**Evaluation as an education development to improve practice: Teacher ICT knowledge, skills and integration.**

**Introduction**

Over the past ten years innovations in the use of ICT in schools have moved from introducing them into the classroom, integrating into teaching and learning, through to sophisticated e-learning practices that have continued to evolve (Garrett, 2011). Current policy and practice, nationally and internationally, accepts that e-learning can enhance student learning. Whilst there is some debate on the impact on the use of ICT on student achievement (Reynolds, Treharne & Tripp, 2003; Ward & Parr, 2010), it’s use has been found to have positive impacts, especially when integrated into teaching and learning in authentic learning environments (Chandra & Lloyd, 2007; Herrington, Reeves & Oliver, 2010). The continued progress in e-learning requires different and innovative ways of conceptualising, measuring and evaluating the educational developments in both teachers’ use of ICT and the effect it has on student learning outcomes (Reeves & Hedberg, 2003; Reeves, 2006; Trimmer, Kennish & McNamara, 2007). New and different approaches to educational technology research and evaluation of e-learning and related pedagogy are evolving concurrently with educational practice.

This chapter will refer two evaluations conducted by the author in the emerging environment of ICT adoption in schools. The first provides a benchmark demonstrating how ICT innovation was conceptualised, measured and evaluated in 2001 in an audit approach. The focus is on meeting set targets. The skills of teachers, access, use and levels of integration are secondary considerations. The second takes an education development approach to evaluation that commenced with the development of a conceptual framework to represent factors of importance in understanding and measuring the ICT competence of teachers. It was developed initially in 2006 to assess the level and nature of ICT knowledge and skills among Western Australian (WA) public school teachers and to establish to what extent teachers were integrating their ICT knowledge and skills in classrooms. The evaluation methodology in the second evaluation was innovative in that it used psychometric measurement to validate teachers’ self-reported ICT knowledge and skills, the ways in which they use ICT and the extent to which they promoted the use of ICT in student learning against an objective online test of teacher ICT competence and integration. Structural equation modeling was then used to analyse the relationships between ICT skills and knowledge, ICT integration within learning, and the other factors identified in the conceptual framework. This conceptual framework and methodology has since been used nationally and internationally to assess teacher competence and utilisation of ICT and e-learning (Alazam, Bakar, Hamzah & Asimiran, 2012 a & b; personal communication University of Glasgow, 2009 and National Committee for Evaluation of Digital Education Revolution, 2010).

**The Performance Review Evaluation**

In the late 1990’s national and state governments allocated millions of dollars to departments of education to fund the provision of learning technologies for schools across Australia. Since this time the digital revolution in education has continued to gather momentum. At present ICT integration remains a major focus in education and globalised futures based learning is at the forefront of many curriculum and learning initiatives and ICT is an expected tool in every classroom. But is the digital revolution translating to progressive use and integration in all school classrooms?

The requirements related to receipt of the funding in the 1990’s focused on levels of access for students, through increasing the number of computers in schools. Targets set by funding bodies were then the basis for measurement in evaluations of initiatives. For example, the Learning Technologies Project for Government schools in Western Australia, funded $80 million over four years in 1998, set computer to student ratios of 1:5 for secondary students and 1:10 for primary students to be achieved by 2002 (EDWA, 1999). Once these targets were met, funding could be utilised for acquisition of additional hardware and software, development of connectivity, professional development of teachers, and technical support. Actual student access to learning technologies however, is also dependent upon other factors including the infrastructure capacity of schools and the capability of teachers to use the equipment for teaching purposes. A 2001 examination of the planning and monitoring of the Learning Technologies Project showed that increased numbers of computers was not always translated into increased student access, use or integration into teaching and learning programs in schools (Office of the Auditor General, 2001). Whilst computer to student ratios were often met, these included computers that were inoperative or not accessible to students. In addition, teachers felt discouraged from making use of computers that were available due to frequent time delays and difficulties with technical support. Connectivity problems were a problem in a high proportion of rural schools, and many schools relied on teachers on either a time-release or voluntary basis to provide technical support.

Whilst conducting the 2001 review in one metropolitan high school on asking to sight the location of over 10 newly acquired computers, I was taken to a locked storeroom. The computers that were included in the ratios to meet the targets were in un-opened boxes. This school met the target criteria of having the computers in the school. However, the principal explained that there were insufficient power points in classrooms to be able to run them and they had no funding to do the electrical work required.

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Underlying the aim of integrating and improving the use of ICT by students is an assumption that teachers themselves are competent and confident in the use of ICT in terms of teaching and learning. In 2001 over 95 percent of teachers interviewed in WA schools indicated that they assessed themselves as having more than a basic level of ICT operational skill. However, the majority of teachers were not confident about applying ICT to facilitate student learning. The Office of the Auditor General WA (OAG) review found that over 90 percent of teachers had undertaken some professional development in learning technologies; the majority had focused on development of computing skills. As a consequence, the professional development undertaken was considered of marginal or no use in relation to their teaching and learning program for 31 percent of teachers interviewed (OAG, 2001). Peer mentoring was reported as the most effective method to enhance understanding and application to teaching and learning programs for most teachers interviewed. However, access to learning technology mentors was not readily available to 44 percent of teachers (OAG, 2001). The majority of teachers used learning technology in their classes for research, word processing and document presentation. There was substantial variation within and between schools reviewed in the level of use and integration of learning technologies. It ranged from playing games as a reward at the conclusion of lessons, with no interaction into the teaching learning program, through to extensive use as a tool to assist students to achieve curriculum outcomes across learning areas.

Whilst teachers were using the computers, levels of integration into the curriculum were low. Following the release of the Office of the Auditor General’s report, The West Australian newspaper cartoon 24/5/2001 illustrated four uses for school computers: Tyre chocks, step-ladder, make-up mirror, and typewriter (Alston, 2001).

The lack of confidence of teachers and low level of integration into lessons to facilitate learning were consistent with teacher self-reports collected by the Department of Education and Training in 2000 (unpublished report). Since this time greater emphasis has been placed on integrating learning technologies to the school curriculum rather than simply achieving set targets of computer to student ratios. Evaluations of ICT in schools have had to expand to incorporate the educational developments. This has included a greater focus on professional development of teachers including skills development and also through capacity building to integrate learning technologies into the teaching and learning program. However, research and evaluations are still indicating that many teachers remain reluctant to utilise ICT (Blackberry, 2012; Ertmer & Ottenbreit-Leftwick, 2010; Levin & Wadmany, 2008).

**The Education Development Focused Evaluation**

An evaluation was conducted in 2006 to provide a valid and reliable baseline assessment of the level and nature of ICT knowledge and skills among WA government school teachers and the extent to which teachers were integrating this knowledge in classrooms (Department of Education and Training, 2006; Trimmer, Kennish & McNamara, 2007). In order to promote further innovation in classrooms, the evaluation also sought to identify factors seen by teachers as impacting on the development of ICT competence and its integration in teaching and learning, and to determine potential ICT support and development strategies that the Department could implement to enhance effectiveness in the future. The evaluation methodology was innovative in that it used psychometric measurement to validate teachers’ self-reported ICT knowledge and skills, the ways in which they use ICT and the extent to which they promoted the use of ICT in student learning against an objective online test of teacher ICT competence and integration. Structural equation modeling was then used to analyse the relationships between ICT skills and knowledge, ICT integration within learning, and the other factors identified in the conceptual framework. This conceptual framework and methodology has since been used nationally and internationally to assess teacher competence and utilisation of ICT and e-learning (Alazam, Bakar, Hamzah & Asimiran, 2012 a & b; personal communication University of Glasgow, 2009 and National Committee for Evaluation of Digital Education Revolution, 2010).

*Conceptual framework*

The conceptual framework in Figure 1 was developed to represent factors identified as impacting in measuring the ICT competence of teachers (Department of Education and Training, 2006; Trimmer et al, 2007). The framework was developed based on analysis of existing literature, consultation with key stakeholders and recognised experts in ICT and teaching and learning. It identifies factors at the school level in relation to individual teachers and in the application and use made of ICT by teachers.

**Insert Figure 1 here**

Figure 1: Conceptual Framework (Department of Education and Training, 2006)

The constructs in the conceptual framework include:

* School ICT Capacity - including numbers of computers; their location and supporting infrastructure; other available hardware such as digital cameras, interactive whiteboards and printers; and access to Internet and technical support.
* Professional Development/Training - including informal and formal mentoring; and courses arranged via the school, district or externally to the system. This construct is listed under school based factors as it is considered as a responsibility of the school rather of a teacher even though previous training and skills may have been developed by the individual.
* School Planning and Leadership - including provision of sense of direction; strategic planning; allocation of sufficient resources to implement; and use of ICT to monitor, evaluate and report.
* Demographics – gender; age; teaching experience; teacher level; teachers with administrative duties; mode of employment (full or part time/job share); employment status (permanent, fixed term or probation); school type; learning area; and school region.
* ICT Skills and Knowledge – based on eight commonly used applications including word processing; internet; file navigation; email; presentation packages; spreadsheets; databases; and a curriculum management package.
* Teacher Attitudes and Motivation – incorporates attitude towards use of ICT and its capacity to provide benefits for students; confidence; willingness to explore and adopt; and to allocate time to develop alternative lesson plans.
* Assessing Student Outcomes - including student assignments that involve use of an ICT application; digital artefacts from assignments; other ICT applications that enable teachers to monitor, evaluate or report on student achievement.
* Teaching and Learning Programs – the extent to which ICT skills and knowledge are being applied within teaching and learning in classrooms by teachers. The learning outcomes included in this construct included mastering skills just taught; remediation of skills; communication with others; finding out information; analysing information; presentations; improving computer skills; and working collaboratively.
* Professional Use – this included creation of materials for student use; access to research; curriculum administration; communication with colleagues, students and parents; posting information for students onto a website; and online professional learning.

Two components of the conceptual framework, ICT Skills and Knowledge and Teaching and Learning Programs, are highlighted as independent variables for the analysis. Information on factors that impact on development of ICT knowledge and skills is useful for schools and education sectors in making strategic decisions regarding allocation of resources for professional development of teachers. The framework and associated measurement instruments have since been utilised and their validity confirmed in subsequent studies (Alazzam, Bakar, Hamzah & Asimiran, 2012a, 2012b; Blackberry, 2012) and is also being utilised in research with schools in Glasgow.

*Methodology*

The evaluation methodology comprised of an ICT teacher online survey of 1500 teachers working in WA public schools. The survey enabled teachers to self-report their levels of ICT knowledge and skill, the ways in which they use ICT and the extent to which they promote the use of ICT in student learning, and to identify any factors that impact on each of these. In addition, an objective online test of teacher ICT competence was given to a subgroup of teachers from a stratified random sample of metropolitan and country, primary and secondary schools, to test the actual ICT knowledge and skills of teachers. Responses were received from over 360 teachers in each of the four subgroups. The statistical analysis compared the teacher responses to questions on the survey to the results of objective on-line test to determine the validity of using teacher self-assessments as a measure of teacher ICT capability using the Rasch uni-dimensional measurement model (Rasch, 1960/1980; Andrich, Sheridan & Luo, 2005).

The Rasch model was used to analyse the responses given by teachers and locate their use and competence with ICT applications onto a single measurement scale. The procedure involves scaling the results on each item of the ICT teacher survey and the objective on-line test relative to responses on the other items. The procedure for analysing differential performance uses the principles of latent trait theory. The model requires that there is a single latent trait which governs the responses of all persons to all items. In this case this trait is ICT competence. This component of the analysis aimed to produce a measurement scale of the knowledge and skills of teachers in relation to the 80 ICT skills included in the survey and on-line test.

The Rasch analysis indicated that responses given to ICT teacher survey items provide an accurate measure of teachers’ ICT knowledge and skills with a teacher’s score on the survey being highly likely to be equal to their score on the objective skills test. This result suggests that teachers were neither overestimating nor underestimating their abilities in the self-report survey. There was a correlation of 0.73 between the objective skills test and the teacher survey suggesting that the teacher survey had a sufficient degree of content validity, when validated against the objective skills test. In addition, the objective skills test provided a strong reliability coefficient, with a Cronbach Alpha of 0.89, indicating that it provided a statistically reliable measure of ICT skills and knowledge. The teacher survey provided a very strong reliability coefficient, with a Cronbach Alpha of 0.98. This indicates that the survey has a higher level of internal consistent validity than the objective skills test, so that respondents are more likely to show consistency in responding to the survey.

Structural equation modeling was then used to analyse the relationships between ICT knowledge and skills and the other constructs included in the conceptual framework. This statistical technique allows hypothesised relationships between identified constructs in the conceptual framework to be tested and provides estimates of the strength of these relationships (Gefen, Straub & Boudreau, 2000). This essentially provides a measure of the predictive power of the conceptual framework, in that it demonstrates how much of the variance in the construct is explained by the framework (Barclay, Thompson & Higgins, 1995).

*Results*

The results of the Rasch analysis placed teachers on a linear scale of ICT knowledge and skills competence. At the low end of the scale were teachers who typically had word processing skills and some knowledge of Internet, email and file navigation. The middle portion of the scale comprised teachers who used these skills to a greater extent and in addition had some presentation software and spreadsheet skills. The high end of the scale comprised teachers who used all of these applications extensively.

Examination of the conceptual framework in relation to the data analysis showed that the extent to which a teacher uses ICT for professional purposes, the ICT capacity of their school, and their attitudes and motivation were the three most influential factors on ICT competence. There were also demographic factors that had a statistically significant impact on teacher ICT competence. The analysis showed that males, younger teachers, teachers with less teaching experience and secondary school teachers are more likely to have higher levels of ICT competence. The Alazzam et al (2012b) study also found significant differences in teachers’ ICT skills with younger teachers and those with fewer years of teaching experience having higher levels of skills.

The results of the structural equation modelling also showed a significant relationship between constructs within the conceptual framework. The weights assigned by this modelling are indicated in Figure 2. They provide a measure of the strength of the relationship between each pair of variables. Consistent with the results from the Rasch analysis, factors with the strongest relationship to ICT skills and knowledge were professional use of ICT; school ICT capacity; and teacher attitudes and motivation. Considered together these three factors accounted for 86% of the variance in ICT skills and knowledge.

**Insert Figure 2 here**

Figure 2: Relative strength of relationship of factors on ICT competence of teachers (DET, 2006)

The professional use of ICT was found to be the most influential factor on ICT knowledge and skills accounting for 51% of the variance, which was double the influence of the next most influential factor. This finding strongly suggests that teachers should be encouraged to use ICT professionally to a greater extent. This could be through creation of materials for student use; access to research; curriculum administration; communication with colleagues, students and parents; use of websites to post information and online professional learning. The creation of materials for student use was undertaken by the vast majority of teachers but very few indicated that they posted information to websites for their students to use in their work. As most of the use requires access to Internet it is a critical issue that infrastructure is in place to support teacher access to promote professional use of ICT.

*Integration of ICT*

In addition to the level of teachers’ ICT skills and knowledge, the study sought to examine the extent to which those skills and knowledge were applied by teachers within teaching and learning in classrooms. While the vast majority of teachers were found to be conversant in the use of word processing, Internet, email and file navigation applications, a much smaller proportion of teachers indicated they were integrating ICT in the classroom on a regular basis. Rasch analysis was again used to place the teacher responses onto a measurement scale. As shown in Figure 3, it was found that just over half of the teachers reported a high level of integration. However, over a quarter of teachers indicated that ICT was having little or no impact in their classroom. In contrast to level of knowledge and skills, there was only one demographic variable that impacted significantly on integration of ICT in the classroom. This factor was mode of employment, with full-time teachers being significantly more likely to integrate ICT than part-time or job share teachers.

**Insert Figure 3 here**

Figure 3: Frequency of professional use of ICT (DET, 2006)

*Results in response to question: Below is a list of statements about the extent to which you apply ICT within your teaching practice, please choose the one that best describes your situation? In my current teaching ICT is …*

Structural equation modeling was then used to investigate the factors from the conceptual framework impacting on teacher integration of ICT within teaching and learning. Factors that impacted on the extent of integration included: school ICT capacity; teacher attitudes and motivation; school planning and leadership; and professional development. When these five factors were combined the aggregated weight summed to 96% which indicates that they account for almost all of the influence of ICT integration within learning. This is a finding of great import to schools and education systems with a policy view that is looking to increase integration across classrooms in Australia. Figure 4 shows the strength of the relationship for each of these factors with integration within learning. The ICT skills and knowledge of the teacher has the strongest relationship and accounts for 38% of the variance. Clearly the strength of this relationship highlights the importance of upskilling teachers.

**Insert Figure 4 here**

Figure 4: Relative influence of ICT competence and ICT integration (DET, 2006)

**Discussion and conclusions**

A teacher’s level of ICT competence, the ICT capacity of their school, their attitudes and motivation, the planning and leadership of their school and their attendance at training on how to integrate ICT were found to be the most influential factors on a teacher’s integration of ICT in the classroom. These findings imply that measures to increase the use of ICT for professional purposes whether it be for communication, creation of classroom materials, or administrative tasks would be beneficial for increasing skills with a flow on to greater integration. Teachers’ attitudes and motivation were found to be extremely positive over all, but there was frustration with ability to access computers whether due to numbers, timetabling or infrastructure that resulted in reduced use. This should be supported by continuous improvement of school ICT infrastructure and access to technical support as these were reported as being the greatest barriers to use and the development of teacher competence.

Interviews with teachers indicated that one of the most helpful forms of training was mentoring by other teachers. This is because it was targeted to exactly the learning context required and provided just in time for use by the individual teacher. External training courses provided a wide range of skills but if these were not utilised in a short time frame they were often forgotten or unable to be transferred to the individual classroom context. There was also a need demonstrated for formal and informal training in both use of software and databases, and how to go about integration, as analysis revealed that training on how to integrate ICT in the classroom had the most positive impact on a teacher’s level of ICT integration. The importance of training, both pre-service and in-service, has since been identified as impacting on ICT skills and knowledge (Alazzam et al, 2012b; Mahmud & Ismail; 2010). The adoption of new ideas for integration of technology has also found to be limited by the largely transmissive style of training workshop that neglects the explicit acknowledgement of teachers’ attitudes and needs at any point in time and the multidimensional nature of change within organisations (Blackberry, 2012; Ertmer & Ottenbreit-Leftwick, 2010). Innovative approaches to professional development for both competence and integration are therefore required.

Uncertainty about keeping up to date or being embarrassed by the greater knowledge and facility of students was a cause of concern for some and translated into feelings of inadequacy and reluctance to integrate. Opportunities to share practice were considered useful as they provided real examples of good practice, encouraged critical reflection, and increased confidence. At the school level, improvement of integration should also be improved through enhanced school planning and leadership to provide a clear focus for acquiring ICT resources and their strategic use and to promote and support teachers in professional development through training and use of ICT. Blackberry (2012) indicates that issues of time pressures, access to and reliability of ICT resources and school culture continue to create barriers that can hinder integration. At this time, the need for more and better access to computers was the most frequently cited barrier. This was due to location of computers, timetabling for laboratories, and slow response when technical support was required. The teachers interviewed had a positive attitude but experienced frustration when planned lessons could not proceed due to access and technical problems.

Increased profile and focus through school planning and leadership should also include monitoring, evaluation and reporting at schools at system level to provide feedback and guide continued improvement. Use of the conceptual framework and the established measures developed through this evaluation were then able to be utilised by districts, school clusters and individual schools as a tool for educational development. This framework and methodology was also one of a number approaches discussed by the National Committee for Evaluation of Digital Education Revolution (personal communication, 2010). This Commonwealth initiative was implemented to promote integration of ICT in classrooms across Australia and to identify innovative strategies for implementation and evaluation of the initiative.

**Evaluation leading to development of strategies for future support**

Analysis of the data collected in the evaluation using the conceptual map provided evidence, impetus and direction for further educational development. Investigation of the relationship between a teacher’s level of ICT competence, the extent of their integration of ICT in the classroom and the range of factors that influence each of these revealed five distinct groups within the Western Australian government school teacher population, with each group sharing a demonstrable set of characteristics. These groups are illustrated in a matrix in Figure 5. The matrix represents the combinations of ICT competence and ICT integration and their proportion of occurrence in the sample surveyed. It is of interest that low levels of ICT competence did not preclude integration, though as expected they were associated with lower levels of integration. Conversely, high levels of integration were not always associated with the highest levels of competence. The inter-relationships were complex and it was clear that there could be no one solution to enhancing the competence or the level of ICT integration for teachers.

**Insert Figure 5 here**

• 2 Figure 5: ICT Competence and Integration (DET, 2006)

-3 years teaching

The characteristics of each of these groups as identified in the study was further explored to determine what approaches and strategies may be of greatest use in enhancing both ICT competence and level of integration in the classroom. The characteristics of each group and their needs as identified in the study were considered. Support strategies identified from the findings as having the greatest potential to increase ICT competence and/or integration for each identified group are shown in Figure 6 (Department of Education and Training, 2006; Trimmer et al, 2007). This analysis provides a further tool for schools and education systems to use in combination with the conceptual framework to further promote innovation in schools and classrooms in relation to ICT. It also provided focus for development of professional development for teachers at a system level.

**Insert Figure 6 here**

Figure 6: Strategic Directions (DET, 2006)

The competence, confidence and levels of integration by teachers have continued to be evaluated and measured and the level of ICT usage in classrooms continues to be mandated as a priority that requires further funding and focus (Alazzam et al, 2012a & b; Blackberry, 2012). The outcomes for students from e-learning pedagogy, including academic, social and behavioural outcomes, have also continued to be researched and evaluated. The inclusion of impact evaluation (Reeves & Hedberg, 2003) has become an important consideration for evaluators and researchers in enabling results to be used effectively as educational development tool for continuous improvement for education systems as well as for individual schools and teachers. The conceptual framework and methodology developed for this study continue to have relevance as a tool to measure ICT competence and levels of integration going forward. Further new methodologies and approaches to evaluation and research will be required to validly and reliably measure innovative e-learning pedagogy as successful use of ICT in the classroom is a complex system involving teachers’ ICT knowledge, skills and integration, teaching and learning contexts and strategies, and students involvement in and experience of learning (Alexander, 2001). The transition to comprehensively embracing new technologies is still underway and the transformation will continue as new technologies continue to be developed. This is the case for learning and teaching, but equally for evaluation and research, which need to develop in parallel in order to inform and direct improved developments in practice.

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