The Development of The Pedagogical Content Knowledge (PCK) Standard for Malaysian ICT Teachers

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Abstract

The main aim of this study is to develop the Pedagogical Content Knowledge (PCK) standard for Malaysian ICT teachers. The researchers used the Delphi method to analyze data elicited from a group of practitioners, namely 245 expert ICT teachers who volunteered to participate in the study. Using this method, the teachers' opinions were elicited through three rounds of survey to reach a consensus regarding the importance of three domains of ICT teaching: (a) Knowledge of students and learning, (b) Knowledge of curriculum, and (c) Knowledge of teaching strategies. The analysis of the data showed that there were 13 important knowledge items required by ICT teachers, 45 very important knowledge items, and one moderate item. This finding helped the researchers in developing the PCK standard that can help institutions of higher learning to improve current training practices of ICT trainee teachers.

Keywords Content Knowledge, Delphi Method, ICT Teachers, Pedagogical Content Knowledge

INTRODUCTION

Information and Communication Technology (ICT) has radically changed, and will continue to change, the way of our lives. To keep abreast with the rapid development of ICT, school curricula need to be upgraded and improved to produce students who are conversant in technology. Given this imperative, the Ministry of Education (MOE) of Malaysia has introduced several elective subjects to be taught at the secondary school level where the ICT subject is one of the electives (Ministry of Education, 2012). The subject is taught by teachers who hold Bachelor of Education (Technology Education) degrees or equivalent

after graduating from the public universities, including *Universiti Pendidikan Sultan Idris* (UPSI). With this qualification, these teachers are expected to possess the necessary ICT skills to impart students with the right knowledge that is relevant to the needs of our globalized world (Ministry of Education, 2006). In view of the rapidly changing ICT, teachers are encouraged to study at the postgraduate level so that they become more proficient and highly trained; in turn, students will benefit tremendously from improved teaching by these teachers. In the long run, these students could develop a keen interest in pursuing ICT-related careers – jobs that form the core of the ICT workforce, which is badly needed by companies operating at the Multimedia Super Corridor (MSC). Currently, efforts to recruit local talents to fill up numerous ICT positions at these companies with the MCS status are not making an impact. Apparently, the average quantity and quality of existing crop of ICT students may partly contribute to this problem. Thus, public universities of Malaysia need to improve their ICT programs, especially for teacher training to produce highly-trained ICT teachers who will be able to teach ICT subjects at the secondary schools with greater efficacy.

Currently, a number of public universities are offering the ICT teacher training programs in Malaysia. However, there is no common structure for the programs being offered. In fact, the ICT trainee teachers are being trained in eight semesters using different program structures. Thus, these trainee teachers will gain knowledge and skills at various degrees of competency. For example, the teacher training program offered at UPSI will use the program structure that focuses on trainee teachers acquiring the relevant content knowledge, pedagogical knowledge and pedagogical content knowledge. Upon graduation, these teachers will be posted to various secondary schools throughout the country to teach ICT. Naturally, these new ICT teachers will rely on an amalgam of knowledge gained from their university training (Rice, 2003), teaching practicum (Fransson, 2010; Hobson et al., 2009), and new teaching environment (Carlgren & Klette 2008). More importantly, the experiences that these teachers gained during teaching practicum help develop their pedagogical content knowledge (PCK), which is an important amalgamated knowledge in teaching and training careers.

PROBLEM STATEMENT

Most Malaysian institutions of higher learning (IHLs) offer teacher training programs, including ICT, based on their own program structures, where the common goal is to develop teachers with sound PCK. The program structures used by these IHLs differ quite markedly due to the absence of a single and unified standard or guideline. Consequently, the trainee teachers will develop the PCK at various levels of competency, depending on their training institutions. Upon graduation, these new teachers, with varying degrees of PCK, will begin their career as ICT teachers in the secondary schools nationwide. Inevitably, teachers with different PCK will teach the subject

matter quite differently in schools, making teaching practices inconsistent on a national scale. Hence, students will learn in different teaching environments, which ultimately lead to different learning outcomes. Further compounding this problem is that schools are not able to gauge these new teachers' abilities in teaching ICT due to a lack of guidelines. Similarly, universities offering the education degree in ICT do not have a PCK standard to measure teachers' ICT teaching skills.

The training of ICT teachers is carried out both at the IHLs and schools. Most of the theoretical aspects of ICT teaching are dealt with in the respective faculties of education. On the other hand, the practical aspects of ICT teaching are carried out in schools. During practicum, which spans 16 weeks, trainee teachers are supervised by teacher supervisors (Universiti Pendidikan Sultan Idris, 2010). The teaching skills of the trainee teachers are appraised both by the teacher supervisors and lecturer supervisors. However, the current practice of appraisal is solely based on the evaluation guidelines; there is no PCK standard used to measure trainees' teaching skills in terms of content, pedagogical, pedagogical content knowledge.

RESEARCH OBJECTIVES

The aims of this research is to formulate a PCK standard to assess the competency of ICT teachers in Malaysia. In this research, PCK refers to three knowledge domains: (a) knowledge of the students and learning; (b) knowledge of the curriculum; and (c) knowledge of the teaching strategy.

LITERATURE REVIEW

The importance of the PCK was first acknowledged by Dewey (1964) who stated that to understand teaching is actually to know how to consolidate students' curriculum. This notion was further discussed by other researchers (Shulman, 1986, 1987) until it became clear that PCK is very important in the teaching profession because this knowledge represents the basic knowledge in teaching. Shulman (1987:15) explains the importance of the PCK as

> "The key to distinguishing the knowledge base of teaching lies at the intersection of content and pedagogy, in the capacity of a teacher to transform the content knowledge he or she possesses into forms that are pedagogically powerful and yet adaptive to the variations in ability and background presented by the students"

Researchers such as Shulman (1986), Carlsen (1999), Grossman (2003), and Borko and Putnam (1996) assert that teaching quality is determined by a teacher's mastery of PCK so the teacher will be able to translate the subject into lessons in the class. This assertion concurs with other researchers who contend that PCK is a teacher's content knowledge, which is transformed into practical application in teaching. This type of knowledge differentiates a teacher from a

content expert (Cochran, 1993). Teachers with PCK will be able to help students to learn the content (NCATE, 2002) by understanding the contents to be taught using different methods, which are appropriate to the culture, background, prior knowledge, and experiences of the students.

The PCK of teachers is classified into four knowledge areas: (a) teachers' knowledge of students' understanding of concepts; (b) knowledge of curriculum; (c) knowledge of teaching strategies; and (d) knowledge of requirements and teaching aids (Grossman, 1990). More specifically, the areas of content knowledge and pedagogical knowledge (Grouws & Schultz, 1996) cannot be separated (Marks, 1990), and PCK is used by teachers as a guide to plan, manage and conduct teaching.

Knowledge about students and learning is used by teachers to choose suitable teaching and learning strategies (Shulman, 1986; Borko & Putnam, 1996) appropriate to students' background, socio-economy, learning style, ability and benefits, difficulty of topics, and misconceptions. This knowledge is known as pedagogical knowledge (Grimmett & MacKinnon, 1992) which must be acquired by all teachers. The lack of this knowledge will result in teachers not being able to teach effectively, which is (among other things) due to their inability to discern students' learning disabilities and misconceptions in ICT (Sulaiman, 2010).

Curriculum knowledge deals with understanding of ICT subject contents as stated in the specific subject teaching plan (Grossman, 1990), including substantive and syntactic knowledge. For example, in the standard of teaching of science (NCTA, 2003), teachers must have the ability to understand and explain the knowledge and current practices in science. They must be able to relate and interpret concepts, ideas and applications in that field as well as to carry out research and generate reports. Teachers should transform content knowledge into the school's curriculum. This transformation process is dependent on the teacher's knowledge and beliefs of the subject curriculum, teaching objectives, students, pedagogy, school context and curriculum (Wilson, Shulman, & Richert, 1987).

Teachers' knowledge of the curriculum will enable them to understand specific attributes of a subject, including each topic as well as able to differentiate the attributes that will have an impact on students' learning styles (Coffield et al. 2004). Teachers need to understand the teaching and learning objectives and how to deliver the lesson to meet the objectives (Shulman & Shulman, 2004). The key to this understanding is through the use of pedagogy, evidence, and explanations, and the related concept (Lubinski & Otto, 2004).

The teaching strategy knowledge includes aspects of time management, choice of teaching materials, and class control during teaching. Invariably, new teachers will encounter problems in managing time during a teaching and learning process. Typically, trainee teachers will write all activities in the lesson plans and try to teach based on these plans. However, in practice, they often encounter two problems in managing time during teaching: they could spend either more time or less time than planned. In both cases, they do not

have the skills to cope with such situations (Basile et al, 2003). To better control their classes and to manage time efficiently, they could use the problem-based teaching models for group activities, where with proper guidance, would result in self-directed learning (Berkel, & Schmidt, 2000). Teachers' ability to conduct teaching is also influenced by the materials used in delivering the curriculum (Lumpe, & Beck, 1996; Chambers, & Hardy, 2005; Lunetta, & Tamir, 1981). There are teachers who are too dependent on textbooks that precludes the use of other teaching and learning resources, and this is a common problem faced by new teachers (Sulaiman, 2010).

Research has found that there was a difference in teaching between low performing students and high performing students (Evertson, 1982; Gamoran, 1989). The teaching of low performing students must be simplified, slower, better structured and divided into smaller elements of the content (Metz, 1978; Schwartz, 1981). The ability to teach the ICT subject by new teachers and experienced teachers also differs. Experienced teachers may have gradually developed sound PCK through long teaching experience, enabling them to employ different teaching strategies for low and high-performing students. In contrast, new teachers may not have the skills to discern this difference in learning styles, and even if they are aware of this difference they may not be able to reformulate a new teaching approach in time. In addition, there are also teachers who tend to emulate their former school teachers' teaching styles, which may not be suitable to today's learning environment (Sulaiman, 2010; Cochran, DeRuiter, & King, 1993; Kilpatrick, Swafford, & Findell, 2001). Evidently, PCK must be acquired by trainee teachers to enable them to teach effectively. Both their teacher mentors and lecturers need to use an appropriate PCK standard to guide the trainees in acquiring the necessary skills and knowledge. Using such a standard, the training of future ICT teachers will be more streamlined and structured in both IHLs and schools, effectively reducing the existing difference of appraising trainees' teaching skills (Chesley & Jordan, 2012; Alper, 2014).

METHODOLOGY

This research aims to develop a PCK standard for ICT teachers in Malaysia based on a consensus of opinions of the Malaysian expert ICT teachers using the Delphi method. This method, which was developed by Dalkey and Helmer (1963) at the Rand Corporation in the 1950s, is a widely used method for achieving convergence of opinions concerning real-world knowledge solicited from experts within certain topics or areas (Hsu & Sandford, 2007). In this research, the Delphi method was used in three cycles to obtain a consensus from expert teachers in ICT who were selected from several schools all over Malaysia. Questionnaires were sent to 650 expert teachers; however, only 245 (37.7 %) respondents returned the questionnaires. In this study, an expert teacher refers to an ICT teacher with more than 5 years' teaching experience. After each round, the researchers provided an anonymous summary of the

experts' forecasts from the previous round, including the reasons provided by the experts. The experts were also encouraged to revise their answers in the following round. During the process, the range of answers decreased, and the opinions converged to a consensus. After three rounds, the means of the scores were determined and used as the standard.

The research instrument was built based on the PCK of ICT (Sulaiman, 2010) with a Cohen's Kappa Coefficient value of 0.92 (Cohen, 1960). The instrument consists of 59 items, 9 for the knowledge of students and learning, 17 items for curriculum knowledge, and 33 items for teaching strategy. The respondents were asked to rate these items based on the importance of the PCK using the 5-point Likert scale: '1'(*Not important at all*), '2' (*Not important*), '3' (*Average important*), '4' (*Important*), '5' (*Very important*). The computed Cohen's Kappa Coefficient values ranged between 0.85 and 0.96.

RESEARCH FINDINGS

To determine the knowledge needed by ICT teachers, three cycles of administration of questionnaires were carried out to gauge the importance of the relevant domains: (a) domain knowledge of students and learning of ICT (9 items), (b) domain knowledge of ICT curriculum (17 items), and (c) domain knowledge of ICT teaching strategy (33 items). The research findings are discussed based on these domains.

Knowledge of Students and Learning

Out of the nine items surveyed, two items were rated to be very important, and the remaining seven items were rated to be important, which ICT teachers should acquire. Table 1 summarizes the ratings of the nine items for this domain.

Table 1 Items of Knowledge of Students and Learning of ICT

Item Description	*M*	*SD*
Aware of topics which are difficult for students to learn	4.69	0.57
Know the causes of difficulties in learning	4.61	0.62
Identify the ICT concepts which may be misunderstood by students	4.40	0.62
Detect students' prior knowledge	4.32	0.60
Explain the needs of students in learning contents	4.29	0.60
Detect students' abilities to learn ICT	4.24	0.62
Detect the differences in understanding of concepts among students	4.24	0.62
Detect students' learning styles	4.20	0.74
Explain each student's ability to communicate	4.06	0.68

Knowledge of Curriculum

The consensus from the expert ICT teachers' responses shows that four items were rated to be very important, and 13 items were rated to be important. Table 2 summarizes the ratings of the 17 items for this domain.

Table 2 Domain Knowledge of ICT Curriculum

Item Description	*M*	*SD*
Understand the ICT teaching objectives	4.78	0.48
Understand information in the ICT detailed Syllabus	4.78	0.50
Understand information in the ICT syllabus	4.77	0.52
Be proficient in each topic of the ICT detailed syllabus	4.76	0.52
Write the learning objectives based on the learning outcomes	4.43	0.59
Analyze suitability of the contents with the students' abilities	4.39	0.62
Understand the depth of the learning outcomes to be evaluated	4.30	0.60
Understand the teaching methods proposed in the ICT syllabus	4.27	0.62
Explain the skills will students acquire by learning the ICT subject	4.27	0.66
Understand the moral values incorporated in the ICT curriculum	4.25	0.60
Explain the knowledge gained by students through learning the ICT subject	4.19	0.64
Explain the relationship between the NEP and the purpose to teach ICT	4.18	0.68
Comment on the coverage of the ICT contents for students	4.06	0.67
Reason out changes made to the order of topics	4.03	0.71
Comment on the depth of the ICT contents for students	4.02	0.70
State the differences of attributes in ICT subjects with other subjects	3.93	0.80
State the similarities of the ICT subject to other subjects	3.59	0.83

Knowledge of Teaching Strategy

For the domain of Knowledge of Teaching Strategy, seven items were rated to be very important, and 26 items were rated to be important. Table 3 summarizes the ratings of the 33 items for this domain.

Table 3 Domain Knowledge of Teaching Strategy of ICT

Item Description	*M*	*SD*
Choose materials that facilitate the learning process	4.75	0.49
Enforce rules for the computer labs	4.72	0.55
Use various teaching resources suitable for the contents	4.71	0.55
Plan the time segments to conduct teaching	4.68	0.53
Perform assessment of learning based on school contexts	4.68	0.54

Table 3 *(Cont.)*

Item Description	*M*	*SD*
Plan teaching activities suited to the students' learning styles	4.64	0.58
Maintain students' focus on learning	4.64	0.58
Evaluate each student's learning development	4.42	0.62
Estimate the time needed to achieve each objective	4.41	0.57
Modify ineffective teaching strategies	4.41	0.58
Include moral values in teaching and learning	4.41	0.59
Correct misunderstandings of concepts before starting the class	4.40	0.64
Choose a strategy that fits to the difficulty of the content and the students' ability	4.40	0.59
Reflect on teaching to identify and overcome problems	4.39	0.58
Allow sufficient chance for students to practice skills	4.39	0.58
Use the skill-based teaching	4.38	0.61
Use the assignment-based teaching	4.37	0.61
Maximize students' learning time for ICT contents	4.37	0.65
Use e-learning materials to facilitate learning effectively	4.37	0.58
Use the information-based teaching	4.35	0.55
Conduct self-directed learning	4.34	0.61
Find and search for suitable e-learning materials	4.34	0.62
Implement group learning based on the ICT contents	4.32	0.61
Overcome students' difficulties based on the causes	4.31	0.55
Use students' prior knowledge in teaching activities	4.30	0.61
Maintain the learning momentum through proper teaching methods	4.30	0.55
Conduct self-accessed learning	4.24	0.62
Overcome problems due to computer software	4.24	0.72
Overcome problems due to computer hardware	4.24	0.75
Build good e-learning materials for the ICT contents	4.18	0.65
Overcome problems due to the computer lab layouts	4.12	0.76
Conduct self-assessment	4.10	0.68
Conduct self-paced learning	4.09	0.64

DISCUSSION

The findings of this research show that the knowledge pertaining to students and learning, curriculum, and teaching strategy is deemed critical; thus, teachers teaching the subject matter should acquire this knowledge to ensure the teaching of ICT will be effective. In this research, the knowledge of students and learning, curriculum, and teaching strategy comprise nine (9), 17, and 33 items, respectively. The discussion that follows is limited to the items that were deemed very important.

The expert teachers agreed that "Aware of topics which are difficult for students to learn" and "Knowledge of the causes of difficulties in learning' are very important. This finding is similar to Penso's study (2002), which found this knowledge to be equally important. According to Penso (2002) teachers must be able to know the topics that are difficult for students to learn. Moreover, teachers must take into consideration a host of factors that can influence students learning. These factors include students' cognitive and affective characteristics, types of content, teaching activities, or specificity of the lessons. Students' cognitive and affective characteristics are strongly influenced by their prior knowledge (to enable them to cope with the lesson contents in a meaningful way), preconceptions acquired from experiences, partial or inconsistent causal thinking, concentration and motivation.

In this research, the teachers' ability to "identify the ICT concepts which may be misunderstood by students" was rated important. This ability is one of the important skills that teachers should master because teaching involves explaining both conceptual and factual knowledge of a particular subject or topic. Between the two types of knowledge, explaining concepts is more difficult than teaching facts or procedures because the former is more abstract than the latter. Thus, teaching topics that are mainly based on conceptual principles will be challenging to some teachers, particularly among new teachers, as skill is needed to explain correctly the underlying concepts. The lack of this skill is prevalent among new teachers or trainee teachers who are involved in teaching ICT and ICT-related subjects (Sulaiman, 2010) and Mathematics (Lilia & Subahan, 2002).

For the domain knowledge of curriculum, the items "understand the ICT teaching objectives", "understand information in the ICT detailed syllabus", "understand information in the ICT syllabus", and "be proficient in each topic of the ICT detailed syllabus" were deemed very important knowledge for ICT teachers. These findings emphasize that teachers need to master the content of the ICT subject both in terms of its breadth and depth. The mastery of the content of a subject matter reflects "the amount and organization of knowledge per se in the mind of the teacher" (Shulman, 1986, p. 9). The domain knowledge of curriculum also includes the substantive knowledge on how the subject, concepts, ideas, analogies, images, and principles were built (Davis & Simmt, 2006), and the substantive knowledge of the procedures and systematic ways to verify knowledge or to discover new knowledge.

For the domain of teaching strategy, seven (7) items were rated to be very important. Among these, knowledge of "choosing materials that facilitate the learning process", "planning teaching activities suited to the students' learning style", and "using various teaching resources suitable for the contents" have also been stressed by a number of researchers, such as Deng (2007), Kutnick, Blatchford, Clark, MacIntyre and Baines (2005), as important knowledge that guides teachers to identify and use strategies that are appropriate to students' characteristics.

Similarly, the importance of the item "planning the time segments to conduct teaching" was rated very high. This finding is similar to the finding

of Basile, Olson and Meji's study (2003), which reinforces this imperative of teachers to have good time management skill. This skill needs to be acquired by all teachers given the limited time that they have in teaching most of the subjects. More importantly, training to effectively manage teaching time must be given considerable weight to trainee teachers or new teachers to ensure lessons can be conducted efficiently. Likewise, the item "perform assessments of learning based on school contexts" was also rated very important. This finding highlights the importance of taking into account the differences that exist among schools given that urban schools and rural schools may have dissimilar settings in terms of logistics, infrastructure, or background. Surprisingly, the item "enforce rules for the computer labs" was rated very high in this study. This finding is in contrast with other findings where the enforcement of rules was not deemed important in previous studies. Apparently, there have to be some compelling reasons as to why the expert teachers opined that rules for the computer labs must be fully enforced. In the Malaysian school context, the use of computer labs is strictly controlled in view of the expensive set up and maintenance of both the hardware and software. Most Malaysian schools do not have extra or special financial allocation to carry out maintenance involving major repairs. Hence, the use of these important assets needs to be carefully monitored to ensure computers and other peripheral devices can run or function for many years.

CONCLUSION

In this research, the Delphi method was used to elicit expert teachers' opinions on the important attributes of an effective ICT teacher. Using this method, several items of knowledge domains concerning the making of an effective ICT teacher have been examined to determine the level of their importance, ranging from average importance through moderate importance to very importance. From the consensus of the expert practitioners, an ICT teacher must acquire 58 knowledge items, consisting of 9 items for the domain knowledge of students and learning, 16 items for the domain knowledge of curriculum, and 33 items for the domain knowledge of ICT teaching strategy. These findings can help formulate a sound, solid standard of PCK for teachers who are responsible for the teaching of the ICT subject in the Malaysian secondary schools. In addition, relevant faculties of the IHLs or teacher training colleges can use such a PCK standard to tailor their educational programs to be relevant and sustainable to the continually changing landscape of the ICT technology.

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