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ICT: Implications and Concerns for Teachers

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Recent reforms in Education Queensland have seen an increasing emphasis on the use of technology and the teaching of multiliteracies through multi-media resources in Queensland classrooms. The difficulties encountered by teachers in meeting these demands are becoming more evident as they are confronted with a plethora of commercially produced programs that make convincing claims about improved student learning outcomes. Furthermore, the role of teacher-educators in preparing technologically literate preservice students remains largely unexplored. Findings of two research projects highlighted critical things teachers should know about selecting and integrating technology in their teaching programs.

Introduction

In this paper results from two case studies illustrate ways technology can influence learning. The first project was located at a primary school and focused on researching the effects of a computer software program on a beginning reader's literacy development. The second project examined the effects of computer-based assessment on tertiary student mastery of course content. Findings from each project contribute to a clearer understanding of those factors that need to be in place if the promise of information and communication technologies (ICTs) as tools for learning is to be realised.

Technology, reform and education

Over the past five years, national and state education policies have called for reform in the use of ICTs as tools for learning. The challenge for educators across sectors and in pre-school to tertiary teaching contexts is to find ways that will prepare students with necessary skills, knowledge and processes required for effective interaction with these new technologies (Commonwealth of Australia, 2000; DEST, 2002).

In Queensland, a 'Smart State' view of teaching, learning and assessment advocates the use of ICTs to adequately prepare students for present and future technologically focused worlds and workplaces (See Education Queensland, Queensland State Education – 2010, 1999; Queensland the Smart State – Education and Training Reforms for the Future, 2002a). Education Queensland curriculum policies, guidelines and frameworks document a need for ICTs to be integrated across Key Learning Areas. Current reforms emphasise the need for innovative and purposeful use of technologies to achieve pedagogical aims and improved student learning outcomes (See <http://education.qld.gov.au> for policy documents).

These initiatives have implications for the tertiary education sector, particularly in

education faculties where graduates need to

demonstrate communication skills in a range of social and cultural contexts. They will be confident with multiliteracies and proficient in the use of ICT in learning environments. (Board of Teacher Registration, 2002, p. 6)

In preparing future teachers to be confident and capable users of ICTs when designing curriculum and planning for learning, academics need to rethink their own approaches to program design and course delivery. Further, the use of ICTs in tertiary education offers a promise of increased efficiencies for overworked academics at a time when academic work has become a significant industrial issue (NTEU, 2003). Increasing student numbers, decreasing full time staff, casualisation of academics, restructuring of programs and delivery of courses across multiple sites are some of the factors that have contributed to the changing work demands. In response, universities have employed ICTs to facilitate delivery of course content and communication in more efficient and flexible ways. However, research reporting outcomes from such initiatives is conflicting. Furthermore, systematic evaluation of information communication technologies remains an infrequent practice when practitioners incorporate ICTs into their curriculum (Oliver, 2000). The focus of this paper is evaluating two technology programs designed to enhance student learning. The following literature review identifies issues related to the use of ICTs in education contexts.

Technology as a tool for literacy learning

Case study 1: Primary school context

Research examining the effects of information communication technologies on children's literacy performance highlights the different reading demands of electronic and print based texts. Reinking (1992) identified four differences between electronic and print-based texts. Electronic texts:

- are interactive, thus can be altered in response to reader input;
- can be guided to encourage comprehension;
- are structured differently from print texts;
- have an increased range of symbols available to readers.

These differences impose particular reading demands on a reader and may interfere with the transfer of skills from one reading context to another (Sutton, 1994). The effects of reading in a non-linear, more fluid and more interactive environment should be a consideration for teachers when using technology to enhance reading outcomes. For example, Miller and colleagues (1994) raised concerns related to the use of electronic books where children may become dependent on the technological mechanisms that provide them with whole word pronunciations of selected words (Miller, Blackstock, & Miller, 1994, as cited in Lewin, 2000, p. 150). While students may exhibit effective reading strategies in an ICT environment, this may not enhance reading in a more traditional print-based reading environment.

There are an increasing number of software programs, web-based activities and computer-based, skill-building technologies designed to develop literacy practices of beginning readers through opportunities for them to engage with electronic texts. Technology has the potential "to revitalise reading instruction and to make reading more relevant to the lives of children growing up in the electronic age" (Meyer & Rose, 1998–1999, chap. 1: Learning, teaching, and technology: Introduction section, para.3).

Research reporting the effects of technology and the use of electronic texts on reading outcomes identified the following benefits for beginning readers:

- increased interest in reading through transactional experiences with electronic literacy (Chu, 1995);
- improved understanding of an electronic book's vocabulary (Miller, Blackstock, & Miller, 1994, as cited in Horney & Anderson-Inman, 1999, p. 129);
- substantial gains in number of sight words (Lewin, 2000); and,
- increased world knowledge, concepts about print, and story sense (McKenna, 1998).

The addition of voice recognition, speech synthesis, and digitised speech has enabled computers to be able "to *hear* beginning readers and give individualised discriminatory prompting or corrective spoken feedback to promote oral reading accuracy" (Topping, 1997, p. 12) resulting in increased reading rate and accuracy (McKenna et al., 1999). Schultz (1994) investigated a software program (WiggleWorks, 1994) that incorporated these features and made similar claims. In a comparative study, he found first-grade readers who used the program made significantly greater gains on standardised reading tests than students using a traditional print-based language arts curriculum. There were also significant vocabulary gains reported for the treatment group. While this study used large groups of students and standardised tests to measure gains in reading performance, the project reported here was an in-depth case study of one student's interactions with the beginning reading program.

Technology as a tool for learning about literacy

Case study 2: University context

In parallel ways to the previous section, research reporting the effects of technology on student learning in a tertiary context identified conflicting outcomes (DEETYA, 1998). The West Review (1998) warned that "many universities have invested heavily in the latest technology and then found the gains in productivity to be elusive". Vitale and Johnston (1997) raised concerns about the indiscriminate use of technology without more systematic evaluation to determine technology driven outcomes. Fletcher, Bartlett, Bryer and Bowie (2000) found changed views of learning resulted when an integrative assessment task was facilitated using online discussion forums. However, they found there was some student resistance to engage in electronic forum discussion groups. This limited the learning potential to those students who had the confidence to participate in a public forum where a permanent record of their thinking was available for review. There is some evidence that on-line discussion facilitates thinking through socially-negotiated meaning (Lapadat, 2000).

Online assessment quizzes are one medium for learning through assessment that appears to offer learning potentials for students. For example, Yorke (2001) found some evidence of memory benefit from formative computer-based assessment (CBA). Charman (1999) reported factors such as immediacy of feedback to students and staff; repeatability of tests consisting of randomly-generated test items; reliability and equity of computer-marked assessment; flexibility in terms of time and place of assessment contributed to student learning. Further, students have reported enhanced levels of motivation and confidence (Thelwall, 1999) and view CBA as less threatening than traditional examinations (Bocij & Greasley, 1999). In contrast, Brosnan, (1999) and McDonald, (2002) found that when CBA was used as a summative tool, student responses were mixed due to participant variation related to computer experience, computer anxiety and computer attitudes. These findings suggest knowledge of CBA effects on student learning is generally under-researched and under-theorised (Bocij & Greasley, 1999; Charman, 1999; Charman & Elmes, 1998).

An important feature in using technology to enhance learning is the way programs are designed and technologies are used (Andrewartha & Wilmot, 2001; McLoughlin, 1999). Issues such as opportunities for scaffolded learning, learning routines and practice over time, ease of access and reliability of the technology may impact on the quality and quantity of learning.

In summary, and as background to the projects reported in this paper, research findings on effects of ICTs on student learning outcomes are inconclusive and dependent on a range of variables. The projects described below advance understandings related to these issues and offer insights into critical factors that affect student learning.

Method

Each project used a range of different data collection techniques. However, both studies used a pre-test, post-test quasi-experimental design (Gay, 1996) using the ICT as a treatment. They shared a common theoretical framework for interpreting both sets of data drawing on constructivist principles and a socio-cultural view of learning.

Case study 1

The first study was designed to describe, interpret and evaluate the effect of a commercially produced software program on the reading practices of a beginning reader. The multi-mediated literacy program (WiggleWorks, Scholastic, 1994) used electronic books with a range of scaffolding tools aimed at supporting a reader's strategic application of skills and processes when engaging with electronic texts. A pre-test post-test design measured a Year 2 primary school student's reading success and strategy use when exploring four Wiggle Works (1994) electronic books. This took place over 4 weeks, with a different electronic book used each week. A contextualised reading activity tested the student's reading of all words from each of these electronic books, pre- and post-intervention. A questionnaire measured the student's perceptions of himself as a reader of print and electronic text. Running records were conducted during the student's readings of electronic texts and were analysed for errors and self-corrections as outlined by Clay (1993). Results were used to establish the student's independent use of reading strategies to solve problems and to gain meaning from electronic texts. In addition, data

collected through observations, interview and video-recording identified the student's exploratory interactions and application of independent strategies when using the program. Exploratory interactions were defined as any student-initiated interaction using the options and tools available in the program. Independent strategy use was defined as any self-determined reading practice used as the student engaged in monitoring his reading of an electronic text.

Case study 2

The second study was designed to describe, interpret and evaluate the effect of a computer-based assessment (CBA) program on undergraduate students' mastery learning of course content. The project involved 340 second-year students at two campuses of a large university. Students had indicated in course evaluations over a number of years that they found content on grammar particularly difficult and they were not confident in their own knowledge of grammar. As a result a formative and summative CBA was developed for use in a first semester, second-year English course. A pool of 200 multiple-choice items on traditional and functional grammar was constructed. When students logged-on, 40 multiple-choice items were generated randomly for them to complete as a quiz. For four weeks, a formative version of the quiz was available on-line for students to complete in preparation for a summative test in week 10 of the semester. On completion of each formative occasion, an electronically generated feedback sheet was provided based on their incorrect responses. The sheet gave students text references targeting areas for further study. An on-line forum offered students opportunities to begin conversations about their experiences using the quiz and to clarify understandings about grammar questions. For both formative and summative experiences, students were allowed 30 minutes to complete the test.

Results

Case study 1

Results of the effect of the intervention on the reading practices of a beginning reader found word accuracy outcomes had improved. The pre-test score of 61% measuring accuracy in reading showed an increase of 4% accuracy in the post-test, suggesting interaction with the WiggleWorks program may have resulted in some measure of success. However, inconsistencies in the student's use of exploratory interactions and independent strategies when interacting with the program were apparent. Furthermore, successful reading outcomes were not transferred consistently across different reading contexts. While no single exploratory interaction or independent strategy could be attributed to the student's performance, patterns of success were evident when a combination of options, tools, and strategies were used. For example, the student used text monitoring, picture clues, and sub-vocalisation strategies to monitor and clarify understandings of the text. However, there was no evidence that these contributed to reading success either in running record or post-test results. In addition, a decreased use of self-monitoring reading practices resulted in the post-test. In the "Read Area", the student used interactive features such as Word Decoder and Read Button to actively decode and prepare for a recorded reading of an electronic text using Record and

Playback tools. Although words were read successfully following immediate interaction with the program, this success appeared to be temporary as reading results generally were not transferred to the post-test.

Case study 2

Results in the second study indicate three outcomes. First, students' knowledge of grammar improved. Second, students attributed this improvement to the CBA program. Third, students reported a better understanding of their learning pathways. The following table summarises findings in relation to questionnaire items targeting learning outcomes.

Table 1

Student responses about the effectiveness of CBA grammar quiz as a learning tool

QUESTIONNAIRE ITEMS	AGREE (%)	UNSURE (%)	DISAGREE (%)
I found that the formative quiz improved my confidence in talking about English grammar	67	20	13
I found that the formative quiz enhanced my knowledge of English grammar	77	17	6
I found that the formative quiz assisted my learning	76	16	8
I used feedback from the formative quiz to study English grammar independently.	79	13	7
I learnt about my own learning patterns by using the formative quiz	50	34	16

An unexpected outcome of this project was the role technology played in facilitating students' approaches to learning about grammar. Students were positive about the design of the program in providing different pathways for learning about grammar. The program structure incorporating formative and summative assessment with an electronic forum and flexible access was seen as a strength. Eighty-three percent of respondents were positive about the flexible delivery and accessibility with 78% reporting this allowed them to take control of their own learning. Some students worked collaboratively, others independently. Some students used a trial and error approach to learning with multiple logons weekly. There was a minority of students who completed the quiz more than a 100 times. Other students completed the formative quiz several times a week using the feedback sheet to study systematically study areas highlighted. While only 29% of students actively participated in the forum discussions about grammar, 47% of students reported that they used the forum as an observer to learn about grammar. For example, LP explained how she found the forum useful:

I found that a concept that I couldn't understand was posted and answered before I got around to posting it myself. Also, I found the answers to the questions posted to be really clearly explained.

Discussion

In both projects participants engaged with technologies in ways that affected learning outcomes. The frequency and type of feedback provided by the particular examples of ICT were seen to influence the learning contexts and consequently learning outcomes for participants in both projects.

Feedback

Feedback is a critical component in enhancing student learning. When students sit in front of a computer and engage with a task, the effectiveness of their approach to the task is dependent on their ability or capability to experiment, problem solve. Feedback when interacting with ICT learning encounters may encourage independent strategic problem solving or dependent reliance on feedback solutions. For example, a beginning reader may choose to apply problem solving reading processes such as read-on, re-read or sounding out when an unfamiliar word is encountered when reading an electronic text or, as demonstrated in case study 1, they may choose to utilise the tools built into the program and be 'given' the word immediately through electronic features. In a tertiary context, students did not have access to the answers in the quiz. They were not given correct responses. They were encouraged to find their own learning solutions through electronic feedback that highlighted learning needs.

Program design

The design of ICT programs can determine how students interact with learning tasks and their levels of future success. For example, in case study 1, although interactive tools assisted the student to read words successfully within the program, this success appeared to be temporary as it was not transferred to other reading contexts. Furthermore, after consistent use of the program where an emphasis on whole word decoding tools was predominant, the student failed to use decoding sounding out strategies for word identification in the post-test reading context. Decoding strategies had been frequently used by the student in the pre-test, so it appears the program may have discouraged its use. In addition, the program did not explicitly guide the student's use of particular program features (for example Record and Playback) that had the potential to provide feedback and improve reading outcomes. Consequently, the student never used these electronic features strategically to monitor and self-correct errors in readings. A declined interest for problem solving, taking risks and monitoring reading tasks became evident as interactions with the program continued and the newness and novelty of the program features lessened. Furthermore, some words pronounced using the program's digitised speech feature were unrecognisable and proved problematic for the student because of unfamiliar American accent. Although the student would repeatedly press '*Play*' to hear these words again, he did not attempt to try alternative learning solutions. Generally the student had a positive attitude towards using the program and interacted with the electronic features with different levels of reading success.

In case study 2, the program design encouraged active learning with students making strategic choices about ways to find learning solutions. They were supported in this process with a range of options. However these options were only part of the solution. The students remained responsible for pursuing their own learning. They were encouraged

to use feedback information related to their quiz performance to guide their learning. They had access to a range of scaffolded learning options. First, they could use the forum as a medium to clarify understandings. Second they could bring their questions to a tutorial for discussion. Third, they work in groups or independently using textbooks to refine their responses. However, students were always engaged in a problem solving learning process. This was the main distinction in how learning was constructed across the projects. In the first study, the student was given the correct answer through immediate feedback built into the computer program. In the second study, students were given feedback based on incorrect answers. Feedback identified topics to be studied and suggested texts to use.

Common findings across both projects can be summarised as follows:

- ICTs have the potential to support constructivist approaches to learning.
- The form and type of feedback is critical in determining effective, independent strategic approaches to learning.
- ICT programs that provide immediate, correct answers may be counterproductive in encouraging strategic knowledge construction.
- Evaluation of the effect of ICTs on student learning outcomes needs to be incorporated into any teaching program.

Conclusions

In this study, constructivist principles and a socio-cultural view of learning inform our findings. We recommend that teachers need to:

- monitor their students carefully over time as they interact with technologies;
- explicitly demonstrate strategy use for students when engaging with technology;
- provide opportunities for students to reflect and discuss their approaches when using technology to facilitate metacognitive and self-monitoring strategies;
- integrate the teaching of learning strategies and content in a range of traditional and technological learning environments;
- provide opportunities for students to develop higher order thinking skills through collaborative problem solving and critical analysis and construction of meanings using ICTs;
- provide opportunities for students to clarify understandings through reflection and discussion;
- develop assessment tasks that will establish learning outcomes achieved through the use of technology;
- evaluate the design features inherent in ICTs in an effort to understand how these features will shape the learning and 'construct' the learner as an active participant in the learning experience.

In conclusion, it is tempting to incorporate ICTs into the curriculum in the belief that students will learn what the ICT is designed to support. However, unless ICTs are carefully evaluated and the learning is monitored over time, what students learn and how they learn may remain invisible to everyone concerned.

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