Lowering the integration threshold: enhancing learning through computer-based technologies

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Abstract
This paper reports on how six diverse NSW government schools were attempting to integrate computer-based technologies during 2000. It draws upon classroom observations and interviews made during visits to these schools. Our key findings are; (1) successful integration of computer-based technologies is underpinned by a coherent vision for learning; (2) school leaders need to take an active role in the integration of computer-based learning in their schools; and, (3) despite the often-heralded transformative effects of computer-based technologies, currently there are few examples of how these technologies are creating new affordances for learning. The notion of an integration threshold is proposed as a mechanism for describing and linking the various factors that influence the uptake of computer based learning such as the pedagogical capabilities of teachers and access to supported technology.

Background
The introduction of computers into NSW schools is a major Government priority that has received significant funding in recent years. The NSW government's Computers in Schools Plan aims to improve learning outcomes for all students in all key learning areas, from Kindergarten to Year 12. A key aspect of this plan is the recognition that computer-based technologies have the potential to significantly contribute to achieving this aim. It involves a comprehensive program of support to schools that includes: the provision of regularly updated computer hardware and software; connection of all schools to the Internet; provision of training and development of teachers in the use of computers; and, the development of curriculum support materials to enhance curriculum in all Key Learning Areas.

As the program developed through its initial stages, it became clear that the rate of uptake of computer-based learning and the success of school-based practices varied enormously across school communities. The design of ongoing support strategies needed to be well informed by the successful experiences of early-adopters and those schools where change in practice was sustained. Scarce resources available to support changes in teaching and learning needed to focus on those initiatives that would promote effective integration of the technologies into mainstream curriculum.

It was within this context that the study upon which this paper draws, titled Net Gain?, was commissioned by the Curriculum Support Directorate of the NSW Department of Education and Training (DET). The research was undertaken during 2000 by the Change and Education Research Group (CERG) at the University of Technology, Sydney. It had a number of purposes related to the integration of
computer-based learning in a range of government schools including identifying the
issues, documenting a range of strategies, synthesising the views of key stakeholders
and describing of the current use of computer-based technologies for teaching and
learning.

Below we summarise the major findings of the research, describe the approach taken
and position it within the literature. We also introduce the notion of the integration
threshold, which was developed to describe the various factors that influence the
uptake of computer based learning in schools. Throughout we use the term computer-
based learning in preference to other terms, such as information and communication
technologies (ICT) to emphasise our focus on learning mediated by technology. We
also interpret the scope of technologies described by the term computer-based
technology broadly to include the Internet, Intranets, email, CD ROMs, software
packages and other forms of educational technologies.

Overview of the study

The data we describe was collected during visits to six government schools at
different stages of development of integrating computer-based technology. The
schools were selected after discussions with a range of sources, including consultants,
teachers and other researchers, who were of the opinion that these schools were
making concerted efforts to integrate computer-based learning. Additionally, to
ensure that different types of schools were represented in the study, indicators such as
geographic location, school type and socio-economic status of the surrounding
community were also taken into consideration. Two researchers spent two
consecutive days in each of four schools and one day in each of the remaining two
schools. Information gathered during these visits included classroom observations that
focused on teaching and learning processes, as well as structured interviews with key
personnel, students, parents and other stakeholders. The findings present a “snapshot”
of how these schools approached the integration of computer-based learning during
2000.

Our approach was underpinned by two assumptions informed by prior research:

- The most important factor affecting the learning outcomes of
  computer-based technology applications is not the kind of technology used,
  but the design of the learning experience which makes use of these

This assumption informed our selection of interview questions and our inclusion of
classroom observations in order to broaden the scope of information collected during
the school visits and to focus the collection of data on describing the forms of
computer-based learning evident in each school.

- Learning programs that require students to think, to develop in-depth
  understanding, and to apply academic learning to important, realistic
  problems boost student achievement equitably for students from all social
  backgrounds (Newman and Wehlage, 1995).
This assumption informed our approach to the data collection and analysis in two ways: (1) we wanted to describe the degree to which computer-based learning in the participating schools reflected these types of learning programs; and (2) we wanted to make some comparisons between classrooms where computer-based learning was being integrated and those where it was not.

Hence, we utilised a classroom observation instrument derived from the *Standards for Authentic Pedagogy: Instruction*, developed by Newman and Associates (1996, p.33). The four standards of authentic pedagogy are: Higher Order Thinking, Deep Knowledge, Substantive Conversation and Connections to the World Beyond the Classroom. We also made comparisons between our classroom observations and the large scale Queensland School Reform Longitudinal Study because it had also used the *Standards of Authentic Pedagogy: Instruction*, we had access to this data and it reported classrooms where, for the most part, computer-based technology was not being integrated.

**Locating this study within related literature**

The research reported has some similar characteristics to case studies reported in the literature on computer-based learning but there is great variation in the scale and focus of these case studies. Hadley and Sheingold’s (1993) early classification of this literature into two major areas is still relevant today:

i. Small-scale case studies in a number of schools that focus on a particular pedagogical purpose, such as student inquiry or systems thinking;

ii. Case studies that have tracked practices and impacts resulting from classroom environments richly endowed with computers.

Whilst these studies have been informative, the first type does not easily yield implications for the broader picture. In addition, the second type does not tell us much about schools that have not had access to such resources. Due to scale and purpose, this study has not been able to address these general shortcomings but it has attempted to describe a broad range of factors related to the integration of computer-based learning in different schools at different stages of integration. Hadley and Sheingold (1993) suggested that:

*What we need to understand, are the complex circumstances that surround the use and incorporation of technologies over many different examples, and how these are related to a variety of outcomes that are of interest. (p. 263)*

Our interest in learning mediated through technology resonates with earlier studies that have focused on the context of technology integration in schools and the relations developing around this process. For example, Windschitl (1998) examined the importance of being able to describe and analyse how computer-based technology impacts on learning in relation to the integration of Internet applications. He argued that there is a need to develop theories and methods to analyse web-supported inquiry. He recommended that more critical qualitative studies be conducted, which investigate learners’ activities and teachers’ roles in relation to the use of the World Wide Web (www). He suggested questions such as: Is the www helping students as an inquiry tool? Is it changing pedagogy? How do students share meaning? And, how are social constructs such as authority or co-operation affected?
Similarly Selwyn (1997) noted that, whilst there has been a concentration on large-scale surveys or small-scale case studies, there is a need for contextualised, qualitative and ethnographic research to analyse, rather than predict, what is actually happening and what type of relations people are developing toward technology. Like Moll (1997), we reject the common prediction that technology will improve the outcomes and processes of teaching. A number of authors have criticised this “techno-romantic” (Selwyn, 1997, p.305) view of educational technology, a view which is largely uncontested and partly responsible for infecting research in the field with excessive optimism.

Moll (1997) also stated that the need for integration of technology in the classroom is really tied to the greater plan of introducing information technology in society in general. Therefore, she suggested that a responsible plan to introduce technology in the classroom should firstly agree on a definition of education and its goals and second, be based on how technology will affect and restructure the learning environment and process rather than on how good a teaching tool it is. Through interviews with key stakeholders we attempted to gain some insight into how school communities conceptualised the process of integrating computer-based technologies in schools.

**Key findings**

In this section we briefly outline the key findings from the study and link these findings to some related literature.

- *The integration of computer-based learning in schools is enhanced by the existence of Technology Vision Statements*

The importance of consistent vision that articulates the integration of computer-based learning with other elements of the curriculum has been identified by previous studies (see for example Wright, 1994 and Tavalin & Gibson, 2000). We observed a number of schools where a consistent vision had been established as a result of the development of a Technology Vision Statement. In schools where these statements had been developed we noted the executive more able to articulate a clear vision for technology integration:

*The vision for computer-based learning within the school is that children understand that it is just part of normal work and normal life.* (Principal)

*The ultimate goal is to get everyone using it as a tool rather than as an add-on.* (Computer coordinator)

*A part of the “vision was to empower staff to become lifelong learners … especially in technology where it’s changing so rapidly … and to have all staff and students using technology.* (Principal)

One principal described the situation prior to the development of their statement as, “very haphazard, depending on the teachers' capabilities and interests”. Although schools approached the development of these statements in varying ways, they generally detailed plans for achieving various educational objectives such as
empowering students in their use of technology, enhancing learning through technology and enhancing administrative procedures.

- **Leadership is critical to the successful integration of computer-based learning**

Previous studies have highlighted the importance of leadership in supporting the process of integrating computer-based learning. For example, Treagust and Rennie (1993) pointed to the need for continuous coordination and Sherry, Lawyer-Brook and Black (1997) focused on the importance of vision and support for technology. Also, the NSW Audit Office (2000) made a connection between leadership and vision by claiming that a school is likely to be more technologically advanced with leadership that “articulates a clear vision for the use of computers in teaching and learning” (p. 63).

Our observations lend weight to this general consensus that, whatever its form, leadership is an essential element of the integration process. We observed different forms of leadership, including integration processes led by the executive, committees, and enthusiastic teachers operating solo, but the most significant was the active involvement and support of the principal.

- **Successful integration of computer-based learning is supported by accessible technical support**

Whilst this study focussed on how technology is being integrated into learning programs, we were continually alerted to the need for computers to be well maintained and for teachers to have access to technical support. It is clear from our observations that functioning computers, and “fast fixes” when they break down, are essential to effective computer-based learning integration. One teacher explained the situation in her school in the following way:

> There's a constant maintenance problem because things go wrong - just bits and pieces. But you have to be able to resolve those problems yourself. You've really got to become adept at sort of understanding your own computers. And you tend to if you have them long enough.

Our findings echo the observations made by the Audit Office (2000) in its report into computers in NSW government schools. It observed variations in the ratio of computers to students; significant variation in the extent of technical support; variations in the amount and type of software available for student use; and some schools had significantly greater capacity to fund computers than others.

- **Whole school projects have the potential to mobilise broad-based support for the integration of computer-based learning**

A clear benefit of whole school approaches is the involvement of multiple stakeholders in the process of computer-based learning integration. This relieves a small group of people, or an individual, bearing responsibility for carrying out the process of integration and encourages a degree of commitment from all stakeholders. One principal described this as “a hands-joined approach”:
We all went to the side of the cliff, held hands and jumped…but I had confidence that the staff would (float). There’s enough trailblazers to give us buoyancy and linking the hands really made people more buoyant.

From our observations, we believe that computer-based learning integration requires fundamental shifts in the core activities of the school. These shifts include new teaching practices and new agreements about how resources are distributed. A whole school approach supports successful integration because it requires all teachers to be involved in the process; encouraging a sense of ownership and support for a smoother integration. Previous studies also noted the importance of collaborations. For example, Wright (1994) stated that it is essential for teachers and administrators to collaborate in developing and integrating effective technology education programs (see also Means, 1994; Dwyer, 1996; Saye, 1997; Davis, 1997; and, Dockstader, 1999).

Whole school approaches appear to be particularly effective when they support opportunities to enhance teachers’ sense of belonging to a professional learning community. One classroom teacher summed this up in the following way:

> I think it’s that knowing each other makes a difference. It wasn't like someone outside coming in and saying, ”You do this”. I sort of said ”Oh, I've got an idea for your outback class, do you want to have a play with it?” And it was introduced that way. I said, ”Oh, have you seen this stuff... it looks interesting.” So we did it from that sort of base.

> I'm not going to be here forever...so, I hope that what happens here, when I leave, is that everything continues as if I still was here. There are a lot of schools that I've seen where one person does everything. And if they leave or they spit the dummy and the whole thing falls flat, the kids and staff are the ones that miss out. So, we're trying really hard to give everybody expertise and responsibility.

Acknowledging the expertise of individuals and providing a mechanism for them to share their knowledge with colleagues builds the confidence of those involved as well as their commitment to the integration of computer-based learning. Additionally, this mechanism contributes to succession planning by nurturing and maintaining locally developed expertise and knowledge. One assistant principal described this situation in the following way:

> It is also recognised within the literature that teachers generally need assistance (after the introductory training) to prepare them to use the technology in meeting their particular instructional goals. Opportunities to work with mentors in a sustained way over a period of time, and provision of onsite support increases teachers’ use of computer-based learning (Becker, 1994; Collis and Carleer, 1992; Swetman and Baird, 1998; and, Greenberg, Raphael, Keller, and Tobias, 1998).

- **Teachers tend to implement computer-based learning in ways that reflect their existing teaching strategies**

Our observations suggest that teachers generally integrate computer-based technology into their existing teaching strategies. This observation was confirmed during our
interviews with teachers as most stated that computer-based technology had not fundamentally changed the ways in which they teach or the ways they design learning experiences within the classroom. In other words, they were using technology as a replacement tool to provide tasks similar to those not mediated by technology.

A notable exception to this was found in a physical support unit. The severe physical disabilities faced by some of the children make the contributions of computers essential in developing the children’s independent learning processes. As one of the learning support teachers explained:

*Any of these children that need to write to do anything can only use the computer because they have no hand functions. So for maths, they can’t use their hands to count or actually manipulate objects so quite often it’s all done on the computer... Computers have opened up opportunities that they otherwise wouldn’t have.*

We also observed a small number of teachers who were utilising technology in ways that transformed learning experiences. For example, we observed multimedia project work in a Year 6 class that illustrated open ended learning activities and higher order thinking; the use of email in Year 11 English to provide increased opportunities for discussion and shared understanding by keeping track of dialogue and maintaining an archive of discussion; and, a Year 7 literacy room built around interdisciplinary thematic units structured by team teaching and cooperative learning.

In the literacy room, the students cycle through homework, reading and computer-based activities. They work in groups of about eight under the supervision of either a teacher or teacher’s aide. The activities are interrelated. For example, the students might select a reading from a collection of texts, chosen by the teacher from the library or from popular texts such as newspapers, then after reading for 10-15 minutes they move to the computers where they write a daily reflection on what they have read. This is a critical reflection about what they enjoyed, disliked and learned. Additionally, the homework activity builds off the readings and develops their critical literacy and writing skills. According to their teacher:

*Kids like computers but they don’t like reading and they don’t like writing, so what I’ve done is use computers to teach reading and writing. (Literacy Teacher)*

For the most part, teachers who were integrating transformative learning activities were recognised as good teachers generally. They tended to be confident early adopters of technology, they were prepared to take risks and respected by their colleagues as high quality educators. These teachers illustrated earlier research findings that identified a strong link between exemplary approaches to computer-based learning and constructivist approaches to teaching. Even so, Hannafin (1999) acknowledges that approaches to computer-based learning will not be widely implemented unless teachers’ beliefs and expectancies about learning coincide with the pedagogical underpinnings upon which these approaches are based. Similarly, Means (1994) stated that teachers’ views about learning must be recognised as critical factors in curriculum reform and adoption of the technology that supports reform. As one Principal explains:
Because I'm beginning to use it more, I begin to see the extended possibilities. And it can be overwhelming but I've got to keep saying to my staff that the more you get into this the more your vision will expand.

As previously acknowledged, it is difficult to extrapolate our findings beyond the schools in our study, nevertheless, these findings are consistent with another recent Australian study which concluded that “the substance of learning and teaching remains more or less the same as it was in the ‘pre-computer era’, only now ‘technologised’ under a new technology regime, machines having replaced pens” (Lankshear, Snyder & Green, 2000, p.22).

- In a large proportion of the classrooms we visited, computer-based learning was being integrated in ways that afforded less opportunity for higher order thinking, deep knowledge and substantive conversation than classrooms where it was not being integrated. At the same time, these classrooms appeared to increase opportunities for making links to the world beyond the classroom.

These findings are based upon a comparison of our structured observation of the level of authentic pedagogy in the classrooms in our study with the large scale Queensland School Reform Longitudinal Study. Like the Queensland study, our findings suggest that there is limited intellectual demandiness in relation to what students are asked to do in classrooms (QSRLS, 2001). Indeed our findings suggest that in some classrooms where computer-based learning is being integrated, the levels of intellectual demandiness may be slightly less than in classrooms where integration is not being attempted. At the same time, our findings suggest that classrooms where computer-based learning is being integrated may be more connected to the world than classrooms where computer-based learning is not being integrated.

An example of what this might look like in a classroom was provided by a Year 5 “ask an expert” activity. We observed small groups of students devising lists of questions to email an expert in a particular field. This facilitated the students’ contact with a source of knowledge beyond the classroom but the focus was on the technology rather than on access to expert knowledge. Hence, the questions tended to be superficial and perhaps could have been more appropriately answered by reference to readily available printed sources.

The comparison of our structured observations with the QSRLS is a preliminary attempt to begin to describe in more quantitative terms the impact of computer-based learning integration on teaching practices. The small number of observations and observers, combined with possible subsample effects, suggest that we treat these comparisons cautiously. Even so, they have been included here because of their potential contribution to future research directions and because they provide a different, albeit speculative, lens through which to view the qualitative data.

Analysis of findings: The Integration Threshold

Our findings indicate that teachers with high pedagogical skills appear able to exploit the most basic of computer-based technology to create new learning benefits. Whereas, even a technology enriched environment is unlikely to improve the effectiveness of teachers with low pedagogical capabilities. This underscores one of
the assumptions that informed our study, namely, that the most important factor affecting the learning outcomes of computer-based technology applications is not the kind of technology used, but the design of the learning experience which makes use of these applications. It suggests that if we want teachers to integrate technology in innovative ways then we need to focus on enhancing teachers’ pedagogical skills together with their technological capabilities.

We also acknowledge the powerful effect of leadership support on the integration of computer-based learning. Our observations suggest that all teachers can utilise technology more effectively when they have strong support from school leaders and this support appears to be most effective when it is focused on enhancing learning. Effective technology integration is perhaps more dependent on vision than technology. This is by no means to suggest that technology is unimportant, particularly functioning and well resourced technology, but that it is just a gadget without a vision for how it relates to learning. In other words, exemplary computer-based learning integration requires well coordinated whole school projects focused on improving learning through quality teaching that is facilitated by access to well supported technology.

Taking these factors into account, we argue that there is an integration threshold below which computer-based technology is simply incorporated into the curriculum and above which it has a transformative effect. Our findings suggest that currently the levels of incorporation are much larger than the levels of transformation, and that there is great variation in the potential of different forms of integration to enhance learning outcomes. Lowering the integration threshold involves creating the conditions that will support teachers as they develop their pedagogical capabilities. As well as the findings we have detailed related to leadership, whole-school approaches to professional development and a shared vision for learning, we also want to emphasise the need for teachers and students to have access to well supported technology. Lowering the threshold also requires resisting the tendency to make technology the focus of integration, as the accompanying “noise” may divert attention away from improving the quality of learning.

**Where to now**

*Net Gain?* provided the foundation for a follow-up study that has been funded through the Australian Research Council’s Strategic Partnerships with Industry - Research and Training Scheme (SPIRT). This new study, *the effects project: exploring & theorising learning with technology in schools*, has two main lines of interest. The major overall interest is: what are the effects of CBL in classrooms?; and how do teachers develop transformative pedagogies? The second interest is in difference: how do different kinds of students (boys and girls, students of different background, students in different localities) relate to uses of CBT?; and how do different types of schools develop effective CBL practices? The emerging priority surrounding the use of online learning materials will also be a focus of the effects project, particularly explored through the work of the two postgraduate awards that accompany the grant.
References


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i Members of the team that conducted this research include: Dr Debra Hayes, Joanne Dwyer, Dr Sandy Schuck, Dr Gilda Segal, and Dr Graham Barnsley

ii The four standards of authentic pedagogy instruction are:

  *Standard 1. Higher Order Thinking*: Instruction involves students in manipulating information and ideas by synthesising, explaining, hypothesising, or arriving at conclusions that produce new meaning and understandings for them.

  *Standard 2. Deep Knowledge*: Instruction addresses central ideas of a topic or discipline with enough thoroughness to explore connections and relationships and to produce relatively complex understandings.
Standard 3. Substantive Conversation: Students engage in extended conversational exchanges with the teacher and/or their peers about subject matter in a way that builds an improved and shared understanding of ideas or topics.

Standard 4. Connections to the World Beyond the Classroom: Students make connections between substantive knowledge and either societal issues or personal experiences.

The quantitative analysis of the classroom observation data involved a one sample t-test comparison of our classrooms in New South Wales (n = 25) with a tentative standard based on the very large Queensland School Reform Longitudinal Study (n = 975). The QSRLS sample was sufficiently large for us to use it as a representation of the population. Both the NSW and Queensland studies were conducted in a range of government schools. Apart from size and location, the most distinctive difference in the two studies is the presence of computer-based technology in the classrooms that comprise the NSW sample.

Collectively the NSW sample is significantly lower than the population represented by the QSRLS on higher order thinking, depth of knowledge and substantive conversation. The t-test comparison of means on these items are, respectively: t(25)= 2.239, p <.05; t(25) = 3.815, p < .01; t(25) = 2.486, p <.05. Data was examined for violation of the assumptions of t-tests. Given the sample size, the data appeared to be relatively normal, did not suffer from extreme skew, or kurtosis, and had no substantial outliers.

These are t-tests of single mean results comparing the sample means to the population mean estimated from the QSRLS data. This suggests that current CBL teaching strategies may afford less opportunity for higher order thinking, deep knowledge and substantive conversations than classrooms where CBL is not being integrated. Additionally, the NSW schools scored higher on connectedness than in the population (t(25)= 2.291, p < .05).

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