Teacher practice and the integration of ICT: Why aren't our secondary school teachers using computers in their classrooms?

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The integration of Information and Communication Technologies (ICT) is seen as a priority by governments and schools here and overseas. Yet despite the resultant provision of infrastructure and professional development little appears to be happening in secondary school classrooms.

This paper describes a study undertaken in four New Zealand secondary schools recommended as being successful in their implementation of ICT. Data obtained during this study regarding the current levels and types of use as well as potential constraints are discussed. Findings from the study support the contention that there is only limited use of computers in classroom practice. They also show that there is a clear need to do more than provide infrastructure and professional development if this level of use is to increase and the current level of expenditure be justified in terms of improving teaching and learning. Finally a theory of action for increasing the use of computers in classroom practice is suggested.

The inclusion of information and communication technologies (ICT) into school practice can be broken into four separate categories as shown in Table 1. These categories should not be seen as necessarily sequential for installation is an ongoing process and, given the complexity of altering teacher practice, it is suggested in this paper that it is naive to presume that administrative or professional use will lead automatically to integration and ultimately innovation. Similarly early adopters of technology may move directly to innovation after the initial installation of infrastructure.

Table 1
Categories of inclusion of ICT into schools

Installation	The provision of sufficient infrastructure and staff training
Administrative/ professional use	The use of computers in a limited way for routine tasks such as reporting, communicating with colleagues and lesson planning
Integration into the curriculum	The use of computers for curriculum delivery by teachers (teacher centred practices
Innovation	Change in teaching and learning practices (student centred practices)

Both New Zealand and overseas research shows us that there have been major advances in the level of installation and administrative and professional use of computers. However, it also shows us that little has occurred in terms of either integration into the curriculum or, perhaps more significantly, given the rhetoric linking computers with reform, change in classroom practice. Currently computers appear to be used more for strengthening current practice than as an agent of change (Girod & Cavanaugh, 2001).

The advantages that have been made in installation are well documented. In New Zealand the ITAG (Information Technology Advisory Group) 2000 report showed that there was a ratio of 1:7 computers for students in our secondary schools and that only 33% of secondary schools had no networking between classrooms while 26% had more than 80% of their classrooms networked (Sullivan & Anso, 2000). In terms of access to the Internet the 2001 Educational Review Office (ERO) report showed that 98% of all schools are now connected with students having access in 61% (ERO, 2001). Such figures would appear to support the contention that infrastructure can no longer be seen as the main barrier to the integration of ICT (Cuban, 2001).

Similarly it would appear that schools are committed to offering professional development to their staff in order to facilitate the integration of ICT. Smerdon et al (2000) found that professional development was available to most teachers on a number of topics. They also found that participation was relatively high. In their 2001 report ERO stated that 80% of schools had committed their own resources to this area and that they were making ICT professional development a high priority.

Findings from current research in the area of integration into the curriculum are, however, disappointing (Henry Jay Becker & Ravitz, 2001; Cuban, 2001; Lai, Pratt, & Trewern, 2001). In fact as Shakeshaft (1999) states: "just because ICT is present does not mean that students are using it" (Shakeshaft, 1999, p.4). Current research in New Zealand appears to reflect similar findings. Lai et al (2001) claim that "the lack of technology integration into the curriculum is rather evident in New Zealand schools" (Lai et al., 2001, p.13).

Given the level of integration shown in the studies cited here it should not be surprising that there has been little change in classroom practices as a result of the implementation of ICT. While over 60% of teachers interviewed by Cuban (2001) stated that their teaching had been changed because of technology this was in terms of their preparation and their use of the computer as a tool. In reality only 20% of teachers said they had modified their practice in any major way. These findings are supported by the ITAG study in New Zealand where only 1% of teachers were using ICT creatively in new contexts, the last level of adoption in the technology adoption model used (Sullivan & Anso, 2000). Lai et al (2001) in their study of the Otago Technology Project also found that "by and large technology was used to support existing teaching styles" (Lai et al., 2001,p. 50).

Despite these findings explanations for the level, and manner, of use are still generally attributed to a number of factors which are reported in many studies to be barriers to the integration of ICT. For example, Smerdon et al (2000) report that the two most significant barriers are access to computers and release time for teachers to learn how to use them. Murray and Campbell (2000) in their report on the ICTPD (information and communication technologies professional development) initiative identified teacher skill levels; a lack of professional development and training; workload and curriculum pressures; time; and a lack of equipment as the most frequently given reasons.

Cuban (2001) considers three possible explanations for the lack of integration and innovative use despite the high level of installation. The first of these is the slow revolution theory, which is based on the contention that "small changes accumulating steadily will create a gradual transformation in how teachers teach" (Cuban, 2001, p.152). The second explanation relates to the school context and suggests there are

"complex, deeply embedded factors that will continue to retard wide-spread classroom use of technology" (ibid p. 173).

As Cuban points out both of these theories, while having some validity, do not adequately explain a number of findings. These include why some teachers use their computers at home far more than at school; why, when they are used, it tends to be to strengthen current practice; and more significantly why a small minority of teachers are using ICT in widespread and innovative ways in their classrooms while others primarily use it for administration. Firstly, if the slow revolution theory was accurate one should see a clearer pattern of progress than is apparent in research. Secondly, if contextual factors such as the structure of the timetable or an emphasis on traditional practices were the main barrier then levels and types of use should be relatively consistent across all teachers.

To answer these issues Cuban (2001) proposes a third explanation which is that teachers, as "gatekeepers to their classrooms" make "contextually constrained choices". In this view teachers make their own decisions regarding what happens in their classrooms. While contextual factors will impact on their decision-making there is still considerable leeway for individual choice at a classroom level.

In this paper a fourth explanation, encompassing many of the features of each of the three theories considered by Cuban, is suggested. This explanation is related to the nature of practice and is closely aligned to the concept of teachers as 'gatekeepers'. In reality it is extremely difficult to change teacher practice to any significant degree. School reforms that have succeeded in the past have tended to be those that do not impact to any real extent on classroom practices. Strong views are held not only throughout our schools but also society as a whole about what constitutes a "real school" and "the grammar of schooling". As a result, where substantial reforms altering how things are done in the classroom are attempted they tend to founder and never really take hold. The reality is that behind their classroom doors teachers can choose the level to which they are willing to comply with any reforms no matter how strongly mandated (Tyack & Cuban, 1995).

Study Rationale

Strategies at both a national and school level for the integration of ICT into New Zealand secondary schools appear to remain based on the assumption that as long as there is a well developed infrastructure and adequate professional development integration, and in some cases innovation, will follow. Government initiatives such as Digital Opportunities and the Information and Communication Technology Professional Development (ICTPD) clusters are aimed at increasing both the level of infrastructure and teacher training in computer use (Ministry of Education, 2001). There are also calls for increased spending on infrastructure and training suggesting that this will result in increased usage (Lai et al., 2001). This theory of action, which can be described as 'build it and they will come' can be seen in Figure 1.

Figure 1
Theory of action for the implementation of ICT into schools
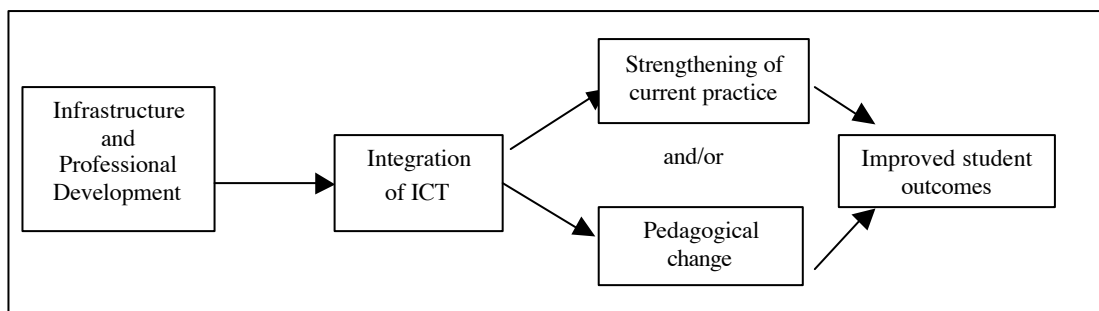
The study discussed in this paper is founded on the premise this model is too simplistic. It does not sufficiently take into account the complexity of the school environment and the many interacting factors that impact on classroom practice. This includes factors external to the school such as national policy and societal expectations. As a result it does not acknowledge how difficult it is to alter teacher practice or the "substantial discretionary authority [teachers have] in their classrooms" (Cuban, 2001). That is not to deny that without a sufficient level of installation there can be no integration. What appears to be ignored is that the provision of infrastructure and professional development does not guarantee use in classroom practice.

Research Design

This study focuses on the use of computers in the classroom and their impact on classroom practices in four schools where there is already substantial infrastructure and/or professional development and a strong commitment to the use of ICT in order to determine the validity of the theory of action currently being used. The purposes of the study are three fold.

1. To see whether teachers are using ICT in their classroom practice to any real extent in these schools, which are reportedly "strong ICT schools".

2. To look at possible explanations for the level of use described.

3. To develop a new theory of action for increasing the use of computers in classroom practice.

Underpinning this research are two key assumptions.

1. That the use of computers in classroom practice even in "strong ICT schools" is limited to small pockets.

2. That given the expenditure in terms of time and money there is a clear need to increase classroom use of computers if this expenditure is to be warranted in terms of improving student learning and/or academic achievement and that to do so will require more than the provision of infrastructure and training.

Research Process

A 31-section survey containing 193 items was distributed to the teaching staff at four purposively selected schools. At each of the schools staff completed the survey during a staff meeting. This resulted in a high return rate (82%) and ensured a wide representation of the teaching staff at each school.

Development of survey instrument

The purpose of the survey was to test two main assumptions. Firstly that there is limited use of ICT in classroom practice and secondly that more than professional development and infrastructure is needed to increase this use.

The survey design was therefore based on a causal model which took into account those constraining factors suggested by literature and the specific context of this study (New Zealand state secondary schools). This model can be seen in Table 2.

Table 2
Casual model for the integration of ICT into classroom practice

Inputs	Activities	Potential Constraints	Direct Outcomes	Long Term Outcomes
Staff	1. Skills based training 2. Application training 3. Professional development 4. Leadership 5. Support systems	1. Cost 2. Time 3. Relevance to staff and their needs 4. Staff values, beliefs and perceptions 5. Teaching practice 6. School demographics 7. School structure 8. School culture 9. School climate	1. Staff are able to use ICT effectively 2. Staff strengthen current practice using ICT	1. Improved curriculum delivery 2. Improved student learning 3. Improved academic outcomes 4. School wide change in teaching and learning practices
Infrastruc-ture	Provision of 1. Internet 2. School network 3. Hardware 4. Software	1. Availability 2. Accessibility 3. Reliability 4. Relevance to staff and their needs 5. Cost 6. Difficulty to use	1. Staff have access to the ICT they need	

The survey used by Becker in his 1998 study of computers in schools was also used as a framework (H.J. Becker, 1999). Items from the original survey were adapted to suit the New Zealand context and the total number of items reduced to facilitate

completion. It was necessary to make compromises between the quantity and depth of data achieved and ensuring teachers completed the survey. For all items related to use and potential constraints teachers were asked to respond using a four-point scale where 1 was the minimum value and 4 the maximum.

School selection

Educational technology providers, Ministry personnel and ICT contractors were asked to recommend secondary schools, which met the following criteria:

1. High level of infrastructure

2. High level of staff professional development

In this way the appropriateness of the theory of action described above could be tested. If sufficient infrastructure and professional development are indeed the key ingredients for successful integration of ICT into classroom practice then the teachers in this study could be expected to show relatively high levels of use with little variation. If, on the other hand, more complex constraints impact at an individual level on teacher use of computers in classroom practice levels of use will vary, and given the difficulty of changing teacher practice are also likely to be low and related to current practice rather than showing any change.

In total 16 potential schools were recommended from throughout New Zealand. A second set of criteria was then applied to these:

1. Decile

2. Location

3. Size

4. Student demographics - gender and ethnicity

5. State schools

The purpose of these criteria were to ensure the final selection was representative of the range of secondary schools to be found within the New Zealand state system. The schools also needed to be readily accessible for the researcher and their senior management fully supportive of the study. In return for participating schools were given detailed reports of the use of ICT in their school and the impact of a number of factors on that use.

Participant schools

The selected schools are from three different areas within the North Island. They range in roll size from 528 to 1815. The student population in two of the schools is predominantly Pakeha (55% and 70% respectively). Of the other two one has a 66% Maori student population while the other has a predominantly Pacific Nations student population (67%). The schools range in decile from 1a to 10. All four are state schools with three being co-educational and one a single sex girls' school. Three of the schools have been involved in ICTPD clusters.

Research Findings

A total of 199 questionnaires were returned from the four schools. For purposes of statistical analysis this paper details the findings across all participants thereby treating the staff at the four schools as one group. The warrant for doing so can be

found in research on school-based initiatives which shows greater differences within than between programmes and within schools rather than between schools (Alton-Lee, 2003).

The current level and type of use participants are making of computers in their classrooms is firstly described. Subsequent sections consider the impact of a number of factors on this use. Finally predictors of classroom use are determined and a theory of action suggested for increasing the use of computers in the classroom. Throughout this paper the word 'computer' has been used in a broad sense to imply the full range of computer technologies.

Participants' use of computers in classroom practice

Two sections of the survey related to the level of use of computers in teaching and learning. A reliability analysis across all 21 items within these two sections gave an alpha of .9270. This means that the items can be treated as a single category called 'classroom practice'. The means and standard deviations for the 21 types of use within this new category are shown in Table 3.

Table 3
Frequency with which teachers use computers in their classroom practice

Type of use	Mean	sd
Research using the Internet	2.88	1.040
Finding out ideas and information	2.68	1.030
Using computer applications such as word processing, spreadsheets etc	2.49	1.040
Learning to work independently	2.48	1.049
Creating their own knowledge from data and information they have discovered	2.26	1.038
Expressing themselves in writing	2.21	1.107
Analysing information	2.11	0.981
Learning to work collaboratively	2.10	1.018
Presenting information	2.09	1.055
Mastering skills just taught	2.08	0.999
Research assignments using reference material on CD ROMs	2.07	1.036
Subject specific software	1.97	1.107
Remediation of skills not learned well	1.93	0.998
Communicating electronically with other people	1.84	0.950
Creating multi media presentations (PowerPoint etc)	1.75	0.999
Simulations or exploratory environments	1.60	0.824
Corresponding with experts or students from other schools via email or the Internet	1.58	0. 863
Collaborating with classmates on projects	1.56	0.892
Games for practicing skills	1.52	0.822
Using multi media software for projects/reports (Microworlds etc)	1.37	0.771
Overall classroom practice category	2.01	

The overall mean for this category is low (2.01) suggesting that computers are only rarely used in classroom practice. None of the individual types of use reached 3 (sometimes) while nine were between not at all and rarely. The high standard deviations imply a wide variation in the level of use within items.

From the analysis of these 21 items two factors emerged. These factors were generic use and subject specific use. The alphas for these factors were .9223 and .8358 respectively thereby showing a high level of reliability within each factor.

Generic use of the computer predominantly involves the use of the Internet and basic applications such as word processing and simple multi media presentations. They require little in the way of software or hardware, and are not subject specific. These uses require basic skills, which are usually learned in school based training sessions or which teachers have acquired through their own personal use of the computer. They can be seen as relatively non-threatening and easily accessible. The overall mean level of use for this factor was 2.15.

Subject specific use of the computer on the other hand generally involves more specialist software and therefore additional skills and cost. Its use suggests a greater level of commitment on the behalf of the teacher and either a wider skill level or a higher confidence in the use of computers in the classroom. Issues of accessibility and ease of use for students are then raised. These issues go someway towards explaining the lower overall mean level of use for subject specific use (mn = 1.73). Rhetoric concerning the need for a change to constructivist teaching and the power of computers to allow this may also have some bearing in that computers may be seen by teachers as predominantly useful for constructivist rather than more traditional teaching.

Factors Impacting on Use

Six sections of the survey considered factors that could potentially impact on participant use of computers in classroom practice. The factors were skill level, preparedness to use computers, external and internal barriers, and perception of advantages and disadvantages. Reliability was high for each of these factors with the lowest alpha being .7993.

Participant skill level

Participants were firstly asked how well they performed a number of tasks. The overall mean level of skill across all these tasks was 2.48 implying these teachers see themselves as reasonably well skilled across a range of areas.

Where they felt well skilled were in the generic uses of the computer: word processing (mn = 3.43); the use of e-mail (mn = 3.35); accessing information on the web (mn = 3.17) and managing and organising computer files (mn = 3.14). They perceived themselves to be poorly skilled in the areas of multi-media software and publishing on the web. The means for both of these were below 2 (rarely used). There was a wide range within the reported skill levels of individual teachers with standard deviations in all areas being higher than 0.735.

Level of preparation to use computers

Participants were also asked how prepared they felt to use computers in the classroom with their students. Teachers felt least prepared to integrate computers into their classrooms (mn = 2.41) or to adopt a new teaching style (pedagogy) where necessary (mn = 2.28). They did feel more confident about using basic applications (mn = 2.94). This suggests a lack of confidence by participants in their ability to use computers in their classroom teaching practice. The clear implication is a need to consider the type of professional development that is occurring and to ensure it both raises teacher

confidence in the use of computers in the classroom and in their ability to change their teaching practice where necessary.

External barriers

Participants were asked to what extent a number of items were barriers to their use of ICT These potential barriers included accessibility to hardware and software, the reliability and quality of computers, training, time and support. Participants saw few real external barriers to their use of computers with no individual items having a mean above 3 while the overall mean was only 2.31 midway between slight and moderate. The two greatest barriers for participants were time related: lack of release time to practice/learn/plan ways to integrate ICT (mn = 2.96) and not being able to access computers when they need them (mn = 2.93).

The relatively low scores for external barriers overall can perhaps be attributed to the fact that these schools were chosen for their high levels of infrastructure. However, given the low levels of overall use, it does suggest that the emphasis on the provision of infrastructure both in the literature and in educational rhetoric may be overstated. It may well be that beyond a certain level more infrastructure does not equate with more use.

Internal barriers to use

Participants were also asked about internal barriers to computer use. That is to say they were asked to what extent a list of potential attitudinal concerns impacted on their use of ICT in the classroom. The mean level of concern across all items was only 2.22. This is interesting given the low level of use and could imply a lack of interest rather than a lack of concern.

Only two items had means approaching moderate. These were the ongoing need to upskill and keep up with new developments (mn= 2.84) and the need to change teaching style to more fully utilise the benefits of ICT (mn=2.52). Both of these are related to professional change suggesting that these participants are not confident in their ability to change classroom practice.

Advantages to using computers

Two sections were related to participants' beliefs about computers. They were firstly asked to what extent a number of items were potential advantages to using computers in teaching. The overall mean for advantages was 2.61, midway between slight and reasonable suggesting these teachers are somewhat ambivalent about the advantages offered by computers. The low level of use would suggest this is not high enough to ensure use regardless of contextual barriers such as limited infrastructure.

Only one item had a mean above 3 (better final products). The four items with means between 2.5 and 3 are interesting in that they are not necessarily directly related to academic achievement and appear to be "cosmetic" reasons for using computers (welcome break for students, interesting way to deliver curriculum, motivates students, peer support increases).

Disadvantages to using computers

Participants were also asked to what extent a number of items were disadvantages to using computers. The mean overall score for disadvantages was 2.17. This was lower

than that for advantages suggesting that participants are more positive than negative about the use of computers.

The main disadvantage (mn = 2.96) was the unpredictability of computers. This implies that teachers are still not confident in their ability to cope with computer technology if things do not work properly. For teachers this can be an important constraint on using technology in the classroom where they are in many ways on 'stage'.

Potential disadvantages with means below 2 (slight) were that students get too wound up, that the teacher gives up to much instructional responsibility and that computers are hard to use. Of interest here is that teachers are not seen as having to give up instructional responsibility. This could be seen as suggesting that teachers are not moving towards student centred practices.

Classroom activities and pedagogy

Two further sections related to activities in the classroom and the pedagogy implied. Three factors were determined from these sections: student centred pedagogy, teacher centred pedagogy and classroom activities. Reliability was slightly lower for these factors reflecting how difficult it is to categorise teachers within one pedagogical framework.

Predictors of use

In order to determine the relationships between the factors described above and the levels of both subject specific use and generic use a maximum likelihood factor analysis with oblimin rotation was performed (Table 4).

Table 4
Factor pattern between levels of use and potential constraining factors

	I	II	III
Disadvantages	.999		
Barriers	.445		
Concerns	.401		
Prepared		.838	
Skill		.647	
General use		.602	
Subject specific use		.554	
Advantages		.422	
Teacher centred			.702
Classroom activities			.649

Note: Student centred activities did not load with any factors

Five main findings can be drawn from this analysis. Firstly, that all negative constraints can be grouped together. (A reliability analysis on all items from those sections related to barriers to use: perception of disadvantages, external barriers and internal barriers gave an alpha rating of .88 confirming this.) Secondly, negative constraints do not impact to any significant degree on teacher use of computers in the classroom. That is to say the perception of barriers to use while often cited may be little more than rationalisation of a lack of use. Thirdly, the factors that do significantly impact on the level of use are preparedness, skill and a perception of

advantages. A reliability analysis showed that all items relating to preparedness and skills could be regrouped together (alpha = .93). This category is called teacher readiness and appears related to the concepts of self-efficacy and confidence described in Lloyd and Yelland (2003). Fourthly, teacher pedagogy and classroom activities do not appear to impact significantly on computer use in the classroom. Finally, classroom activities remain largely teacher centred despite the introduction of technology in these schools.

Conclusions

In conclusion then it would appear from these findings that any theory of action designed to increase teacher use of computers as a tool for teaching and learning needs to focus on two key areas: teacher readiness and teacher motivation. Beyond a certain level of necessity it would appear that more infrastructure does not automatically equate with more use. What is suggested is that teachers who feel confident about their ability to use computers in the classroom and see clear advantages to doing so overcome any negative constraints that may otherwise limit their use.

It must be noted here that these participants are teaching in schools where there is already a reasonable level of infrastructure. However, the clear implication is that negative constraints such as a lack of infrastructure are being overstated in both literature and rhetoric. Beyond a certain level of necessity more infrastructure does not automatically equate with more use. Furthermore, the perception of advantages is a more powerful influence than the perception of disadvantages or internal concerns. It is also apparent that teaching style has no significant impact on use of the computer although the difficulty of categorising teachers as either fully constructivist or transmissional must be acknowledged.

Discussion

The findings described here have significance at both a national and school policy level regarding the implementation of ICT, specifically in the area of professional development. Currently there appears to be a strong belief that as long as there is a well-developed infrastructure along with adequate, skills-based, professional development integration, and in some cases innovation, will occur ultimately leading to improved student outcomes. What this study shows is that this theory of action is too simplistic. It does not provide a true causal model taking into account the complexity of the school environment and the many interacting factors that impact on what happens in the classroom. Nor does it take into account how difficult it is to change teacher practice (Cuban, 2001). Indeed school reforms that have worked in the past have tended to be those that do not impact to any real extent on classroom practices (Tyack & Cuban, 1995).

The current professional development model seen in many schools which largely focuses on skill based learning in "one-size" fits all workshops can be seen as a deficit model in light of these findings. As Berliner (1992) states teacher expertise is not readily transferable between either contexts or activities. Ensuring teachers are expert users of computers will not necessarily equate with them becoming expert in using computers for teaching and learning which requires a wider set of skills and abilities.

The first step to ensuring teacher use of computers, as teaching and learning tools, must be to provide them with sound educational reasons for doing so. The discovery

of such reasons must be collaborative involving teachers as active participants in the process. This should include reflection on current practices, and their shortcomings, and an awareness of what the new technologies can offer to improve both teaching and learning. Only when there is sufficient intrinsic motivation for teachers will they be willing to fully participate in the implementation of ICT including gaining the requisite technical skills. The use of computers must be seen to provide desirable outcomes not readily achievable without them.

Secondly, professional development must assist teachers to become change agents and risk takers able to adapt to the new teaching paradigms implicit in the use of ICT. Without this they will continue to frame the use of ICT within their current paradigms and not fully maximise its potential. They must be shown how to alter their practices so that constraints on the use of ICT are minimised. It must also provide then with the strategies and skills needed to enable them to use computers confidently in the classroom context.

In summary the theory of action proposed here places professional development, rather than skills based training and the provision of infrastructure, at the forefront. It is argued that unless teachers are able to change their teaching practices and become capable of adapting to new technologies continued expenditure on ICT will have little impact on student learning and classroom practices.

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