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## How Does Pre-Service Teacher Preparedness to Use ICTs for Learning and Teaching Develop Through Their Degree Program?

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*Abstract: It is now well accepted that graduating teachers need the capacity to integrate Information and Communication Technologies (ICTs) in ways which harness their learning affordances and develop students' digital literacies. However, effective ICT integration in the classroom is challenging because it requires complex application of technological, pedagogical and content knowledge. A key challenge for teacher educators is the provision of learning experiences at university and on professional placement that will allow pre-service teachers to develop these capacities. Understanding the learning process of pre-service teachers in relation to ICT integration is essential if this teacher education challenge is to be addressed. This article reports on a study in which a group of 11 pre-service Primary school teachers were interviewed at stages through their program with a focus on their preparedness to use ICTs in their teaching. The study used a model developed by Taylor (2004), which defines three stages of teacher ICT capacity development (uncritical and accepting, beginning to problematise, and reflection and theorisation), as an analytic lens. Using this model, pre-service teachers were positioned against the stages in the model at six points during their four year program, and factors contributing to their movement through the phases were identified.*

### Introduction

Across the world, student's skills with ICTs are seen as a critical part of 21st century capabilities, as they provide the opportunity for them to participate in and contribute to society as a citizen and worker (ACARA, 2013; Department for Education 2013; US Department of Education, 2013). To achieve this end, and with the potential for educational advantage as another prime reason for their use in the classroom, governments and education departments have invested significantly in infrastructure and other initiatives. Despite this, and although there are pockets of desired levels of use of ICTs in schools for learning and teaching, it is not widespread, and it largely remains below expectation (Bate, Day & Macnish, 2013; Morris, 2010; Stobaugh & Tassell, 2011; Yeung, Tay, Hui, Lin, & Low, 2014).

Pre-service teachers, a group largely comprised of students that have grown up with ICTs all around them, and those who have received the most current preparation, are expected to be proficient in their use of ICTs for learning and teaching. However, Tondeur, Roblin, van Braak, Fisser and Voogt (2013) report that pre-service teachers often feel

inadequately prepared to use ICTs for learning and teaching. This raises questions for teacher preparation programs, and highlights the need to better understand what influences pre-service teacher attainment of knowledge and skill in the use of ICTs in the classroom.

This article, which builds on Gill and Dalgarno (2010), aims to contribute to this understanding by reporting on the findings of a four year study that investigated pre-service primary school teacher development in the use ICTs for learning and teaching. Here, particular attention is paid to a three stage model conceived by Taylor (2004), which was used to identify and demonstrate the developing knowledge and skill of the pre-service teachers. As the measurement of developing capacity with technologies used for teaching is an ongoing matter being researched, Taylor's model is discussed in light of the results of the study, and other models.

## **Background**

### **Developmental Models**

There are a number of ways that researchers have sought to define levels or stages of pre-service teacher proficiency and development with ICTs for learning and teaching. These include examples that refer to ICT standards for teachers such the U.S. NETS-T (National Educational Technology Standards for Teachers) indicators (Stobaugh & Tassell, 2011; Kovalik, Kuo & Karpinski, 2013), the SMART Classrooms Professional Development Framework (SCPFD) , (Smart, Sim & Finger, 2013), the TPACK (Technological, Pedagogical, and Content Knowledge) framework that uses descriptors of teacher knowledge and skill (Schmidt, Baran, Thompson, Mishra, Koehler & Shin, 2009; Albion, Jamieson-Proctor & Finger, 2010; Jaipal & Figg, 2010), and a number of models that apply descriptors to identify developmental progress or scales and levels of expertise, for example 'beginner to expert' (Lei, 2009), 'entry to invention' (Chen, Tan & Lim, 2012), and 'routine to innovative' (Hammond, Reynolds & Ingram, 2011).

The model used for this study, developed by Taylor (2004), describes three stages of student capacity development, that are defined in terms of the degree of sophistication of pre-service teacher thinking in regard to the use of ICTs for learning and teaching. The first of the three stages is where ICT related pedagogic decisions are largely characterised as 'uncritical and accepting', the second signifies a 'beginning to problematise' the learning and teaching situation with ICTs, and the third 'reflection and theorisation' on their own and others experiences, including analysis and problem solving. The model provides a series of descriptors which characterise each of the developmental stages. Table 1 lists the three stages within the model and the descriptors of characteristics within each stage.

Stage	Characteristics
Stage 1: Uncritical and accepting	Good knowledge of possible uses of ICTs in teaching Unsubstantiated generalisations about ICT use, language definite Uncritical, unselective about own/others practice Straight transfer and/or acceptance others' ideas Awareness of issues only at a generalised level
Stage 2: Beginning to problematise	Increasing focus on specifics of own experience Reflecting on and questioning own and others work Starting to anticipate issues and develop pedagogical sensitivity Suggests simple and context specific solutions Acknowledges complexity, language more tentative, but doesn't follow through the strands of causation
Stage 3: Reflection and theorisation	Starting to group ideas from various sources and insights from experience, able to suggest own set of principles/practical theory Critical engagement with own previous ideas and experiences of others Conditional understanding: Able to identify and explore some contingent circumstances Suggesting explanations and solutions to issues based on deeper analysis and understanding of the complex nature of teaching and learning

**Table 1 - Taylor (2004) Model including Stages of Development and Descriptors of Characteristics**

A relative strength of the Taylor model is that it does not attempt to define achievement through descriptions about ability to use specific software, hardware, or systems; instead, it provides a taxonomy of levels of understanding and pedagogical thinking. This provides advantage in terms of the ongoing currency of the model, as it is not susceptible to quickly becoming out of date when rapid or the inevitable longer term changes in technology and its use occur. The acknowledgement and reference to both theoretical and practical aspects of teaching with ICTs is also seen as valuable as this enables a more holistic assessment of development to be gained.

A number of the aforementioned models will now be discussed. When compared with the Taylor model, the TPACK Confidence Survey (TCS) instrument developed by Albion et al. (2010) is a much more detailed and focussed instrument. It includes close to 150 items with 4 Likert responses designed to measure “interest in and attitudes toward using ICT; confidence to use ICT for specific teaching and learning tasks (TPACK); competency with ICT applications; Technology Knowledge (TK); and their TPACK Vocational Self-efficacy” (p. 3772). The inclusion of teachers’ beliefs, attitudes, confidence and competence with ICTs in the survey is seen as critical, as these dimensions are of central importance “in the pedagogical adoption of ICTs”, however, the absence of items relating to aspects of context, would it is suggested, result in a more limited understanding of the use (Somekh, 2008, p. 450). Having said this, the survey is considered to provide quite a comprehensive measure of pre-service teacher perceptions of the attainment of knowledge, as well as their beliefs about their capacity to apply that knowledge in teaching situations, and for professional purposes.

While this survey has been statistically validated, Albion et al. (2010) raise the question of pre-service teachers’ capacity to accurately assess their own ability, an issue also raised by Harris, Grandgenett and Hofer (2010) in regard to self-reported data, particularly by “inexperienced teachers” (pp. 3833-3834). Also worthy of mention, Albion et al. (2010) flag

a maintenance issue, indicating that “regular review” of the tailored and detailed instrument is needed if it is to “continue to measure meaningful elements of TPACK” (p. 3778).

A survey developed by Hammond, Reynolds and Ingram (2011) is also comprised of around 150 questions, and predominantly uses closed questions such as Likert and frequency of use responses. Eight themes are covered by the survey: “biographic details; access to ICT in school; support for using ICT; constraints on using ICT; use of ICT; attitudes to ICT; attitudes to professional development; general beliefs about teaching and learning” (Hammond et al., 2011, p. 193). Unlike the Albion et al. (2010) TCS instrument, this survey does attempt to establish details of the environment in which the pre-service teachers are operating. The presence of items in the survey to establish details of context is seen as important when considering ICT use, as access, support and development are critical factors to consider (Lim & Khine, 2006).

Having gathered data on the eight themes, and although they found it difficult to do so, Hammond et al. (2011) then grouped the ICT use into one of three levels: ‘Routine use’ where users typically focused on “the use of the IWB for whole class teaching;” ‘Extended use’ where there were “greater opportunities for pupils to use ICT for themselves”; and ‘Innovative use’ which was characterised by student teachers using “ICT in a greater range of contexts and... more effort [being made] to overcome barriers such as access” (Hammond et al., 2011, p. 191). These level descriptors assume the value of, and privilege student centred pedagogical approaches, as well as higher frequency of ICT use. Critically, an own reflection by Hammond et al. (2011) identifies a limitation to this model, the lack of attention to the dimensions of “quality of use and of pedagogical reasoning” (p. 199), both of these being addressed by the final model to be discussed in this paper.

Chen et al. (2012) also applied an approach which referenced categories of development in ICT use to establish progress over time. In this adaptation of the Dwyer, Ringstaff and Sandholtz (1991) developmental model, observed pre-service teacher practices in the classroom were matched with one of five levels of ICT integration. Their version retained the original categories of Entry to Invention, however, the descriptors were modified to suit the pre-service teacher context.

1) Entry stage	where the physical environment of learning starts to change with the introduction of ICT devices yet the learning activities and supporting tools used remain relatively traditional (e.g. pen, paper and books);
2) Adoption stage	where ICT devices are used but for traditional learning activities (i.e. using new tools for old practices);
3) Adaptation stage	where various ICTs are used with increasing depth and breadth, and integrated into specific learning scenarios;
4) Appropriation stage	where ICTs are routinely used and transforming pedagogical practices in a broader context (e.g. more extensive and frequent application of technology-enhanced collaborative learning) ;
5) Invention stage	where both the physical environment and teachers’ mindsets about learning have been transformed and teachers are actively exploring and experimenting with new tools and activities to enhance learning effectiveness.

**Table 2 - Levels of ICT Integration (Chen, Tam & Lim, 2012, p. 192)**

Once again, this type of model has as an advantage of timelessness as no reference to specific ICTs is made. However, to become more broadly applicable in terms of desirable practice, the following assumptions may need to be considered: the notion that more frequent

or greater use of ICTs is necessarily advantageous, the need for a transformed mindset in regard to technology to be recognised as operating at the highest level, and perhaps also whether a reference to the quality and nature of ICT use and contextual factors should be added.

With a focus on assessing desirable practice, Kovalik et al. (2013) employed a commercially developed instrument to measure the progress of pre-service teacher attainment of knowledge and skill to use ICTs for learning and teaching according to the ISTE (International Society for Technology in Education) developed NETS-T standards. This online test comprised 60 randomised multiple choice performance-based questions, all aligned with the 2008 NETS-T (12 items for each of the five standards). While this test overcomes issues with self-reported knowledge and skill, and though the questions simulate a teaching situation, without the need for application of the knowledge and skill in the classroom, it needs to be remembered that development assessed is only a part of the overall picture.

The final and most recent approach for assessing teacher development with ICTs is based on the SMART Classrooms Professional Development Framework (SCPDPF) developed for the Australian State of Queensland, in conjunction with and as viewed through the lens of Schulman's (1987) MPRA (Model of Pedagogical Reasoning and Action). To explain how this works, Smart, Sim and Finger (2013a) advise that the SCPDPF serves as means and process through which teachers can self-assess, through discussion and the provision of evidence, typically in electronic portfolios, "their professional values, relationships, knowledge and practice in line with a series of predetermined indicators" (p. 3380). To assess the teacher's Technological Pedagogical Reasoning (TPR), relevant items from the framework are referenced to the six processes that the MPRA identifies as "to develop the knowledge base for teaching: Comprehension; Transformation; Instruction; Evaluation; Reflection; and New Comprehension (Smart, Sim & Finger, 2013a, p. 3382).

This approach too, it is suggested, offers ongoing currency due to the use of timeless terms, and it achieves adequacy in covering the essentials of TPACK through a focus on both technology and pedagogy, and their link with content knowledge. The requirement for evaluation of and reflection facilitates deeper thinking about practice and creates potential for development, and the consideration of context opportunity for greater understanding of the teaching situation, and the reasons behind pedagogical decisions. While the teacher provides the evidence in this case, achievement is externally assessed effectively minimising the inherent issues with self-reporting.

Interestingly, and bringing this discussion full circle, the Model of Pedagogical Reasoning and Action, and the notion of TPR seem quite compatible and consistent with the model of development established in the Taylor (2004) study. If the evidence of progression through the identified stages is examined, for example from stage 1 which is characterised by the possession of knowledge for possible uses of ICTs, and unselective practice and/or unsubstantiated thinking, through to stage 3 where personal principles and practical theory can be suggested, and critical reflection and examination of own and others practice is evident, it is clear that the basis of the Taylor (2004) model is also very much about the ability to reason, as well as growth in pedagogical and technological knowledge and skill.

What this discussion has shown is that pre-service teacher development to use ICTs for learning and teaching is a multi-faceted and complex matter. The instruments featured all gather data about one or more of these aspects, whether it be self-reported data about technological, pedagogical, content knowledge and skill (TPACK), summative data about the nature of ICT use (Standards), a determined degree of creativity or innovation, an observed or

reported extent of ICT integration in learning and teaching, the context for ICT use, and/or an assessed level of technological pedagogical reasoning. It is suggested that depending on the identified need for information about pre-service teacher development to use ICTs, that each instrument could serve a valuable purpose.

The next section describes the methodological approach employed for this study, including use of the Taylor (2004) model as a lens for analysing the developmental process of 11 pre-service Primary teachers.

## **Research Method**

The study set out to address the following overall guiding research questions:

What are pre-service Primary teachers' perspectives on their preparedness to use ICTs for learning and teaching?

What influences pre-service teacher preparedness to use ICTs for learning and teaching?

How does pre-service teacher preparedness to use ICTs for learning and teaching develop during teacher training?

The research was undertaken as a case study, where the individual cases were volunteer students drawn from a year cohort within a Primary teacher education program. Stake (1995) distinguishes between collective, intrinsic and instrumental case studies. In this terminology, this research was a collective case study, exploring a series of related cases designed to contribute to understanding of pre-service teacher characteristics and experiences in general (see also Stake, 2006). In Yin's (1993) terminology, the research was designed as an exploratory (rather than explanatory or descriptive) case study, given the intention was to explore the context in an open way in order to develop new insights into the way in which pre-service teachers developed their capacities to use ICTs for learning and teaching over the course of their degree program.

The research was undertaken from an interpretive standpoint with the aim of developing a rich understanding of the 'lived experiences' of the participants (Creswell, 2007). Accordingly, qualitative data collection methods were used in order to maximise the depth and breadth of information about the experience of the pre-service teachers. Specifically, interviews were carried out with each pre-service teacher at intervals through their degree program. As the focus of the study was on the feelings, thoughts and intention of the pre-service teachers, the interview was the ideal vehicle to be employed to gain the participants perspectives (Patton, 2002).

## **Participants and Data Collection**

Participants for the study were pre-service teachers training to be Primary school teachers (teachers of children in their first 7 years of school, typically aged 4 to 12). The collection of data for the study took place over a four year period via six phases of semi-structured interviews, each of approximately one hour in length. The semi-structured format

was favoured as it allows some freedom for the researcher and the participants to go beyond the pre-determined questions, while maintaining a focus and degree of consistency which assists with the comparison and analysis of the interviews (Hamilton & Corbett-Whittier, 2013). All interviews were carried out by the investigators, digitally recorded, and transcribed verbatim.

In total, over its four year duration, this study involved 11 pre-service teachers, all from the same cohort of primary education students. The vast majority of the cohort was from the Riverina region of New South Wales, which in its first year comprised 118 students' (24 male, 94 female). The initial call in 2007 for participants from this population yielded eight volunteers, two males and six females. After the first round of interviews, two of the female students became unavailable to the study, one student choosing to opt out, and the other as a result of changing to another degree program. After two years, the decision was made to seek additional participants and the same cohort was approached for additional volunteers, with three additional students (two males and one female) recruited for the final two years of the study. These three participants along with the six remaining participants recruited at the beginning of the study remained in the study for the final two years, and it is the data from these nine participants which is reported in this article. Of these nine students, each identified below by pseudonym, two were from the 18-21 age bracket, two from the 26-30 bracket, three from the 31-35 bracket, and two from the 36-40 age bracket. The resultant gender balance is skewed towards males, and the age distribution while broadly representative, is balanced toward the mature end of the pre-service teacher population at the university where the study was undertaken. As is common with qualitative case studies, the suggested generalisability of this study is for contexts with similarities to those depicted (Hamilton & Corbett-Whittier, 2013).

	<b>Pseudonym</b>								
	Jenny	Jack	Jason	Joan	Judy	Jess	Jenna	Joe	Jeff
Age at start of study	33	38	34	32	20	29	18	37	29

The six phases of interviews were timed to allow for a focus on one or two particular semesters of study or on experiences during a particular professional experience placement. Table 3 outlines the milestones during the degree program, the interview phases and the students who participated in each interview stage.



Year and Months	Milestone	Interview phases	Jenny	Jack	Jason	Joan	Judy	Jess	Jenna	Joe	Jeff
March to June 2007	Semester 1	Phase 1, May	*	*	*	*	*	*			
July to Oct 2007	Semester 2 incl. 10 days of placement										
March to June 2008	Semester 3	Phase 2, June-Aug	*	*	*		*	*			
July to Oct 2008	Semester 4 incl. 5 week placement Aug/Sept	Phase 3 Oct-Nov		*	*	*	*				
March to June 2009	Semester 5 incl. 5 week placement Apr-Jun	Phase 4 June-Aug	*	*	*	*	*	*	*	*	*
July to Oct 2009	Semester 6										
March to June 2010	Semester 7	Phase 5 May-July	*	*	*	*	*	*	*	*	*
July to Oct 2010	Semester 8 incl. 10 week internship Aug/Sept	Phase 6 Nov-Dec	*	*	*	*	*	*	*	*	*

**Table 3- Timeline of Participant Interviews and Professional Placements**

Expanding on the rationale for the timing of the interviews, and the nature of the experiences mentioned above, this schedule reflects the potential of professional placements to demonstrate and facilitate development to use ICTs for learning and teaching, and the progression in this which occurs over the duration of the student’s studies. The university taught subjects which directly created opportunities to learn to use ICTs for learning and teaching included a specialist subject called ‘Information and Communication Technologies in Educational Studies’, and a suite of curriculum method and other discipline specific subjects.

The specialist ICT subject was taught in first semester of the first year of the course and predominantly focussed on skill and knowledge development of ICTs that could be used for teaching and learning. It was linked to a Personal Development, Health and Physical Education (PDHPE) curriculum subject also taught in the first semester, and a placement subject in second semester where the students were expected to use the created learning resources in their teaching. The curriculum subjects taught in the first semester of the second year of the course covered the application of ICTs for learning and teaching in the disciplines of Science and Human Society and its Environment (HSIE). Similar to the PDHPE subject, a Multiliteracies subject taught in the first semester of the third year of the course required the

students to develop an ICT-based learning resource, and use it with students while on professional placement.

### **Interview Questions**

The interview questions for each phase of the study were designed to elicit responses that would provide answers to the three research questions (see above), each of which relates to and explores a dimension of the central question and phenomenon of how pre-service teacher preparedness to use ICTs for learning and teaching develops. The focus of the interview questions shifted depending on whether it occurred at the end of a teaching semester, or immediately before or after a teaching placement. Interviews in early phases focussed primarily on developmental progress and intent to use ICTs in teaching, with later phases focussing increasingly on strategies used while on professional placements. The Phase three interviews with the three students who joined the project after two years included additional questions designed to obtain the students' perspectives on their developmental progression over the previous two years. The semi-structured model of interviewing proved ideal as pre-designed questions focussed the discussion yet allowed room for additional questions to investigate emerging aspects or to probe for additional or deeper information.

### **Analysis**

Interviews were transcribed by a transcription agency and then imported into the nVivo software for analysis. Nodes were created in nVivo corresponding to each of the 14 descriptors within the three stages of the Taylor model. Additionally, a grounded analysis of the data was carried out through which a number of additional themes emerged, and nVivo nodes for each of these themes were also created. These emergent themes included various attitudinal issues relating to the use of ICTs in learning and teaching (10 nodes) as well as themes relating to the factors that contribute to student development both within and outside of their degree program (21 nodes). Passages within the 42 interviews were then coded using these 45 nodes.

Coded passages were generally about a paragraph long, although there were some shorter passages and some longer passages coded. The coding was carried out by one member of the research team but with checking by a second member of the team and regular discussions of the three members of the team to ensure there was agreement over the interpretation of each Taylor descriptor and the definition of each emergent theme. As discussed further below there were some descriptors where there was significant ambiguity and regular meetings of the research team were required before the coding of all passages was able to be finalised.

### **Results**

#### **Applying the Taylor Model**

In analysing the interview transcripts, then, a judgement was made about whether, at each stage of the research, there was evidence that a particular participant had achieved a particular criteria associated with a particular developmental stage. In order to illustrate the kinds of statements from students which we took as evidence of achievement of particular criteria, Tables 4, 5 and 6 provide examples for each criteria within stages 1, 2 and 3

respectively. Comments have also been included within the table highlighting the key issues identified or challenges faced in applying that criterion.

<b>Good knowledge and possible uses of ICTs for teaching</b>	
Comments about application	Interpreted to mean knowledge of ICTs and some ideas about how they might be used in teaching for specific purposes.
Example excerpt	<i>...we're doing procedures in English so I took photos of the students as they ... were putting a recipe together and then after that we edited which photos we'd use in a presentation to show a procedure (Judy, phase 4).</i>
<b>Unsubstantiated generalisations about ICT use, language definite</b>	
Comments about application	This category included 'sweeping statements' or unfounded claims about ICTs being 'good' for students to use.
Example excerpt	<i>I found, that kids these days just love being on the computer, they just seem to love it, they're not scared of it, they don't think it's scary, they think it's great, so, you know, it's something different, you know. (Jess, phase 2)</i>
<b>Uncritical, unselective about own/others practice</b>	
Comments about application	Accepting of what they see/are told/exposed to – no questioning of practice.
Example excerpt	<i>...through their application or practice with the computer they were obviously learning some skills, graphic design and maybe ... how to construct the visuals and how it's appealing from a visual perspective. (Joe, phase 4)</i>
<b>Straight transfer and/or acceptance of others' ideas</b>	
Comments about application	The acceptance and/or implementation of others' ideas regarding ICT use for teaching and learning.
Example excerpt	<i>...the lecturers highlighted various different resources and sites for us to utilise in teaching, in programming and all that sort of stuff, so it's been handy to have, to be able to actually look at these sites and be instructed on the negatives and positives and all that sort of stuff. (Jack, phase 2)</i>
<b>Awareness of issues only at a generalised level</b>	
Comments about application	A general awareness of issues but lacking deeper thought/engagement, including how these issues might interact with or be linked to personal experience.
Example excerpt	<i>[ICT's are] not used enough and I think there's a lot of teachers that are maybe a bit scared of them, or don't program them. (Jess, phase 4)</i>

**Table 4 - Illustrative Examples of Interview Excerpts Coded using each Criterion within Stage 1 of the Taylor Model, 'Uncritical and Accepting'**

Increasing focus on specifics of own experience	
Comments about application	Reflection, critical selection of significant happenings, evaluation, interpretation, explanation and integration with previous thinking, pulling out significance and implications.
Example excerpt	<i>... when the results of the election came out, the local election in particular, I had the students go in and in the newspaper there was a table of the results and so what I did was have them go on and type in the results in Excel and make a spread sheet and then turn into percentages so turn it into a pie graph so that was sort of a Maths lesson that we did in there using the local election results so that was really relevant to us and our community. (Jess, phase 6)</i>
Reflecting on and questioning own and others work	
Comments about application	From direct experience and reading, however, may accept complex, abstract ideas uncritically.
Example excerpt	<i>It was just sort of get on the computer and have a play and it just seemed like a waste of time to me. There was no point in what they were doing – you know they might have played a game on a maths concept that they were learning or sometimes even that they weren't learning and then they did that so then the teacher said you can get on here and play just a motorbike game – it just seemed very pointless. (Jenna, phase 5)</i>
Starting to anticipate issues and develop pedagogical sensitivity	
Comments about application	For example appreciating how technology might cater for different learning styles, or showing awareness of the importance of using technology as a tool to assist with the delivery of content rather than the technology being at the centre of the learning.
Example excerpt	<i>...we get to think about the learning style of the student we're teaching [and] you're able then to put strategies in place to sort of, to help them move along...that's where ICT's are coming in...kids with problems in handwriting, if they're able to type it, and their handwritings ordinary, well you know, utilise it, because if it's going to help them learn. (Jack, phase 2)</i>
Suggests simple and context specific solutions	
Comments about application	Solutions were, for example, related to university experience/preservice teacher training, lesson plan ideas or issues encountered on prac.
Example excerpt	<i>...it's a bit limiting when you've only got 2 in your classroom and you've got lots of kids ... maybe we could have a roster system where each student had time during the day to be on there and – like even put 15 minutes for each student to go in and go through... the math's games folder. (Jenna, phase 6)</i>
Acknowledges complexity, language more tentative, but doesn't follow through the strands of causation	
Comments about application	Moving beyond the overly generalised identification of issues in Stage 1.
Example excerpt	<i>...some teachers ... use[d] a smart board [but in some cases] some of the students kind of got a little bit distracted with the capabilities and were more interested in trying things out ... than thinking about what they're learning ...it's hard to know whether that was a positive thing or not but it's good that they want to have a go and it keeps them quite engaged. (Judy, phase 5)</i>

**Table 5 -Illustrative Examples of Interview Excerpts Coded using each Criterion within Stage 2 of the Taylor model, 'Beginning to Problematiser'**

Starting to group ideas from various sources and insights from experience	
Comments about application	Not necessarily a conscious process; able to suggest own set of principles/practical theory, able to predict likely issues.
Example excerpt	<i>We spent time in class at university looking at various websites ... you know we talk about using them but this time you actually get to assess it and have a look – okay I’ll give this some use and then get the feedback from the kids and in their work ... and actually I’ll tell you the truth I think I used one for some science stuff and that wasn’t that flash ... so I crashed with one lesson with that so I think there’s various stuff there – work out what the right thing is for your class. (Jack, phase 6)</i>
Critical engagement with own previous ideas and the ideas of others	
Comments about application	Testing against current experience, selectively integrating with beliefs, and practical theory; may intend to change future practice because of these new understandings.
Example excerpt	<i>I think with all due respect to those subjects [and] the lectures themselves ... the visual teaching of it was minimal ... it’s the relevance of the subject I think when you get the visual and you talk the visual I think you get the relevance ... a lot of that information you could have gone to the internet and found that information, rather than go to a lecture and hear someone just talk about it and introduce it text based. (Jack, phase 5)</i>
Conditional understanding: able to identify and explore some contingent circumstances	
Comments about application	Increased appreciation of complexity, able to identify and explore some contingent circumstances.
Example excerpt	<i>What I noticed in schools is a lot of ICT is used as a reward, it’s not a teaching tool; a lot of teachers don’t use it as a teaching tool, they use it as a reward system...teachers will do a worksheet, if a kid finishes the worksheet early, you can go and play on the computer ... I just think one of the big problems with ICT in schools is people using it for rewards. (Jeff, phase 5)</i>
Suggesting solutions and explanations to issues based on deeper analysis and understanding of the complex nature of teaching and learning	
Comments about application	Certainties are based on own experience e.g. good practice in technology management.
Example excerpt	Nothing was coded under this category from any of the participants/interview transcripts (see discussion below)

**Table 6- Illustrative Examples of Interview Excerpts Coded using each Criterion within Stage 3 of the Taylor model, ‘Reflection and Theorisation’**

When assessing the evidence presented by the students through interview, as a part of the process of determining whether a criterion had been achieved or not, ambiguities were found and the research team needed to agree on minimum standards for certain criteria. The means through which various levels of performance within a stage might be indicated was another question that had to be resolved. For example, as highlighted in Table 4, in assessing the participants’ achievement of the Stage 1 criterion “good knowledge of possible uses of ICT in subject teaching” (Taylor, 2004, p. 49), there was a question about what in this context ‘good knowledge’ actually meant. Could or should ‘good knowledge’ refer to measures of breadth, depth, and/or the extent of a pre-service teacher’s knowledge? What kind of identifier would be needed to make such a determination? For the purposes of coding

examples within the transcripts, we defined this category further, interpreting it to mean knowledge of or ideas about ICT for teaching in specific subjects or contexts. Similar questions arose for the Stage 3 item “starting to group ideas from various sources and insights from own experience” (Taylor, 2004, p. 49). For instance, how many individual or sets of ideas and insights are needed before this criterion can be considered met? In both cases the researchers needed to establish a minimum standard to indicate what evidence was necessary for the criterion to be considered achieved.

It became clear during this analysis process that while, in the main, the level of detail in the instrument’s criteria were sufficient for this project and its researchers, the model could be improved by including indicative examples for each criterion. For example, in Stage 2, ‘acknowledges complexity’, it could be helpful to indicate that this item could be taken to represent or relate to many possibilities such as complexity in technology (affordances, technical issues, keeping current), complexity in pedagogy (appropriate approaches for content and technology, classroom management), complexity in context (social, organisational, cultural e.g. changing practice in schools, and perhaps legal, ethical issues as well. Examples would help to show the intended meaning of key terms within the criteria.

### **Students’ progression through the stages**

Having discussed the stages themselves and the process used in mapping participants’ capabilities against the stages in the Taylor model using their interview responses, Table 7 shows the developmental levels identified across participants at each interview phase.

In the table, the numbers in the columns indicate the interview phases in which evidence was found that the participant had met a specific criterion. In carrying out this analysis, there was a question about whether or how the varying levels of quality in meeting a criterion, or the extent to which a criterion was met might be indicated. For example, in many cases in Table 7, there are multiple numbers in the one box, which indicates that sufficient evidence was presented at more than one phase of the project for the item to be considered achieved. Often times, repeated phase numbers were an indicator of an item being quite comprehensively met, however, it was not always the case. Additionally, just as Taylor (2004) found in her investigation, in this study, in the majority of cases, “student teachers’ thinking at any one time did not fit into just one stage” (p. 48). This is not seen as an issue, rather as a sign of the non-linear and individual nature of pre-service teacher development to use ICTs for learning and teaching.

Characteristics	Jenny	Jack	Jason	Joan	Judy	Jess	Jenna*	Joe*	Jeff*	
Stage 1: Uncritical and straightforward	Good knowledge of possible uses of ICTs in teaching	4	4, 5	2, 3, 4	3, 4, 5	3, 4, 5	2, 4, 5	4	4, 5	4
	Unsubstantiated generalisations about ICT use, language definite	1, 2, 4, 5	3, 4, 5	3, 4	1, 3, 4, 5	3, 4	1, 2, 4, 5, 6	4	4	4, 5
	Uncritical, unselective about own/others practice	2	1, 2	1	1, 4	2	2		4	
	Straight transfer and/or acceptance others' ideas		2	1	3	2, 3, 4		4	4	4, 6
	Awareness of issues only at a generalised level	1	1	1, 2	1	1	1			
Stage 2: Beginning to problematise	Increasing focus on specifics of own experience	2, 4, 5, 6	2, 3, 5, 6	3, 4, 5, 6	3, 5, 6	3, 4, 5, 6	2, 4, 5, 6	4, 5, 6	4, 5, 6	4, 5, 6
	Reflecting on and questioning own and others work	2, 4, 5, 6	2, 3, 4, 5, 6	2, 3, 4, 5, 6	3	3, 4, 5, 6	2, 4, 5, 6	4, 5, 6	4, 5, 6	4, 5
	Starting to anticipate issues and develop pedagogical sensitivity	2, 5, 6	2, 3, 4, 5	2, 3, 4, 5, 6	3, 4, 5, 6	3, 4, 5, 6	2, 4, 5, 6	4, 5, 6	4, 5, 6	4, 5, 6
	Suggests simple and context specific solutions	5, 6?	2, 5, 6	5	4, 5	3, 4, 5	6	6	5, 6	5
	Acknowledges complexity, language more tentative, but doesn't follow through the strands of causation	2, 6	2	2, 5, 6	6	5, 6	5	5	5, 6	5
Stage 3: Reflection and theorisation	Starting to group ideas from various sources and insights from experience, able to suggest own set of principles/practical theory		6	6	6	6	6	6	6	
	Critical engagement with own previous ideas and experiences of others		5	6		6	6			5, 6
	Conditional understanding: Able to identify and explore some contingent circumstances		5, 6	6		6				5, 6
	Suggesting solutions and explanations to issues based on deeper analysis and understanding of the complex nature of teaching and learning									

**Table 7 - Mapping of Participant Capabilities Evident during each Interview Phase to Individual Criteria within Taylor's (2004) Stages of Development**

\* Note that Jenna, Joe and Jeff joined the project at Phase 4.

The following sections discuss the developmental levels identified across participants at each interview phase.

## Phase 1

At this early point in their course, the students had undertaken a single ICT related subject with a focus on both ICT skills and pedagogy although being a first year and first semester subject, the majority of time was allocated to learning about and how to use ICTs, with little time being assigned to lesson design using ICTs. The participants' descriptions of expected use of ICTs for learning and teaching were consistent with Stage 1 of the Taylor model where ICT use is largely uncritical and accepting. Statements about planned use of ICT in the classroom which aligned to the Stage 1 criteria included "like using, for example, how in our lectures they use PowerPoint presentations" (Jacquie) and "in seeing the way the lecturers teach us ..., using the PowerPoint displays...going to be a great tool" (Jason). The applicability of PowerPoint presentations to Primary teaching pedagogy suggests that this may be an example of unintended modelling where the practices used by lecturers are assumed by students at this stage of their development to be appropriate practices for use in school classrooms. Around half of the participants made comments which appeared to meet the Stage 1 criterion "good knowledge of possible uses of ICTs in teaching" by providing suggestions about the use of ICTs for specific teaching scenarios.

## Phase 2

While there was evidence that participants' knowledge about teaching with ICTs had developed since the Phase 1 interviews, four of the five participants made comments which were found to meet criteria for Stage 1 of the Taylor model where knowledge of ICT use is uncritical and accepting. The exception to this was Jess, who showed signs that she had largely transitioned to Stage 2. Jess appeared to have embraced ICTs, taking up opportunities to use them in class and on placement. She also showed signs that she was able to effectively reflect on her experience and on the practice of others. For example she made use of an mp3 recorder on placement to capture and play back her kindergarten pupils storytelling. In relation to the source of the ideas behind this, Jess indicated that "I tend to look at the syllabus...the recording idea I sort of thought up myself...I wanted to do different things...you have to be inventive if you're going to be a teacher...you have to keep changing it (practice), mixing it up a bit".

The "awareness of issues only at a generalised level" was a common identifier of positioning (Taylor 2004, p. 49). For example, Jason raised concerns in a generalised way about class organisational issues such as when there was a need to share resources (e.g. computers) between a number of students. The "straight transfer and/or acceptance of others' ideas", and being uncritical about their own or others' practice were other key Stage 1 indicators (Taylor, 2004, p. 49). For example Jenny suggested that she might "be able to get the students to use [ICTs] for presentations" or "make a video or something and use that as a way to get students thinking about something" which replicated her own experiences in subjects at University. Providing an example of how he might use ICTs in the classrooms, Jack described practices which replicated his experiences in a University child development lesson that used video: "I reckon to be able to show the kids some vision... and certainly the web gives you the opportunity to look at ... such a huge range of resources... that's what probably what I'd use".



### Phase 3

In the Phase 3 interviews, only two of the participants presented evidence of progressing into the second stage of the Taylor (2004) developmental model. In the case of Judy, much of this advancement appeared to be due to thought and action in response to observations and experience of ICT use for learning and teaching during her five week placement. Her comments during the Phase 3 interview included critical accounts of the practices of other teachers on placement. Similarly, Jason, despite limited opportunities to use ICTs on placement himself, was able to provide critical commentary on practices he had observed. For example, having observed lessons where little seemed to be achieved, he suggested that “the thing that I’d probably do different is integrate the ICTs... into [an]...English lesson..., doing both together”. His responses also demonstrated pedagogical sensitivity and the ability to anticipate issues, which seems to have come about as a result of considered reflection on ICT use for learning and teaching rather than from his own experience in using ICTs.

The remaining participants’ Phase 3 interview responses generally met the Stage 1 criteria. For example, although he saw potential for ICTs to be used for learning and teaching, the coding of Jack’s responses against the Taylor model suggested that he had made minimal progress in his development. Having self identified as being one who could do with more ICT skill development, and having limited opportunity to either observe ICT use or use ICTs himself on placement, this could be considered a predictable outcome. While Joan was a willing user of ICTs, her comments suggested that her use of ICTs for learning and teaching to this point largely mirrored practices modelled by her supervising teacher, consistent with the criteria in Stage 1. Describing her ICT use on placement Joan stated “This is what she (the teacher) [did] before I arrived on prac, and we just continued it and I got to learn and observe.” Having said this, through placement and in class experience Joan appeared to have gained some confidence and insight which allowed her to demonstrate some pedagogical sensitivity.

### Phase 4

As discussed above, three new participants joined the study at Phase 4 (Jenna, Joe and Jeff). Their phase 4 interviews included questions asking them to describe their experiences at University and on placement over the previous two years of their degree, as well as the questions asked of all participants in this phase asking them about their more recent experiences and their current views. All three new participants provided responses which met some of the Stage 1 criteria (e.g unsubstantiated generalisation or straight transfer of ideas), as well as some of the Stage 2 criteria (e.g. questioning the work of others and anticipating issues). For example, illustrating an unsubstantiated generalisation, when asked if an activity could have been completed without using the technology, Joe responded “the use of the ICT made it more enjoyable and more aesthetically pleasing piece of work from the kids and the teacher’s perspective”.

Of the six continuing participants, all provided some evidence of progressing to Stage 2 in their responses to questions in the Phase 4 interviews, while also providing some responses which still met elements of the Stage 1 criteria, such as unsubstantiated generalisations. Joan, while providing evidence of starting to anticipate issues and developing pedagogical sensitivity, provided responses suggesting that she was to an extent uncritical of practice. For example, when asked about the kinds of lessons in which she had made use of

some ICT lesson templates and worksheets she had downloaded from the Internet, she responded “Everything – it could be literacy, I could have the same template they’ve got just photocopied it... we did it in science, we did it in HSIE and maths, so I covered all the KLAs [Key Learning Areas]”.

Similarly, Judy’s responses suggested that she was still exhibiting straight transfer of ideas in some instances, while also in other responses showing an ability to reflect on and question her own and others’ work. For example she described a writing activity where she had planned to have the student type up their work and develop a computer-based presentation but then made a judgement that this approach was not the best way to achieve the literacy outcomes she was focussing on.

## **Phase 5**

The phase 5 interviews occurred midway through the fourth year of the participants’ degree program, approximately a year after their previous interview. Although they had not undertaken any ICT specific subjects in this period, or undertaken a placement, there appeared to have been noticeable development for most participants, with responses at this Phase generally coded against the Stage 2 criteria. Despite this, a number of participants (Jenny, Jack, Joan, Jess and Jeff) still provided responses that met the Stage 1 criteria of unsubstantiated generalisations, suggesting that moving beyond this aspect of Stage 1 is quite challenging.

For example Jenny made the comment “I probably feel that ICT’s should be used in every aspect of teaching”.

Two participants, Jack and Jeff, provided responses which met some of the Stage 3 criteria (critical engagement with own previous ideas and experiences of others and conditional understanding: able to identify and explore some contingent circumstances).

For example, Jeff made the following comments about the value of students working on laptops compared to the use of a single computer projected at the front of the room: “ICT effectively works properly, if you’ve got laptops, or kids have got, at least access to computers in pairs, because it just becomes a teacher centred activity if it’s not. Like, if you can’t give kids laptops...it’s nothing different to writing on a board, because they’re all sitting there just watching, they’re not interacting”.

## **Phase 6**

The Phase 6 interviews occurred late in the participants’ final year, after a 10 week internship placement, in which they had full responsibility for a class. The value of this placement in their developing capacity to use ICTs in their teaching is evident in the fact that all except one participants was found to be meeting some of the Stage 3 criteria through their responses in this final interview. For example, seven of the nine participants provided responses consistent with the criterion, ‘starting to group ideas from various sources and insights from experience, able to suggest own set of principles/practical theory’. One example of this was Jess, who, in reflecting on the problems she had encountered in a computer laboratory, indicated that a substantial amount of time was wasted in logging on to the computers, and was able to articulate an alternative lesson design strategy where the wait time was used to talk through the upcoming activity with the group.

Four participants provided responses meeting the criteria ‘critical engagement with own previous ideas and experiences of others’. Judy, for example, was able to reflect on some

unsuccessful attempts to use group work and was able to articulate ways in which she could improve the grouping process and the support for groups next time she used this approach.

Finally, four participants provided responses meeting the criteria 'conditional understanding: able to identify and explore some contingent circumstances'. However, and interestingly none of the participants were able to demonstrate 'solutions and explanations to issues based on deeper analysis and understanding of the complex nature of teaching and learning', which suggests that this criterion (or at least our interpretation of it), may have been a stretch for graduating teachers. Only Jenny did not meet any of the Stage 3 criteria in her responses in this interview. Despite most participants meeting some of the Stage 3 criteria, all also met a number of the Stage 2 criteria, indicating that at best this group of graduating teachers were progressing from Stage 2 to Stage 3 at the end of their degrees rather than firmly achieving Stage 3.

Having discussed the progression of the participants through the Taylor stages as evidenced by their interview comments in each phase of the interviews, the following section discusses the overall development process of the students and the aspects of the course that appeared to be important in contributing to noticeable shifts in their development.

## Discussion

Consistent with the findings of Taylor (2004), students in the early part of their course showed through their interview responses that they were at Stage 1 in their development. Progression from this point however tended to be quite variable, with some students achieving a number of the criterion from Stage 2 by the second interview phase, while others did not seem to reach Stage 2 until the third or fourth interview phase (late in the second year or early in the third year of their four year degree). The third Stage in Taylor's model appeared to be challenging for most students, with most achieving elements of Stage 3 only in their final interview at the end of their degree, and no students achieving all elements of the Stage 3 criteria. Taylor (2004) also found that most students tended to meet some but not all criteria for reaching Stage 3 at the end of their course.

The Taylor model proved useful as an analytic lens in classifying the participants' developmental level in use of ICT in the classroom at particular points in time within their course. However, a number of elements of the criteria for particular stages in the model tended to be ambiguous. This degree of subjectivity could be considered a weakness or a strength. High levels of subjectivity can result in inconsistency in the understandings of users and/or anyone reading the results of a study. On the other hand, a lack of specificity allows a researcher to establish and assign a meaning which is appropriate to the context, and to state this so that it is clear. Nevertheless, the inclusion of additional explanatory text or examples to help clarify the intention of each criterion would have been valuable.

The focus in the Taylor model on depth of understanding of issues and appreciation of complexity and context specificity, as well as the ability to critically reflect on practice, as key differentiators between stages, proved valuable in this study, with students clearly demonstrating a developmental progression in relation to these capabilities. This aspect of the Taylor model can be contrasted with the models of Hammond et al. (2011) and Chen, Tam and Lim (2012) which focus to a much greater extent on the way in which ICTs are used in the classroom rather than the level of understanding or appreciation of issues. It may be that a model that draws on elements of the Taylor model as well as elements of the Hammond et al. and Chen, Tam and Lim models, to include both depth of understanding and complexity of

ICT practice could be valuable. The other key model that can be contrasted with the Taylor model is Mishra and Koehler's (2006) Technological Pedagogical Content Knowledge (TPACK) framework, which identifies seven discrete categories of knowledge (technology, pedagogy and content knowledge and the overlaps between them). It could be argued that the natural progression from simplified understandings of technology and pedagogy as distinct areas of knowledge, to more complex understandings where the affordances of technology for learning are understood and ultimately where content area specific applications of technology for learning are identified, align with the increasing complexity in the Taylor model. However, the fact that the Taylor model is presented essentially as a single dimensional progression, whereas the TPACK framework can be thought of as having seven distinct knowledge dimensions is a key point of difference between these models.

Most of the participants in the early phases of the study tended to accept practice that they observed whilst on practicum or within their university classes without question, consistent with various criteria in Taylor's first stage of development. Particularly in the Phase 1 and 2 interviews, almost all of the participants gave evidence to suggest that they had a general awareness of issues but lacked the deeper reflection needed to link ideas encountered with their personal experiences.

This suggests that confidence in the use of technology in a students' social life (e.g. smart phones, the internet, social networking tools, computers in general) doesn't necessarily translate in terms of using technology effectively for learning and teaching. As suggested in Mishra and Koehler's (2006) TPACK framework, the development of understandings of the pedagogical affordances of technology, although requiring both technological knowledge and pedagogical knowledge, won't be acquired automatically once these subsidiary types of knowledge are developed, in the absence of modelling, reflection and opportunities to practice the use of technologies for learning. This has implications for the way in which technology skill development is supported during a course (that is, it needs to be carried out in the context of exploration of the associated pedagogical issues). It also has implications for the positioning of ICT capacity development within a course, and particularly the need for the positioning of ICT pedagogy development after students have studied pedagogy more broadly.

While all students progressed to the Taylor's second stage, an analysis of the interview data across the six phases of interview indicated substantial variability in the degree to which participants were able to demonstrate progression to the third and highest stage in Taylor's model. To illustrate the variability of developmental progression during the course it is helpful to contrast the comments of two participants, Jack and Jenny.

Jack, a mature age student, displayed the greatest and earliest progress into Stage 3. This is attributed in the main to exposure to a range of practices and professional discussion when performing casual teaching work in a number of schools, and on placements. This combined with his thinking about his own practice appeared to readily and actively facilitate much of his progress during his final year. His Phase 5 interview in particular featured many accounts of practice regarding ICTs that he had seen and that had made an impact upon him.

*'I guess from my experience of doing a little bit of casual work ... I'm seeing people's day books with linked websites all through... I've been into a school where in the infants they [had an] IPod there for the reading, listening corner ... it's very very effective you know as is the Smart Board for reading as well because a lot of the teachers are finding that they are able to find these sites where the stories are being read to them with a visual ...from some of the examples I've seen it gives the teacher the opportunity to sit back with the kids and actually learn with them ... without having to be at the front ... and they've got the opportunity to actually watch the children while they're there ... and I think it's also a good observation technique for them to use*

Referring to staff discussions in schools, Jack states...

*'... and the amount of times I have heard – "I have found this site the other day and Nick does this and Nick does that" and I know some staff meetings, like certain schools ... part of their staff meeting has been just a brainstorm of what you know and what you found out and someone scribing and they might end up with 30 websites or all this sort of stuff and they're trying to share or they'll find these websites and then [distribute] on their internal internet or email ...*

From these examples it is clear that time in schools has been invaluable for his development. Jenny on the other hand, in her final year, and while being comfortable using an IWB, had little to no support or guidance regarding ICT use on her internship. As a result she seemed to adopt a trial and error approach which resulted in a perhaps predictable mix of success and failure.

*'I didn't have a lot of support or people there, like people going "Oh yes you could try this or do this" or anything like that so I just sort of made it up myself. A lot of [the lessons] didn't work because I was making them up myself and I didn't really know what I was doing.'*

While professional placements intend to aid and facilitate teacher development, the inference here is that Jenny's practice with ICT for learning and teaching was not sufficiently advanced through university study to enable her to achieve a desired level of confidence and success.

The variability in the experience of students on placement was evident throughout the study. Comments from students identified as being at Stage 1 suggested that they tended to mirror the classroom teacher's routine including their use of ICTs, rather than using strategies emerging from their studies at University. This is important because students also expressed disappointment with observed use of ICTs by their supervising teachers on placement.

There are implications for the ways in professional placements are set up (which largely revolve around mentorship by a single teacher) and also the selection of mentors (who are often more experienced teachers, and consequently not necessarily the leaders in the use of ICTs within their schools). The variable exposure to models of leading practice with ICTs in the classroom also has implications for the reliance on professional experience placement to provide this exposure. The use of packaged materials showing exemplars of practice, including videos of classroom episodes, reflective comments from educators, and supporting preparatory materials, is an alternative or additional strategy that could be pursued.

There was evidence of some students making connections between their ICT related university work, and classroom use of ICTs for learning and teaching during professional placement. This predominantly included ICT use while on placement to meet assessment requirements and putting into practice skills gained on-campus with Interactive whiteboards (IWB) where opportunity arose. For a number of students, significant use of ICTs in their teaching occurred for the first time in third year largely due to an assessment requirement in a

literacy subject. For some of these students, this required use of ICTs resulted in substantial learning and increased confidence and as a result their usage in subsequent professional experience placements was much more significant. This has clear implications for course design because the alignment of ICT related assessment tasks with professional placement requires careful curriculum planning and can be constrained by the availability of placements. Nevertheless, it seems clear that if students are to consistently progress more fully into reflection and theorisation about their use of ICTs for learning and teaching, there is a need for deliberate provision of experiences including assessment tasks which require development of these higher order functions within the course.

The interview data suggests that the students had limited opportunities during their course for reflection and theorising about the role of ICTs for teaching. However, a number of students' comments suggested that the interviews undertaken as part of this research provided them valuable opportunities to reflect on their own practice in the use of ICTs for teaching. Jason, for example, during his Phase 6 interview when asked about the greatest influences on his development of ICT knowledge and skills stated "having these interviews has actually made me reflect on how it has helped me and how it hasn't, and how important it is. ... I suppose as a teacher you should always reflect on, critically and that [the interviews]... allowed me to do that, and think about how I'm using it and how I can use it better and really, the real benefits of using ICTs".

Similarly Jack in his Phase 6 interview responding to the same question ascribed value to reflection and consequent learning explaining that "the last four years I have been able to talk about it [ICT use for learning and teaching], I have been able to debrief with you....and this has made me think even more deeply about it ... when you are doing it you are probably not thinking about the total influence that it has on your work or on your learning so this has given me a great opportunity to reflect on that and kicked a lot of things from the back of my mind to the front of my mind".

This finding has implications for course design because it suggests that the inclusion of an opportunity or requirement for students to reflect on the use of ICTs in various curriculum areas as discussed in curriculum method subjects, the ways in which they have seen ICTs used and used ICTs themselves while on professional placement, and the ways in which they might ideally use ICTS in their future teaching, would seem to be an important inclusion within the course.

## **Conclusion**

This article has reported on a four year study in which a group of 11 pre-service teachers' developing capacities to use ICTs for teaching and learning were explored using a series of semi-structured interviews. In this article the teachers' developmental progression was analysed through the lens of a model developed by Taylor (2004) following a grounded analysis of the progression of a group of students at the University of Cambridge. The use of Taylor's model to guide the analysis proved valuable with students progressing through the stages in similar way to the students in Taylor's study. Nevertheless, some aspects of the Taylor criteria proved ambiguous and a key recommendation from this study is that in order to be used more widely as a tool for classifying pre-service teachers' ICT in learning and teaching developmental stage, some criterion need further clarification including the use of exemplifying examples which illustrate the expected standard needed to achieve the criterion.

With regard to the factors contributing to students' development, a key finding from the study is that students' development seems to be impacted most significantly by whether or not or how the participants have the opportunity to observe and/or use ICTs for learning and teaching while on professional placement. In short, the development of preparedness is in most cases slow or minimal where there is no observed or actual use of ICTs for learning and teaching while on placement. It would appear from this study that experience in the classroom can enable and hasten the development of the awareness of issues and pedagogical sensitivity in regard to ICT use for learning and teaching. This is consistent with the finding of Taylor (2004) who noted that "classroom experience seemed to be central" to students' development.

The more specific findings about the participants' development were as follows:

1. The lack of sophistication of pre-service teachers' planned use of ICTs in their teaching early in their development suggests that the ICT skills they bring from their prior studies or from their social and private lives don't necessarily translate into awareness of use for teaching.

2. The study found that observing ICT use for learning and teaching ultimately provided students with the opportunity to become critical about the work of others however students exhibited a tendency early in their development to adopt strategies modelled without questioning their applicability across context. This was particularly problematic in cases where students expressed the intention to apply strategies in primary school classrooms, such as the use of PowerPoint for presenting content, in ways that they had seen modelled in university lectures.

3. The fact that students' placement experiences varied greatly with some students experiencing noticeable development as a result of placement opportunities and others being provided with limited opportunities to use ICTs on placement due to discouragement by their mentor, highlights the importance of teacher mentors on placement having a level of experience and understanding of the use of ICTs for teaching and learning.

4. The significant progression in some students' development as a result of university assessment tasks requiring them to design, evaluate and reflect upon an application of ICTs for learning and teaching on placement, suggests that despite the barriers to doing so, there is substantial value in aligning university assessment and placement expectations in relation to ICTs.

5. The learning benefits experienced by some students through participating in the research, specifically as a result of the explicit opportunities for reflection that the interviews provided, highlights the importance of deliberate opportunities for critical reflection on ICTs for learning and teaching within a course. This finding is consistent with Taylor's (2004, p. 54) ascribing of the development of the more sophisticated level of understanding and philosophy to the required "reflection on practice and integration with reading" in the latter part of the course.

An important concluding point is that development of pre-service teachers' capacity to use ICT in learning and teaching does not appear to occur as a result of a single strategy or as a result of a series of individual strategies in isolation. Rather, this development occurs through a combination of university and professional placement experiences, along with reflection on these experiences. This study suggests that potential exists to maximise teacher preparedness to use ICTs through teacher modelling of ICT use in tandem with technical and pedagogical skill and knowledge development, and by providing opportunities for pre-service teachers to observe, think about, experience, and reflect on how they might use ICTs for learning and teaching. This affirms Smarkola's (2007) valuing of multiple strategies to build students confidence to use, and insight into ICT use for learning and teaching. It also affirms Taylor's (2004) finding that a range of experiences contributed to students' development, "notably university-based teaching, undertaking assignments which related practice to research literature and experience of teaching using ICT with their classes" (p. 54).

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