implement the professional developments for teachers" long terms practices in science teaching and learning in the classroom using IWBT.

Furthermore, the school leadership can encourage teachers to plan and design their lessons which inspire the integration of the IWBT and help the teachers in planning and designing their lessons by providing sufficient training to integrate the classroom technology. Thus, it can perhaps help to overcome the reluctance of the technologies available in the classrooms and the use of IWBT for instructional purposes.

Lastly, the research findings of this study offer useful data to various parties including the Ministry of Education, Board of Directors and Parent Teacher Associations in deciding upon the investment of IWBT in the classrooms. The investigation of this present study was done in a fully equipped IWBT Chinese primary school but the observation data showed that IWB was used as a normal whiteboard for projection purpose. This point of view gives the decision maker to well plan the investment related to this technology in classrooms. This present study suggested that investment of IWBT should be done stage by stage which incorporate with the trainings that allow teachers to up-grade their knowledge to meet the new installation of IWBT in classrooms.

Suggestions for Future Research

Suggestions for future research were drawn by considering the need to uncover several aspects which remain unclear in the integration of IWBT in primary Chinese government school. Several ideas for this are suggested below.

This present study covered only a selected fully equipped IWBT Chinese primary school in Klang Valley. Hence, it covered only one primary Chinese government school in Malaysia. Future studies should be carried out with other primary Chinese government schools in Malaysia. In addition, the research also can be conducted for primary national schools in Malaysia. By covering different types of schools, the findings of the research will be more comprehensive. A better understanding of integration of IWBT in science classrooms can be obtained in relation to various types of schools with these further studies.

The IWBT Instructional Guide for more effective integration of IWBT to overcome reluctance for science teaching and learning as well as a rubric for profiling science teachers" use of their TPACK using IWBT have been put forward in this present study based on the integration of IWBT and the factors that lead to reluctance in the integration in the selected school. The IWBT instructional guide and rubric may not be appropriate to use in other context as they are based on the context in the selected school. Therefore, the future study can be done by covering bigger sample from various states in Malaysia could produce precise and truthful results.

Another aspect that would be interesting to analyse is the features of IWBT that influence the pupils" engagement in learning. It would be fascinating to see how pupils interact physically, cognitively and affectively with each of the features on IWBT as they are given opportunities to use the technology in classroom. At the same time, explore the preference of using the particular features of IWBT among teachers. Additionally, an in-depth of research can be done in exploring teachers" preferable of using the each of the features of IWBT which can be related to pupils" engagement.

Future studies can also be carried out with teachers from different background, teaching at different level, in rural or urban school, at private or public schools, would add valuable data for development of a comprehensive and meaningful IWBT instructional guide as well as IWBT science lesson plans to help instructors in daily teaching and learning in fully equipped IWBT science classrooms.

Conclusion

This present study looked in-depth into the reluctance of the integration of IWBT by determining the factors that lead to reluctance in integrating the IWBT in science classrooms which was the gap found between the amount of technology available in today‟s classrooms and teachers‟ use of that technology in daily instructions (Al-Qirim, 2011; Gray et al., 2010). It gives a different dimension of integration of IWBT in science classrooms as the investigation was made from the perspectives of TPACK theory and thus it provides data for various parties to have a comprehensive understanding about the real situation in the fully equipped IWBT classrooms.

The novelty of this present study is the development of an IWBT instructional guide for more effective use of the IWBT and advancement of a rubric to profile science teachers‟ use of their TPACK related to IWBT. Furthermore, the rubric was developed according to science teachers‟ integration of the IWBT in science classroom which was compared and contrasted through the data gained from classroom observations, interviews with science teachers and triangulation with other sources of data. With the instructional guide for reference, it is hoped that teachers can excel in the use of the features of the IWBT for science teaching and learning.

With the rubric assessment, science teachers‟ TPACK related to IWBT use can be determined. Science teachers also can use this rubric as an assessment to know their self-perceptions of their TPACK related to the IWBT in science teaching and learning. Eventually, science teachers‟ TPACK is the main concern in overcoming the issue of reluctance in integrating IWBT to provide our pupils with better engagement and learning experiences in today‟s science classrooms.

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