

Developing an Instrument of Assessment for ICT Literacy for Trainee Teachers: Preliminary Findings

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Abstract: The purpose of this paper is to report upon the preliminary findings of a doctoral study underway in Australia that seeks to identify possible indicators of information and communications technology (ICT) literacy for trainee teachers in Malaysia by investigating their ICT proficiency and their attitudes towards computer technology. To evaluate the trainee teachers' ICT literacy in a more "authentic" setting, the data collection used a two-round Delphi technique. Based on the findings from this Delphi data, a preliminary task-based assessment (TBA) instrument will be developed. At the end of this study, a suitable instrument to effectively evaluate ICT literacy for trainee teachers will be constructed.

Keywords: ICT literacy, trainee teacher, task-based assessment, Delphi.

I. Introduction

The term "Smart School" has been defined as a school in which students think about what they are learning [1]. In a sense this term unifies the notion of ICT tools adoption in information-age schools where knowledge construction and knowledge use are the primary pedagogical goals and the primary activity of the school [2]. Others define Smart School as one that uses a technology platform on which distance learning and specific teaching expertise are made available to remote locations [3].

In Malaysia, teaching and learning elements such as higher-order thinking skills and moral values are required to be incorporated into all pre-service training curricula. We suggest that teachers in general, and more specifically those in Malaysia, need intensive training in the use of information technology (IT) to facilitate its integration into classroom activities in ways that enhance thinking and creativity [4]. Moreover, in the short term, Malaysian Smart School teachers also need to learn how to facilitate and encourage students to take charge of their own learning [5]. For the longer term, we recommend that to remain confident in their knowledge of technology applications, these teachers need to enhance their skills regularly and stay up to date through continual professional development.

Furthermore, we believe that the teaching methods of all subject areas require a fresh orientation towards a more

experiential and student-centered approach supported by interactive ICT multimedia tools and IT/information systems (IS) network learning [5]. The overall objective is to produce trainee teachers in Malaysia who are computer literate and comfortable with their adoption of technology in their lesson design and delivery.

In 1991, in an effort to become a fully developed nation, Tun Dr. Mahathir Mohamad, former Prime Minister of Malaysia (1981-2003), presented a working paper known as "Vision 2020," outlining his 30-year vision for a fully developed Malaysia. He identified nine challenges that Malaysians need to overcome in order for Malaysia to become a fully developed country [see 6]. One challenge is to transform Malaysia into a knowledge-based society. Creating an ICT literate society is the central platform in achieving that transformation. The "Malaysian Smart School" project was regarded by the former Prime Minister as a specific response to Malaysia's need to make this critical transformation. The Malaysian Smart School Implementation Plan was then launched by Tun Dr. Mahathir Mohamad; it was targeted to represent a unified and stabilised use of technology as a key enabler for teaching and learning by year 2020. Since then, ICT literacy has been actively promoted in Malaysian schools through various agencies within the Malaysian Ministry of Education.

To cope with the demand of the 21st century, people need to know more than core subjects. They need to know how to use their knowledge and skills by thinking critically, applying knowledge to new situations, analysing information, generating new ideas, communicating, collaborating, solving problems and making decisions. These skills provide both flexibility and security in this constantly changing era. People who can learn new information, new software programs or new ways of doing things have much better prospects in the world than people who cannot [7].

The lack of ability to for critical and analytical thinking and also making own decision is apparent in Malaysian School student today. The students' ability in critical and analytical thinking was rated below satisfactory or fair [8][9][10]. Azlan found that the students were inclined towards critical thinking rather than creative thinking. Meanwhile, Razali, in his study

of the Mathematics subject learned that the students were excellent in with questions that use lower level thinking skills, but when it involved comparing, contrasting and interpreting skills, it was the skills that were less applied by the students. Zaharah on the other hand found that the Islamic Studies textbooks for Upper Secondary students that she analysed have poor decision making skills in its content.

Despite the focus on improvement in school children's ICT literacy, current trainee teachers in Malaysia may not be well prepared to teach with this new approach [11][12]. A similar phenomenon has been identified in the US, where one of the limiting factors for technological studies in K-12 is the inadequate preparation of teachers to teach about technology [13].

Similarly, the Institute of Strategic and International Studies [13] reports that most teachers in Malaysia have insufficient training in facilitating the use of computers for teaching and learning. Instead, computers were used to enhance their traditional teaching methods that include exercises and drills for rote learning. The continuation of such practices reflects the lack of emphasis on ICT literacy during teacher training programs [14]. Teachers, aside from their ability to use ICT tools proficiently, are also expected to be able to design and recommend suitable instructional media and materials to their students. It is expected that these materials should not be limited to resources within schools. Consequently, Malaysian teachers must be able to correctly evaluate and analyse the suitability and validity of such resources.

Malaysian teachers were found either lack the ability to teach this skill or less prepared to teach by incorporating this skills in their teaching and learning activity [15][16]. In

to the theory and skills of critical and creative thinking will respond more positive towards the changes.

Thus, with these issues, this raises the need for a suitable assessment tool which is flexible and not based on self-efficacy theory, which also includes questions that could test cognitive skills. The tasks in this TBA tool will not be too general; instead it focused on a normal computer-based activity and environment that teachers would normally do at school.

This doctoral study's research design was divided into three research phases (Figure 1). *Phase 1*: Phase 1 identified appropriate indicators for ICT literacy through the literature and requirements of the Malaysian Smart School project. *Phase 2*: In the second phase, these indicators were evaluated by a specially chosen panel of experts (PoE) through a two-part Delphi interaction (Delphi 1 and Delphi 2), with each having two-rounds. The indicators that were validated by the PoE in Delphi 1 were then used to guide the design of the preliminary TBA tool in Delphi 2. *Phase 3*: The final phase tested the PoE-revised TBA tool on trainee teachers and led to proposal of the final TBA tool.

The findings from this paper will aid the researchers in the next research phase, the development of the preliminary TBA instrument. As an integral part of a doctoral research study, this paper reports on the preliminary investigation to identify suitable ICT literacy indicators that are appropriate for trainee teachers in Malaysia.

II. Method

This paper reports the preliminary findings from the Delphi 1 panel interaction in Phase 2 (steps 2.1 to 2.4 in Figure 1).

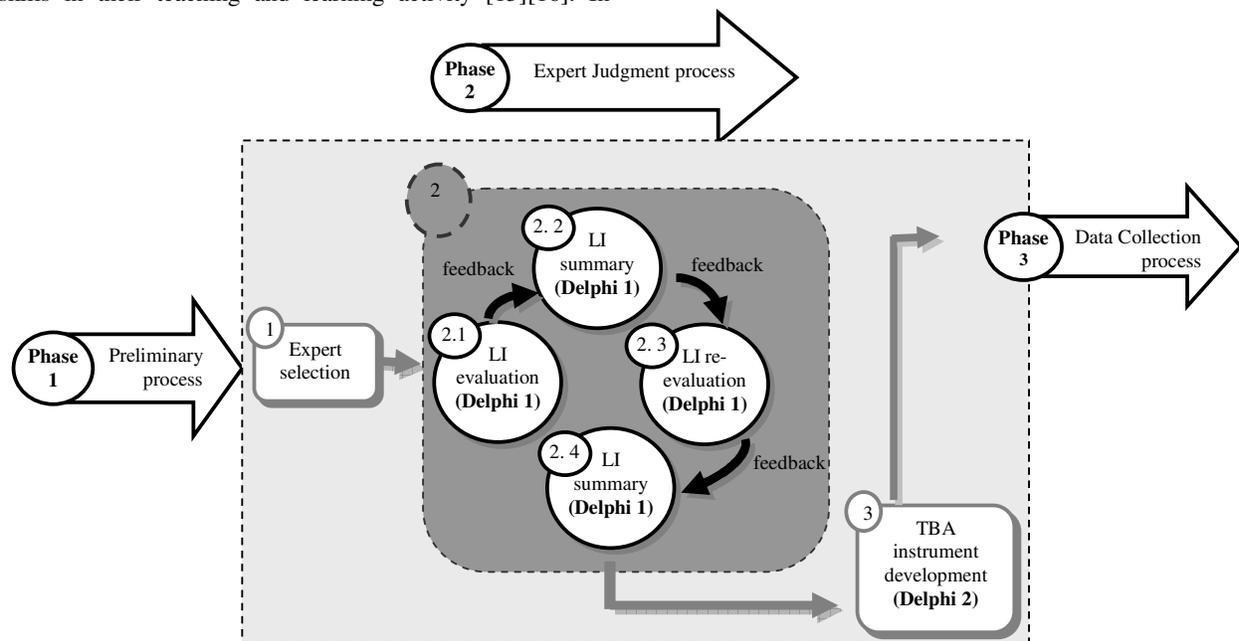


Figure 1. Research design

general, teachers understand the importance of the teaching of thinking to their students, however, some of them did not have the necessary teaching strategy to teach thinking [16]. Rosnani found that there exist a correlation between teachers' perception of teaching thinking and their reported practices. More experience teachers or teachers who has more exposure

Based on the outcomes from this Delphi panel, the researcher will develop a preliminary TBA instrument which will be validated later in Delphi 2.

The Delphi technique that was chosen for the second research phase is currently used in the US for technological forecasting [17]. This well-known technique is effective in

other contexts that require judgemental information, including: normative forecasts, determining values and preferences, simulated and real decision-making, identification of potential measures that might be used to explain a given problem, and assessment of the proposed measures with regard to their feasibility, desirability and effectiveness [18].

Earlier, in Phase 1, twelve ICT literacy indicators were identified from previous research and the requirements statement from the Malaysian Smart School project [19][20][21][22][23][24]. The indicators included: plan/define, access, integrate, evaluate, manage, create, assess, communicate/collaborate, reflect/judge, utilise basic ICT tools, analysis and production with ICT, and navigation and search.

For Phase 2, each PoE was given a Questionnaire with the list of identified ICT literacy indicators. For each of the indicators the PoE was asked to recommend whether they feel that the indicator was relevant to ICT literacy. Each member of the PoE operated in an independent and anonymous manner. The expected skills and the appropriate context of use for each of the indicators were briefly explained in the Questionnaire.

The identified PoE was asked to:

1. suggest the level of relevance of each indicator to trainee teachers in Malaysia, based on of the following scale: “0: not relevant; 1: fairly relevant; 2: relevant; 3: extremely relevant”
2. give comments or suggestions for each indicator
3. suggest an appropriate measurement of quality
4. suggest other indicator[s] (if appropriate)

Comments or suggestions from the PoE, and also their suggested measurement of quality for the preliminary TBA instrument are further discussed on *Part V: Other findings and discussions* of this paper.

III. The participants

Phase 2 was initiated with PoE selection and invitation. In order to obtain a more accurate view and understanding of the computer skills and ICT knowledge requirement of the Malaysian Smart School, the researcher decided that the PoE should be represented by teachers from current Malaysian pilot Smart Schools, academics from the field of educational technology and consultants from the Multimedia Development Corporation (MDeC) of Malaysia. This representation is important as the study calls for a group of experts who can professionally deliberate on the topic of technology, education and the Malaysian school system. Invitations to participate in this study were distributed along with a brief description of the study, along with a description of how the data collection process was going to be employed. Out of 20 invitations, seven experts agreed to participate in this study.

In order to develop rapport with the PoE, the researcher personally met with each expert separately to get to know the expert and try to answer any questions that the expert might have pertaining to what was expected of them in this study. The researcher believed that in order to get honest information from the experts, the experts must trust the researcher. The whole data collection process was conducted via email.

Therefore, it was explained to each participant that by agreeing to participate, they would also be giving consent to the trans-border data transfer.

IV. Findings

Based on the Delphi interaction, the PoE scored **all indicators** either relevant or extremely relevant, with a mean score between 2.50 and 3.00 (Table 1).

Table 1: Mean score for relevance of indicators

No	Indicator	Mean
1	Utilise basic ICT tools	3.00
2	Plan / Define	2.75
3	Access	2.75
4	Manage	2.75
5	Create	2.75
6	Communicate / Collaborate	2.75
7	Perform analysis & produce appropriate document	2.75
8	Navigation & Search	2.75
9	Assess	2.63
10	Integrate	2.50
11	Evaluate	2.50
12	Reflect / Judge	2.50

* 0=not relevant; 1=fairly relevant; 2=relevant; 3=extremely relevant

The highest mean score was for utilising basic ICT tools. Seven indicators scored 2.75: *plan/define*, *access*, *manage*, *create*, *communicate/collaborate*, *analysis and production with ICT*, and *navigation and search*. The *assess* indicator scored 2.63, while *integrate*, *evaluate* and *reflect/judge* scored the lowest with 2.50. However, as all indicators scored between relevant and extremely relevant, all indicators will be included in the preliminary TBA instrument. The findings for each indicator are further elaborated as follows:

A. Utilise basic ICT tool indicator

This indicator obtained a perfect score with a mean of 3.00 (extremely important). The *utilise basic ICT tool* indicator was expected to score well. Expert 1 believed that this skill was a must for trainee teachers, if they were to be acknowledged as ICT literate teachers. Aside from personal purposes, Expert 3 stressed how having basic ICT skills and the ability to use ICT tools is becoming a norm for teachers and students in Smart Schools, and ICT tools are used in their everyday tasks. Expert 6 trusted that this skill was very basic. Not only trainee teachers, but all ICT users should acquire these basic skills in order to progress further. Expert 2 concurred. Expert 5 added, “There are other knowledge[s] and skill[s] that needed to be mastered so that it can be optimally utilised.”

B. Plan/define indicator

The *plan/define* indicator involved the ability of the trainee teachers to determine the nature and extent of the information needed to solve a given situation that involved ICT. The trainee teachers were expected to be able to identify key concepts of the problem and develop potential strategies for a solution. For this indicator the PoE rated a mean score of 2.75. Expert 1 agreed that this skill was relevant and expected that it could test not only trainee teachers’ computer skills, but also

their ICT knowledge. Expert 3 stressed that planning was important in order to carry out a class lesson successfully. According to Expert 3, "Proper planning need[s] relevant information and every component of the lesson needs to be identified and defined clearly." This was necessary especially when it involved computer skills and ICT knowledge, as trainee teachers needed to be able to identify and know the use of specific ICT tools to solve a specified problem. In accordance with Expert 3's opinion, Expert 5 argued that planning encouraged awareness among the trainee teachers about the task given to them. Hence, they would be able to produce relevant and appropriate solutions.

C. Access indicator

Access was another ICT literacy indicator with a mean score of 2.75. This indicator implies that in a situation where trainee teachers have to collect and/or retrieve digital information, they are able to obtain the required information from various digital media and sources. They are also expected to be able to independently utilise the appropriate software and ICT tools that suit the required needs. Expert 1 strongly believed that this is one of the important skills today, which is known as long-life learning. Expert 1 argued, "Teachers have to be creative enough and independent in gathering information related to teaching and learning from ICT-based media." Expert 2, Expert 6 and Expert 7 all agreed that this skill was required. In addition, Expert 3 stressed that digital information is becoming the major source of reference in schools today. So, trainee teachers need to be able to access relevant digital information in various formats to suit the needs of the learning situation.

D. Manage indicator

Next, trainee teachers were expected to be able to organise, classify and store information and its sources in a computer using an existing classification information scheme. The *manage* indicator was scored 2.75 (mean) by the PoE. Almost all the experts agreed that this indicator was relevant to be assessed as part of the ICT skills that trainee teachers in Malaysia should have. Expert 2 stated that it was also important for the trainee teachers to be able to appropriately classify their teaching materials as general or confidential. Expert 3 further explained that schools in Malaysia are currently equipped with Content Management Systems for storing and managing digital content. Thus, trainee teachers must be able to store digital information in the required format and size when needed. On the other hand, Expert 5 believed that this skill is merely a basic form of technical know-how, so not much emphasis is needed on this skill.

E. Create indicator

The *create* indicator assumed that when given an ICT-related problem or task, trainee teachers were able to apply new information to construct new concepts and create new understandings. They were able to adapt, apply, design or construct information in digital environments, which included graphics, documents, presentations and Web pages. They were also able to design suitable teaching and learning tools with cognitively stimulating activities. Scored 2.75 by the PoE, this indicator proved to be very relevant to Malaysian trainee teachers. Feedback from the PoE included:

This is extremely relevant because those who are ICT experts are not only expert in using ICT tools but also capable to innovate new ICT-based approaches or solutions or teaching and learning aids.
(Expert 1)

Using the ICT tools trainee teacher can deliver their material and most of all using their creativity in order to make certain that the material will be well understood and interesting as to maintain conducive teaching and learning environment.
(Expert 2)

Trainee teachers must be able to produce learning materials that facilitate the learning process. They must be able to use ICT tools to prepare learning activities that would attract and keep the pupils interested in the lesson. They have to be creative to produce digitally equivalent flash cards, storyboards, flannel boards, 3-D models and other teaching aids to stimulate the young minds to think and learn.
(Expert 3)

Sufficient training and input should be provided by instructors in order to enhance this component and it should cater to different discipline in the classroom.
(Expert 5)

Trainee teachers should able to do this.
(Expert 6)

Should include all the multimedia features –animation, sound, music, interactivity, narrativity [sic] etc.
(Expert 7)

F. Communicate/collaborate indicator

The next indicator was *communicate/collaborate*. For this indicator, trainee teachers must have skills and knowledge in using ICT tools to communicate and collaborate with various people in a variety of contexts. In their teaching, they are able to effortlessly adapt and use various learning contexts such as discussion forums, appropriate chat rooms and e-groups. The trainee teachers also know how to disseminate information relevant to a particular audience in an effective digital format. Experts 2, 3, 6 and 7 were in agreement that trainee teachers must be able to use all the available ICT tools to share up-to-date information with their colleagues and pupils. They must be able to use ICT tools to collaborate and work in a team without being restricted by time and physical constraints to complete tasks assigned to them. Trainee teachers must be comfortable with the use of emails, discussion forums and other e-social platforms to help them in their tasks. Experts 1 and 5, however, were a bit sceptical. Expert 1 argued that *communicate and collaborate* were not directly related to ICT literacy. A trainee teacher may be good in communicating and collaborating but have poor ICT literacy skills, or vice versa. Expert 1 claimed that most ICT experts are good collaborators in the context of online team work and communication, but not in face-to-face communication. Meanwhile, Expert 5 expressed more concern on the ethical side of digital communication and collaboration, feeling that ethics should be highlighted in the new assessment instrument.

G. Analysis and production with ICT indicator

The PoE agreed that the trainee teachers need to have skills and knowledge in *analysis and production with ICT*. Apart

from the basic ICT tools, trainee teachers must be able to use advanced ICT tools such as advanced features of word processing, spreadsheet, database and also presentation software. Further, they should be expected to understand the different features of the software and the type of document each software application will produce. Expert 1 agreed that this skill is an absolute must for trainee teachers. They must have the basic concept of certain important ICT tools and how to manipulate them in appropriate tasks (Expert 2). Besides, the trainee teachers should already have these skills if they have explored it before (Expert 6). Moreover, students in Smart Schools are constantly exposed to new ICT tools, thus the trainee teachers must be able to keep up (Expert 3). Expert 5 suggested that this skill could be proposed as a part of teachers' Continuous Professional Development programme.

H. Navigation and search indicator

The last indicator that scored 2.75 mean was *navigation and search*. For this indicator, in a situation where trainee teachers were expected to find information from the Internet, they were able to select and use appropriate search engines, use appropriate searching keywords, construct complex queries and also use advanced search features. The trainee teachers were also expected to be able to upload and download digital information, and to understand the concept and use of the bookmark function in Internet browsers. All the experts agreed on the significant role of this skill for trainee teachers. However, Expert 1 was concerned that some teachers might consider that ICT literacy and Internet literacy were two different skills. Expert 5 felt that ongoing training should be provided to the trainee teachers and in-service teachers on the latest strategies and methods for Internet navigation and search.

I. Assess indicator

Unlike previous research studies, the PoE agreed that the ability to use ICT tools to *assess* must be included as one of the important indicators for ICT literacy. Previous research has not included the ability to assess student learning as one of the computer skills for ICT literacy [21, 22, 25, 26]. This omission possibly stems from the fact that none of the instruments were developed specifically for trainee teachers. As PoE members noted in further comments:

This skill is relevant because those who are expert in ICT maybe good in using ICT tools for assessment purposes rather than teaching and learning purposes.
(Expert 1)

Schools are being equipped with on-line based assessment systems. Trainee teachers must be able to use these tools to assess student learning in schools.
(Expert 3)

J. Integrate indicator

The final three indicators scored 2.50 mean, covering the skills to *integrate*, *evaluate* and *reflect/judge*. Skills to *integrate* apply in a situation where trainee teachers manage to gather several bits of information from different digital media, sources and computer applications, and they are able to interpret each of them effortlessly using the appropriate digital tools. They are also able to synthesize, summarise, compare, and contrast the various bits of information from those multiple sources. Expert 1 was doubtful of trainee teachers'

ability to use ICT tools to synthesize, summarise, compare and contrast. Expert 1 believed that they may have those skills but have poor ICT literacy to be able to use ICT tools to accomplish the task, or vice versa. Nevertheless, other experts indicated that by having this skill, trainee teachers would have the ability to distinguish appropriate ICT tools for a given task and make appropriate modification, making the information suitable for the targeted audience.

K. Evaluate indicator

Regarding the *evaluate* indicator, trainee teachers were expected to be able to judge and evaluate the degree to which digital information satisfies the needs of a given task, which includes determining the authority of the source, bias, timeliness and relevance. All the experts believed that this indicator was important. The reasons given included: to be able to ascertain that the information that trainee teachers have was suitable for their students' age/level; to have the skills to sift through the plethora of digital information and identify the most authoritative; and to be able to differentiate between facts and half-truths.

L. Reflect/judge indicator

The final indicator was *reflect/judge*. Trainee teachers should be able to adhere to copyright rules and manage to properly cite and give due credit to the author of the source. Having produced the final digital product, trainee teachers should also be able to critically judge and reflect on the outcome and problem-solving strategies employed in the process. With the exception of Expert 3, other experts felt that trainee teachers might not be aware that the copyright rules also applied to the digital world. In contrast, Expert 3 felt that by assessing this skill it would make the trainee teachers aware of the need to acknowledge and respect material produced by other people. Expert 3 also thought that the T&L reflection exercise which is currently employed by teachers in schools is a good exercise for the trainee teachers to critically judge/reflect in regard to a digital product produced. Though the experts' opinion for this indicator seems a bit uncertain, the mean score of 2.50 was still considered acceptable. Consequently, this indicator was included for the next phase.

V. Other findings and discussions

As mentioned in the *method* part of this paper, aside from substantiating relevant ICT literacy indicators for trainee teachers, the PoE was also required to suggest an appropriate measurement of the quality for each of the indicators. Almost all of the experts agreed that a self- assessment style of evaluation is not appropriate to effectively evaluate trainee teachers' ability to utilise basic ICT tools; a task-based assessment would be more suitable. The findings also show that, when designing an instrument to test skills in utilising basic ICT tools, the task must not be limited to computer applications; it must also include skills in using other ICT tools such as digital camera, digital video, scanner, printer and digital projector. Also, instead of simply telling the trainee teachers what to do and what tools or computer applications to use [see 26], the TBA instrument may give the trainee teachers an authentic educational ICT-related task, and allow them to perform the task with whatever tools or computer applications that they think is suitable. This way, the task will not only test

their declarative and procedural knowledge, it also tests their meta-cognitive knowledge.

Different levels of knowledge dimensions will be tested in the TBA instrument [27][28]: declarative knowledge (verbal information skills and intellectual skills), procedural knowledge (intellectual skills and cognitive strategy) and meta-cognitive knowledge. Declarative knowledge includes facts, terminology, or elements that one must know or be familiar with in order to understand or solve a problem. Procedural knowledge entails the additional knowledge that one has, which may help to do something specific in a discipline, subject or area of study; one is able to integrate knowledge in a new situation, recognise unstated assumptions and know the “how.” And finally, meta-cognitive knowledge describes having a strategic or reflective knowledge about how to go about solving problems, or the ability to “think about thinking.”

These preliminary findings also verify the research expectation for the need to develop a new ICT literacy assessment instrument that conforms to the needs of trainee teachers and the use of a TBA instrument. Previously, many research studies have used self-assessment (or self-efficacy) to evaluate performance in using computer or ICT tools [22][26]. In 1989, guided by Bandura’s self-efficacy theory and Schunck’s model of classroom learning, a Computer Self-efficacy Scale (CSE) was developed by Murphy, Coover, and Owen [29] to measure capability regarding specific computer-related knowledge and skills. They argued that self-efficacy can be reliably measured and can be used to assess a combination of affect, cognition and performance. Nonetheless, when assessing skills and cognitive ability, there is an inclination for people to underrate or overrate themselves [30][31]. This type of self-assessment outcome is more apparent between high achievers and low achievers. High achievers tend to underrate themselves and low achievers overrate their skills.

An Australian study by Forster, Dawson and Reid [32] proposed to develop an assessment tool to measure Australian teachers’ preparedness to teach secondary school science with ICT. One of the challenges the research team faced when developing the tool was to find a single Likert scale to represent computer literacy skills and knowledge in ICT. As a result, they combined two different scales: one for ICT skills and one for ICT knowledge acquisition. The research team acknowledged that a limitation of their study was that self-assessment questionnaires may only measure the respondent’s perception of their own skills and knowledge. Self-assessment questionnaires may not explain the extent to which the respondents can demonstrate their knowledge and competence [32].

The limitations of this doctoral study were foreshadowed in an earlier report that aims to develop a TBA tool as suggested by the International ICT Literacy Panel [25]. This Panel was established in January 2001, when the Educational Testing Service (ETS) assembled experts from education, government, non-governmental organizations (NGOs), and the private sector from Australia, Brazil, Canada, France, and the United States. The main focus of this Panel was to examine the growing importance of existing and emerging ICT tools and their relationship to literacy. The Panel listed seven critical components for ICT literacy: define, access, manage, integrate, evaluate and create [33]. The Panel suggested that a

richer way of collecting ICT literacy capability data would be to use a series of computer-based simulative tasks which integrate both the cognitive and technical domains, as “valuable information will be lost if it is not conducted in a real-world settings” [25].

VI. Conclusions

This paper briefly reports the initial preparations to evaluate Malaysian trainee teachers’ ICT literacy in an authentic setting. To achieve this end, a panel of experts were chosen according to their professional educational technology practice and experience in the Malaysian academic Smart School project. The data collection employed a two-part Delphi technique (Delphi 1 and Delphi 2), with two-rounds for each part. Twelve ICT literacy indicators were verified. One indicator identified by the PoE, which was not suggested in previous research studies, is the ability to use ICT tools to assess student learning. Based on the findings from Delphi 1 interaction, a preliminary TBA instrument will be developed later, to be verified in Delphi 2. The PoE agreed that self-assessment is not sufficient as a tool to assess ICT literacy. When assessing skills and cognitive ability, there is a propensity for people to underrate or overrate themselves when using self-assessment. Moreover, self-assessment does not provide an “authentic setting” for computer knowledge and skill evaluation. Valuable information will be lost if the assessment is not conducted using “real” settings [25]. Thus, this doctoral study will develop an assessment instrument that requires participants to complete a series of tasks which incorporates all ICT literacy indicators agreed by the PoE, and to use “real” computer applications and digital accessories to carry out the tasks. It supports teacher training development by identifying the information technology infrastructure required by teacher training programmes in accordance with the Vision 2020 plan to improve the learning outcomes of students with technology-enhanced learning in the Malaysian school system.

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