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Recommendations for the Development of an ICT Curriculum Integration Performance Measurement Instrument: Focusing on Student Use of ICTs

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Abstract

An analysis of trends in international methodologies for describing and measuring Information and Communication Technologies (ICTs) curriculum integration reveals that there has been an identifiable focus on student access to ICTs, student attitudes toward the use of ICTs, and on teacher training and professional development in the use of ICTs (Jamieson-Proctor, Watson and Finger, 2003). There is now an emerging need for and trend towards the development of performance measurement instruments which measure ICT curriculum integration. This paper provides recommendations for the development of an ICT curriculum integration performance measurement instrument through a summary of recent ICT curriculum integration research, and an examination of international methodologies for describing and measuring ICT curriculum integration Specific reference is made to the theoretical framework conceptualised to guide the development of the instrument by identifying key strategic ICT drivers, dimensions of ICT use (DETYA, 2000a; DEST, 2002), and the integration of ICTs with the Productive Pedagogies framework (Education Queensland, 2000; 2003b).

Introduction

Since the introduction of computers in schools and the emergence of the potential of connectivity afforded by the Internet, most education systems have embarked upon a considerable range of information and communication technologies (ICTs) initiatives. For example, MCEETYA ICT in Schools Taskforce (2002), Finger and Trinidad (2002) and Finger (2003) provide overviews of current Australian systemic ICT initiatives. In addition, through an analysis of the trends that emerged in ICT initiatives between 1998 and 2002, Finger and Trinidad (2002) noted that since 1998, all Australian States and Territories continued to increase the access by students and teachers to computers, connect more schools and classrooms to the Internet, and implement initiatives for students to learn in an online world evidenced by digital content initiatives. As outlined by Jamieson-Proctor, Watson and Finger (2003), the Australian example is reflected in the extensive range and focus of ICT initiatives in other countries as evidenced by initiative documents (DfEs, 2002; Kommers, 2000) as well as by the literature which provides suggestions on how these initiatives might be achieved (James, 2001; BCED, 2001; Somekh & Davis, 1997). Importantly, there is also evidence in the literature of investigations of the relationship of ICT integration and student outcomes (Angrist & Lavy, 2001; Baker, Gearhart & Herman, 1994; Kulik, 1994; Mann et al., 1999; Scardamalia & Bereiter, 1996; Sivin-Kachala, 1998; Wenglinksy, 1998). However, unless more sophisticated notions of *describing* ICT curriculum integration are developed researchers run the risk of promulgating severely restrictive ways of *measuring* it. This observation is supported by the limited suite of research that has explored ICT curriculum integration to date. Cuttance and Stokes (2000) suggest problems arise from the difficulty with *defining* exactly what ICT curriculum integration might comprise as well as difficulties with research methodology that might evaluate it. Moreover, it is suggested that future attempts to measure ICT curriculum integration need to focus directly on *student use of ICTs* to complement data such as student to computer ratios, student attitudes toward computing, and teachers' computing skills (Jamieson-Proctor, Watson & Finger, 2003).

Following a review of international methodologies for measuring ICT curriculum integration performance measurement, this paper provides a set of recommendations for developing an instrument and assisting in the conceptualisation of the relationship of that instrument with key strategic ICT drivers, dimensions of ICT use and Productive Pedagogies. This paper provides a summary of sections of the report on the development of an ICT curriculum integration performance measurement instrument for Education Queensland (Jamieson-Proctor, Watson and Finger, 2003). The subsequent instrument, following initial pre-testing, is currently being developed for use in Queensland schools.

Development of an ICT Curriculum Integration Performance Measurement Instrument – Education Queensland, Queensland, Australia

As indicated earlier in this paper, many education systems have enhanced student access to computers and recognise the importance of teachers' preservice and continuing professional development in integrating ICTs to improve student learning outcomes. Measures such as the amount of money spent on ICT infrastructure and hardware, and the extent to which teachers have undertaken professional development to achieve specified standards are used to gain school and systemic data. Indeed, in the Australian setting there seems to be some interstate competitive approach to being able to claim the best student to computer ratio. Accompanying that provision of increased numbers of computers in schools, there has been an increased awareness of the importance of the role played by teachers in enabling effective ICT curriculum integration (see, for example, DEST, 2001; DEST, 2002). In relation to the Queensland setting, links are made between teachers ICT professional development and ICT curriculum integration to improve student learning outcomes through the *Minimum Standards for Teachers – Learning Technology* (Education Queensland, 1997) which required all teachers in Queensland government schools to have acquired these by 2001 and the *ICT Continua* (Education Queensland, 2003a) which builds on the *Minimum Standards – Learning Technology* to provide an ongoing self-reflection schema for teachers in relation to their ICTs journey.

Education Queensland has collected data on the effectiveness of ICT integration through student, staff and parent satisfaction surveys which contain items relating to student access to ICTs, the percentage of teachers accredited with *Minimum Standards – Learning Technology*, and schools' student to computer ratios. The *ICT Continua* attempts to provide guidance for personal learning and development plans for improving ICT integration. The *ICTs for Learning School Census 2002* sought data related to the six key ICT drivers of Education Queensland's *ICTs for Learning* (Queensland Government, 2002a) strategy namely: learning, teaching and the curriculum; learning and development; ICT infrastructure; connectivity; ICT support; and innovation. The census information was used to create a summary profile of each school's position relative to the foundation benchmarks. The specific challenge which emerged for Education Queensland was to improve the items which sought information relating to the key ICT driver of learning, teaching and the curriculum. This paper provides a summary of the response to that challenge of being able to develop an instrument which will enhance the measurement of ICT curriculum integration in schools.

Review of International Methodologies for Measuring ICT Curriculum Integration

The development of the ICT curriculum integration performance measurement instrument required an analysis of national and international ICT integration performance measurement initiatives in terms of the ICT data sought and the methodologies employed. That analysis revealed that there has been a focus on student access to ICTs, student attitudes toward the use of ICTs, and on teacher training and professional development in the use of ICTs. There is now an emerging trend towards the development of methodologies to measure ICT integration and its resultant impact on student learning outcomes. The difficulty these performance measurement methodologies encounter is that of first describing what ICT integration actually means.

In the USA, the National Educational Technology Standards Project (NETS) is driven by the rationale that 'All children must be ready for a different world' that is increasingly complex and information-rich, and will require them to use technology effectively (ISTE, 2000). Australian documents such as *Learning for the Knowledge Society* (ANTA, 2000) and *Education and Training in the Information Economy* (DETYA, 2000b) take a similar approach, while others such as *Queensland the Smart State: Education and training reforms for the future* (Queensland Government, 2002b) also acknowledge the positive effects of ICT on student attitudes toward learning. Furthermore, ICT curriculum integration can imply an existing curriculum or underwrite significant curriculum reform such as evidenced in the *New Basics Project* (Education Queensland, 2000). Watson, Taylor and Russell (1999) discuss these differences between 're-tooling or re-forming' approaches. *Good Practice and Leadership in the Use*

of ICT in Schools (DETYA, 2000a) emphasise this complexity by identifying four different, but overlapping, dimensions to ICT use in schools, namely:

- a tool for use across the curriculum or in separate subjects where the emphasis is on the development of ICT-related skills, knowledge, processes and attitudes;
- a tool for enhancing students' learning outcomes within the existing curriculum and using existing learning processes;
- an integral component of broader curricular reforms, which will change not only *how* students learn but *what* they learn; and
- an integral component of the reforms, which will alter the organisation and structure of schooling itself.

Even the term 'ICT' itself, while becoming more widely accepted in Australia (DEST, 2002), the UK (OFSTED, 2002) and Canada (BCED, 2001), is not universal. For example, the NETS (ISTE, 2000) project in the USA prefers the term 'educational computing and technology (ECT)' and notes that it encompasses the following sub-disciplines: (a) integration of technology and curriculum to support learning; (b) delivery, development, prescription, and assessment of instruction; (c) effective use of computers as an aid to problem solving; (d) school and classroom management; (e) educational research; (f) electronic information access and exchange; (g) personal and professional productivity; (h) technical assistance and leadership; and (i) computer science education.

In addition to complexities of rationales and terminology, the initiatives documented in this paper also reflect various stages inherent in ICT curriculum integration. Fluck (2001) describes these stages as: providing computers; establishment of frameworks for student and teacher competencies for using ICT across the curriculum; and content changes in all curriculum areas and flexible school learning through the use of ICT. The MCEETYA (2002) initiative *Learning in an online world* identifies similar priorities for online aspects of ICT curriculum integration: availability of connections of sufficient bandwidth; effective pre-service and ongoing professional development for teachers; and developing high quality online content.

One methodology that has been attempted on various scales is case studies of innovative practice such as the Second International Technology in Education Study Module 2 (SITES M2) described in Ainley, Banks and Flemming (2002) and the Innovation and Best Practice Project (IBPP) (Cuttance, 2001). Cuttance notes that 'The schools that developed ICT-based innovations found the discipline of researching and measuring the impact of their innovations to be a significant challenge' (p.99). The 'challenge' of this research has shown itself in approaches that quantify skills such as the National Sample Study of Australian School Students reported in *Real Time* (Meredyth et al., 1999) or hardware such as British Columbia's *Provincial Education Technology Report* (Withers & Coupal, 2002). In summary, the review of literature indicates the complexity of rationales and terminology that underwrites initiatives; the various dimensions and stages of integration; the inherent methodological difficulties; obstacles to integration; and significant issues relating to teacher professional development in relation to ICT curriculum integration.

Table 1 below provides an overview of international ICT curriculum integration performance measurement initiatives in terms of the ICT data sought, and the methodologies used.

Table 1: Overview of ICT curriculum integration performance measurement initiatives
(This summary builds substantially upon the overview presented by Cuttance and Stokes (2000, pp. 49-53)

International ICT Curriculum Integration Performance Measurement Initiatives	ICT Data Sought	Methodologies
National Sample Study of Information Technology Skills (NSSITS) - Australian study. Source: Meredyth, D., Russell, N., Blackwood, L., Thomas, J. and Wise, P. (1999).	Survey in a representative sample of 400schools from all Australian States and Territories to obtain baseline information about students' and teachers' experience and skills in information technology; including basic ICT skills of students and teachers, advanced ICT skills of students and teachers, school infrastructure and student access to and use of computers at school and at home, and teacher professional development.	Survey of students, teachers and principals to obtain baseline information about both students' and teachers' experience and skills in using information technology. Self-reporting and self-assessments of ICT skills and knowledge of a national sample of students.
The Third International Mathematics and Science Study (TIMSS) and TIMSS Repeat Study (TIMSS-R) - TIMSS-R 1998 was conducted in 38 countries, including Australia. Source: National Center for Education Statistics. (not dated).	Assessed the Mathematics and Science achievement of students in their second year in secondary schools. Content areas in Mathematics and Science were assessed.	Used a two-stage sampling procedure to ensure a nationally representative sample of students. In Australia, 170 schools participated and 4032 students were assessed. Students were administered test booklets, including multiple choice and free-response items.
British Educational Communications and Technology Agency (BECTA) - United Kingdom. Source: Becta. (2003).	Relationship between ICT and standards. ICT and subjects. Schools' readiness for ICT (5 factors – ICT resourcing, ICT leadership, ICT teaching, school leadership, and general teaching). Socio-economic factors. Pupils attitudes, behaviour, parental views, attendance, learning, ICT skills, attainment.	Previously explored linkages between schools' ICT resources and educational standards. Now uses Ofsted judgements which require judgements on a) ICT factors relating to ICT as a subject – ICT teaching, ICT learning opportunities and ICT achievement, and b) on the quality and use of new technologies within a subject. Refers to ImpaCT2 - a large scale longitudinal study tracking over 2000 pupils' use of ICT for 3 years.
Organisation for Economic Co-operation and Development (OECD) Centre for Education Innovation and Research (CERI) Studies - Australia participates in OECD studies. The OECD collects a range of data to enable internationally comparable statistics on education. Information and Communication Technologies is an OECD theme. Sources: OECD/CERI. (2001); OECD. (2002); OECD. (2003). Program for International Student Assessment (PISA) - PISA is a three-yearly survey of the knowledge and skills of 15 year olds in the principal industrialised countries with 28 OECD member countries, including Australia, and 4 other countries taking part in the first PISA study in 2000.	In 1998, OECD directed CERI to develop plans for a program on ICT and the quality of schooling (OECD/CERI. (2001). *Learning to Change: ICT in Schools.* OECD.) Resulting program had 3 areas: Markets and Partnerships, Quality Assurance, Impact Studies. Examined ICT as a catalyst for reform, diffusion of ICT, successful implementation of ICT, equity, and academic standards. It examines the domains of Reading literacy, Mathematical literacy, and Scientific literacy. The PISA index includes items relating to student interest in computers, their perceived comfort with and ability to use a computer, and their attitudes towards using computers.	Data collected through surveys with agreed definitions between most participating countries. The Impact Studies (Venezky and Davis, 2002) involved 2 major studies; i.e. case studies and organisational change, and quasi-experimental studies of the factors that affect the learning of ICT and information handling skills. Used explanatory case studies and involved the use of a Teacher ICT Practices Survey, interviews, observations, student work and school documents. Students sat pencil and paper assessments in their schools Self-reporting and self-assessment for a sample of students. Students and their principals also answered questionnaires about themselves and their schools. This allowed PISA to identify what factors are associated with better and worse performance.
Second Information Technology in Education Study (SITES) - was initiated by the IEA (International Association for the Evaluation of Educational Achievement) to investigate ICT-related changes in education. Australia is a participating country. Source: International Association for the Evaluation of Educational Achievement (IEA). (June 2000- July 2001). International Association for the Evaluation of Educational Achievement. (2003).	Investigates how ICT is being utilized in the classroom and examines whether ICT contributes to the improvement of school education; e.g. Principals' Questionnaire sought data about: Use of computers in schools. Students' ICT concepts and skills. Teaching and learning practices. Learning process Student attitudes to ICT. Functional uses of ICT.	Survey was performed on the extent to which ICT is used and how the ICT infra-structure was equipped. A panel of national experts for the study were selected and appointed. The international definition of Innovative Pedagogical Practices Using Technology was adapted. Case selection guidelines were developed. Using the guidelines, cases for pilot study and main study were selected. A pilot study was done using instruments for data collection and analysis. The instruments were modified and supplemented.
CEO Forum - Teacher Preparation StaR Chart - United States of America. The CEO Forum operated from 1996-2001. Source: CEO Forum on Technology. (Jan. 2000).	Has three levels – early, developing and Advanced Tech. For use by Universities, schools, systems. Provides indicators for leadership, infrastructure, and curriculum.	Graphical layout of StaR as well as online version of this tool.

North Central Educational Laboratory (NCREL) enGauge - A Framework for Effective Technology Use in Schools Source: North Central Educational Laboratory (NCREL). (2003).	Discrepancy Analysis (Metiri Group), based on enGauge (NCREL) Six essential conditions; Forward-thinking, shared vision; Effective teaching and learning practice; Educator proficiency; Digital equity; Robust access anywhere, anytime; Systems and leadership.	Provides a visual graphing of results to provide insights into what individuals/schools/systems are doing well, situations where resources need to be redirected, and new areas for strategic planning and direction. Survey checklist containing items using rating scales.
National Educational Technology Standards (NETS) - USA International Society for Technology in Education (ISTE). (2000).	Program to identify educational computing and technology (ECT) standards for students, teachers and school administrators. Performance indicators for teachers are: technology operations and concepts; planning and designing learning environments and experiences; teaching, learning, and the curriculum; assessment & evaluation; productivity and professional practice; social, ethical, legal, and human issues.	Performance rubrics have been developed for 'Technology leadership' and Technology facilitation' using the NETS indicators to identify the standards (approaches standard, meets standard, exceeds standard). Aligned with the National Council for Accreditation of Teacher Education (NCATE) standards.
Schools Online Curriculum Content Initiative: Market Research Report (Cooper et al. 2001) - Australia	Sought data on classroom use, and impact on teaching and learning, of existing online resources as well as implications and expectations for the development of online materials	Quantitative data were generated from responses to an online teacher survey of 276 teachers regarding current and preferred use of online resources. Qualitative data were collected through observations of and interviews with 85 teachers.

From the review of methodologies for describing and measuring ICT curriculum integration, the following issues were identified to inform the development of an ICT curriculum integration performance measurement instrument:

- a need for clarity of rationale for ICT curriculum integration;
- a need for clarity of the terminology 'ICT curriculum integration';
- a need for appreciation of the different dimensions of ICT use in schools;
- the methodological difficulties inherent in evaluating ICT integration;
- there remain obstacles to integration;
- a need for alignment with the ICT competency framework for teachers; and
- the importance of resisting the urge to turn back.

The summary of measurement studies (Table 1) reveals a lack of substantial history and development with most studies being developed since 1998. Most attempts have focused on inputs such as student to computer ratios, expenditure on ICTs, and the training and professional development of teachers. Very little has occurred in terms of developing instruments for measuring the impact of ICT curriculum integration on students and teachers. Large-scale investigations are now highlighting the need for the development of methodologies which effectively measure ICT integration and student outcomes; e.g. SITES, enGauge and the BECTA initiatives. Similarly, Cuttance and Stokes (2000, pp. 32-33) note that the focus of international studies such as PISA 2000, the IEA SITES, and the CERI studies has been on information about ICT use in the learning environment, access and attitudes of students to ICT; and elucidating the factors influencing computer-based assessments of achievement in other domains (literacy, numeracy, science and other core curriculum areas), rather than cross-national assessment against agreed standards of ICT skills and knowledge. Furthermore, constraints associated with large-scale system implementation such as time, costs, ease of implementation, and shared understandings of terminology used in items need to be taken into account when developing methodologies. As there has been a heavy reliance on surveys involving student and teacher self-reporting and self-assessment methodologies, the implementation of those surveys require the provision of support materials and training to improve shared understandings in order to enhance the reliability of responses. For example, methodological challenges were identified in the NSSITS study (Meredyth et al., 1999). In particular, the report indicated that difficulty occurs in defining skills 'in isolation from teaching–learning contexts and from the ends to which those skills might be put by the students who acquired them' (p.294). Similarly, in providing a framework for national monitoring of ICT integration, Cuttance and Stokes (2000, p.32) suggest that 'National monitoring and assessments

of ICT skills and knowledge to date have largely employed weak methodologies, based on self-report measures which they indicate might not be reliable and valid for national monitoring purposes.

Recommendations for Developing an ICT Curriculum Integration Performance Measurement Instrument – Mapping the Way Forward

From the review and identification of those key issues, the following recommendations are made to guide the development of an ICT curriculum integration performance measurement instrument. That development should:

1. be guided by sophisticated understandings of describing ICT integration. Use of the following framework, identified by DETYA (2000a) and provided in *Raising the Standards* (DEST, 2002), would provide the instrument with a nationally robust theoretical basis:
   - A tool for use across the curriculum or in separate subjects where the emphasis is on the development of ICT-related skills, knowledge, processes and attitudes;
   - A tool for enhancing students' learning outcomes within the existing curriculum and using existing learning processes;
   - An integral component of broader curricular reforms, which will change not only how students learn but what they learn; and
   - An integral component of the reforms, which will alter the organisation and structure of schooling itself.
2. be informed by current educational reform theories such as identified by *The Queensland School Reform Longitudinal Study* (Lingard et al., 2001);
3. support the strategic improvement of ICT integration in schools, districts, and at the systemic level through the collation and presentation of data to provide 'current use' and 'preferred use' positions;
4. be ongoing to address the challenges presented by the dynamic changes in ICTs; and
5. pay close attention to the recommendations made in *Raising the Standards* (DEST, 2002). While this framework applies to the development of teacher standards of ICT competency, it also has relevance for a performance measure instrument for ICT curriculum integration. Particularly relevant concepts include:
   - formulation of descriptions of successful professional performance involving the use of ICT;
   - the need for a comprehensive set of context rich ICT exemplars be an integral part;
   - enabling both performance management and professional development;
   - a generic nature i.e. non-subject and non-level specific;
   - supporting different groups of educators; e.g. beginning teachers, beginning users of ICT, accomplished users of ICT, educational leaders, teacher educators;
   - emphasising the specific relevant dimensions of ICT use;
   - taking account of those dimensions of ICT competence and use that may transform education;
   - articulating the need to embrace change but also adequately reflect the concept of leading and shaping change in response to new technology and new educational ideologies;
   - enabling those whose performance is being measured to have some ownership of the process; and
   - taking into account other initiatives at the national level.

Conceptualising Key ICT Drivers, Dimensions of ICT Use and Productive Pedagogies – Future Directions

The following conceptual framework presented in Figure 1 provides a basis for incorporating the six key ICT drivers identified in Education Queensland's *ICTs for Learning* strategy (Queensland Government, the four overlapping, related dimensions of ICT use (DETYA, 2000a), and the Productive Pedagogies framework (Education Queensland, 2000; Lingard et al, 2001; Education Queensland, 2003b). According to Education Queensland (2003b), Productive Pedagogies are "effective pedagogy, incorporating an array of teaching strategies

that support classroom environments, and recognition of difference, and are implemented across all key learning and subject areas" and "stem from the *Queensland School Reform Longitudinal Study*". As the Productive Pedagogies provide the framework for the conceptualisation and enacting of curricula in Queensland schools, it is theoretically sound to develop a matrix which is informed by the dimensions of ICT use (DETYA, 2000a) and the Productive Pedagogies (Education Queensland, 2003b) to underpin the development of an ICT curriculum integration measurement instrument.

ICT Curriculum Integration	Key ICT Drivers								
	Learning, Teaching and the Curriculum				ICT Infra-structure	Connectivity	ICT Support	Learning and Development	Innovation
Dimensions of ICT Use*	ICT Curriculum Integration Performance Measurement Instrument				Schools ICT Census Data -Foundation Benchmarks - Preferred Futures Benchmarks	School ICT Census Data -Foundation Benchmarks - Preferred Futures Benchmarks	School ICT Census Data -Foundation Benchmarks - Preferred Futures Benchmarks	School ICT Census Data -Foundation Benchmarks - Preferred Futures Benchmarks	School ICT Census Data -Foundation Benchmarks - Preferred Futures Benchmarks
	Intellectual Quality	Supportive Classroom Environment	Recognition of Difference	Connected-ness					
a tool for use across the curriculum or in separate subjects where the emphasis is on the development of ICT-related skills, knowledge, processes and attitudes									
a tool for enhancing students' learning outcomes within the existing curriculum and using existing learning processes									
an integral component of broader curricular reforms, which will change not only *how* students learn but *what* they learn									
an integral component of the reforms, which will alter the organisation and structure of schooling itself									

Figure 1: Conceptual Framework

*Reference: DETYA. (2000a). *Good Practice and Leadership in the Use of ICT in School.* Retrieved from the World Wide Web at http://www.edna.edu.au/sibling/leadingpractice on 31 May 2003.
Also located at Department of Education Science and Training (DEST) (2002*). Raising the Standards A Proposal for the Development of an ICT Competency Framework for Teachers*. pp. 20-21

The framework enables the formulation of statements specifically related to students' experiences from the integration of ICTs in the curriculum. It is recommended that the instrument contain both *current* and *preferred* scales in order to illicit information from teachers about their students' current use of ICTs in the curriculum, as well as the level of use teachers would prefer their students to have. In this way, the instrument can be used by individual teachers in order to reflect on their pedagogy with respect to ICTs, and schools, and the system as a whole, could strategise for enhanced ICT curriculum integration. The future directions of this work will include the framing, selection and refinement of statements (items), pretesting and trialling, statistical validation of the items, and the development of an interactive computer-based version which will enable teachers, schools and

educational systems efficient entry and collation of data regarding the productive *student use of ICTs* in the curriculum.

Conclusion

Major challenges exist in moving toward more sophisticated means of describing and measuring ICT curriculum integration. This paper reports on the initial research by the authors aimed at (1) reviewing the international literature related to ICT curriculum integration and methodologies for collecting data related to ICTs, (2) identifying key issues from those reviews, and (3) it made recommendations for the development of an ICT curriculum integration performance measurement instrument. This research was implemented in response to the authors' involvement in developing an instrument for use by Education Queensland in government schools for more effectively gaining teacher, school and system information related to the key ICT driver of learning, teaching and the curriculum. The conceptualisation presented attempts to provide a map for moving forward by incorporating and acknowledging the relationships between the other key ICT drivers such as infrastructure, connectivity, ICT support, learning and development, and innovation, as well as the dimensions of ICT use, and Productive Pedagogies. This provides the framework for the formulation of a measurement instrument that focuses on *student use of ICTs* in the curriculum.

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