Paper code: CAV 04445

Information and communication technology learning in the classroom: The influence of students, the class-group, teachers and the home

Robert F. Cavanagh
Curtin University of Technology

Peter S. Reynolds
Curtin University of Technology

Joseph T. Romanoski
Curtin University of Technology

Paper submitted for presentation at the 2004 Annual Conference of the Australian Association for Research in Education: Melbourne

.

This paper is part of a symposium on *School renewal: Issues concerning professional responsibility, personal responsibility and pedagogy for improving the lives of students, teachers and school leaders*

The research was conducted as part of an Australian Research Council funded Linkage Project between Curtin University of Technology and the Canning Education District

Address correspondence to Dr Rob Cavanagh, Curtin University of Technology, Department of Education, GPO Box U1987, Western Australia 6845
Email: R.Cavanagh@curtin.edu.au

Abstract

A model of classroom information and communication technology (ICT) classroom learning culture inclusive of the influence of the individual student, the class-group, the teacher and the home ICT environment was conceptualised. Data from a survey of 439 primary and secondary students were analysed using Rasch and structural equation modeling techniques. The Rasch analysis results showed students generally expressed confidence in their capacity to use ICT in their learning, but were less certain about the extent to which this learning was supported by teachers and parents. The structural equation modeling analysis showed that attributes of the individual student were more influential than those of the class-group and of the teacher on effective ICT learning. The home ICT environment was shown to mediate the influence of individual student ICT learning behaviours on the development of positive attitudes towards the use of ICT at school. The empirical findings of the study are discussed with regard to the expectations of ICT learning as articulated in the local curriculum. This discussion draws attention to particular aspects of ICT learning and ICT curriculum implementation that could be viewed with concern in terms of the traditional roles of teachers and schools in enabling curriculum realisation.

Paper Presented at the AARE Annual Conference, Melbourne, 2004

Information and communication technology learning in the classroom: The influence of students, the class-group, teachers and the home

Background

The study was conducted in Western Australian government schools that were six years into the implementation of the current state-wide curriculum

This section of the report provides an overview of the major features of the curriculum and of explicit expectations about ICT learning. The notion of classroom learning culture is then introduced and explained in relation to curriculum implementation.

The local curriculum

The Western Australian curriculum, the *Curriculum Framework* (Curriculum Council, 1997) is characterised by identification of sequential long-term educational goals in comparison to previous curricula which prescribed the objectives of specific courses of study, units of work or years of schooling. Five *Core Values* underpin the *Curriculum Framework*: pursuit of knowledge and achievement of potential; self-acceptance and self-respect; respect and concern for the rights of others; social and civic responsibility; and environmental responsibility. The *Core Values* could be considered as the aims of education in Western Australia since they preface subsequent explication of the curriculum and transcend specification of particular areas of learning. There is the expectation that that these values will be developed across all years of schooling and within all areas of the curriculum. The importance assigned to the attitudinal development of students is a significant feature of the *Curriculum Framework*.

The *Curriculum Framework* also specifies seven *Key Principles* to guide schools in planning and curriculum development: an encompassing view of the curriculum; an explicit knowledge of the core values; flexibility; inclusivity; integration, breadth and balance; a developmental approach; and collaboration and partnerships. The *Key Principles* can be interpreted as specification of the school and classroom conditions that are anticipated to support curriculum implementation. So while these conditions might be viewed as complementary to curriculum realisation, they can also be viewed as the indicators of an ‘effective’ learning environment. From a research perspective, these school attributes are mediating variables in curriculum implementation and consequently an important consideration in researching *Curriculum Framework* implementation.

The *Curriculum Framework* articulates thirteen *Major Learning Outcomes* that express the long-term generic outcomes of kindergarten, elementary and secondary schooling. Particular reference is made to ICT; students being able to “select, use and adapt technologies” and to “recognise when and what information is needed, locate and obtain it from a wide range of sources and evaluate, use and share it with others” (Curriculum Council, 1997 p.17). This outcome is to be attained from learning throughout all years of schooling and across all the learning areas within the curriculum. This can be contrasted with ICT being delivered within discreet courses of study or at particular times in the instructional program. Another view of ICT within the curriculum is that while ICT competency is an outcome in its own right, it is also a vehicle for attaining other outcomes. ICT application in classrooms is often seen as a tool or instrument for supporting and complementing the school’s instructional program (Anderson & Dexter, 2000; Latham, 1998).

The issue of whether ICT use in schools is an instructional means or an outcome/ ‘end’ is analogous to the *Curriculum Framework* differentiation between the *Key Principles* and the *Major Learning Outcomes*. Although these examples show the means and can be distinguished from the ends, such delineation is conceptually and pragmatically problematic. Indeed adoption of a dichotomous approach by separating learning process from learning outcomes in at the school level is an overly simplistic approach towards student instruction. A dichotomous approach towards classification of outcomes by differentiating between outcomes concerning values from those concerning knowledge or skills acquisition also presents problems in the design of school and classroom instructional programs. On one hand development of attitudinal systems such as the *Core Values* might be seen as the result of learning. On the other hand, values and attitudes may be considered as influences on learning behaviours in that they are affects on learning rather than the results of learning. The point in drawing attention to this paradox is that research into the role of ICT in schools has to take into account of the presence of dichotomies in the curriculum and in school instructional programs. However, when probabilistic and deterministic quantitative research methods are applied, as was the case in this study, a dichotomous conceptualisation does not provide a theoretical model amenable to statistical validation. Consequently, a more conceptually coherent representation of ICT in schools was developed.

Classroom learning culture

Many years of research into school effectiveness and improvement has shown that improving the educational outcomes of students requires changing belief and value systems throughout the school (Harris, 2001; Sergiovanni, 2000 &1992; Fullan, 1993; Glickman, 1992). This process is usually described in terms of school culture with the change being termed re-culturing (Dalin, Rolff & Kleekamp, 1993). School culture has been defined as the social dimension of the school concerned with belief systems, values, cognitive structures and meaning (Anderson, 1982); and as a combination of processes and shared value systems expected to make schools educationally effective (Stoll & Mortimer, 1995). Ideas, beliefs and values are developed to give meaning to the behaviours of groups and individuals and in turn, these behaviours are an expression of the culture (Maxwell & Thomas, 1991).

Transforming the culture of a school requires teachers to develop new beliefs, attitudes and values about instructional processes that will lead to change in classroom practice and improved student educational outcomes (Halsall, 1998). Although classroom pedagogy and student achievement are at the core of the school improvement, implementation of school improvement programs does not necessarily lead to improved student learning (Lingard, 2001; Newmann & Associates, 1996; Newmann & Wehlage, 1993; Queensland Department of Education, 2001). It cannot be assumed that reforming the organisation of the school, the curriculum or the learning environment will positively impact on student learning. However, when focus of the change process is shifted to the individual teacher and the classroom, improvements in student learning are more likely to be effected (Boland, Cavanagh & Dellar, 2002). So curriculum implementation should be focussed on changing classroom cultures of teaching and learning. Similarly, the success of implementation will be shown by such change and be manifested by the resulting characteristics of 'changed' classroom cultures. This conception of school improvement and curriculum implementation is particularly important when the objectives of improvement and the aims of the curriculum concern student values and attitudes (Cavanagh & Dellar, 2003).

Multiple local studies of school and classroom culture have identified five elements of school and classroom culture (Cavanagh, Dellar, Ellett & Rugutt, 2000; Cavanagh, Waugh, & Dellar, 2003; Waugh, & Cavanagh, 2002). These are:

- Improved educational outcomes;
- An emphasis on learning;
- Mutual empowerment and caring;
- Collaboration; and
- Partnerships (home and local community).

The five elements provide a framework for describing prevailing school culture and can also be viewed as vehicles for building or transforming the school's culture. For example, *an emphasis on learning* is an expression of values concerning the importance of learning. It can also be viewed as a process in which learning is continually emphasised within the classroom environment. Similarly, *improved educational outcomes* concerns the importance of educational outcome attainment and in turn, attainment of outcomes provides motivation for subsequent engagement in the further learning.

Cavanagh, Romanoski, Haris, Giddings & Dellar (2003) developed a Rasch model instrument to measure ICT classroom learning culture. Instrument development was based on a definition of ICT classroom learning culture - "student attitudes, behaviours and values concerning ICT that lead to achievement of generic and ICT-specific educational outcomes" (Cavanagh, Dellar & Romanoski, 2004 p.14). This conceptualisation acknowledged that classroom culture was comprised of both attitudinal and behavioural dimensions. It also recognised two levels of ICT outcomes. The first level assumes the instrumental view of ICT in schools in which the use of ICT enables attainment of general educational objectives. The second level assumes that ICT learning is an objective in its own right. Students demonstrating particular knowledge, skills and attitudes concerning the use of ICT will evidence the attainment of this objective.

The classroom ICT learning culture view of ICT curriculum implementation is conceptually consistent with the major elements of the *Curriculum Framework*. The cultural conception acknowledges the importance of student value systems as explicated in the *Core Values*. This conception is well aligned with the *Key Principles* in that the incumbent features of learning and the learning environment should also be attributes of the prevailing classroom culture. Additionally, the *Major Learning Outcome* concerning ICT is reflected by focus on student use and attitudes towards ICT.

Research objectives

The study examined classroom ICT learning culture with a view towards explaining how this mediates student learning and curriculum implementation. Specifically:

1. What is the influence of the individual student, the teacher, the class-group and the home on classroom ICT learning?
2. How does participation in ICT learning influence student attitudes towards schooling?

Research methods

A quantitative approach was applied on the assumption that this would improve the generalisability of findings. A theoretical model of classroom ICT learning culture was conceptualised, a survey-type instrument was used for data collection, and data were analysed using Rasch model and structural equation modeling techniques.

Theoretical model

The initial conceptualisation was based upon a previously developed representation of classroom ICT learning culture (see Cavanagh, Dellar & Romanoski, 2004). The hypothesised model comprised five-factors: student ICT learning attitudes and behaviours; Class-group ICT learning; teacher ICT attitudes and behaviours; home ICT attitudes and behaviours; and the affect of ICT use on student attitudes towards school. The interaction between individual students within the class group and with the teacher and parents was expected to develop the collective values, attitudes and behaviours that would characterise the culture. Thus the factors can be considered as the both the dimensions of classroom culture and also as the vehicles for developing and maintaining this culture.

In structural equation modeling, the factors within the model being tested are considered to be 'latent' variables and are not directly measured. Alternatively, 'observed' variables are indicated for each latent variable and it is these variables that are measured. In cognisance of this requirement, the model was further developed by identification of sub-factors (observed variables) for each factor (latent variable). For example, the latent variable of *student ICT learning behaviours* was indicated by three observed variables - f*inding information*, *responsibility for own learning*, and

ICT self-expression. The five latent variables and respective observed variable are presented in Table 1.

Table 1.
Latent variables and respective observed variables

Latent variables (factors)	Observed variables (sub-factors)
1. Student ICT learning behaviours	Finding information
	Responsibility for own learning
	ICT self-expression
2. Class-group ICT learning	Peer ICT support
	ICT working together
3. Teacher ICT instruction	Negotiation of ICT use
	Recognition of student ICT ability
	Encouragement of students using ICT
4. Home ICT environment	Home ICT importance
	Homework using ICT
5. Student attitudes towards school	Improving schoolwork
	Increasing engagement

Instrumentation and data collection

The *Student Views of Learning through use of Information and Communications Technology Questionnaire* (Cavanagh, Romanoski, Harris, Giddings & Dellar, 2003) was modified to produce a 44 item scale with items organised according to the above five-component hypothesised model (items are presented in Appendix 1). Students responded on a four point Likert scale from 4 - strongly agree to 1- strongly disagree. The sample was 439 students in two secondary schools and four primary schools. The primary school sample comprised 284 students from Years Six and Seven. The secondary school sample comprised 155 students from Years Eight to Eleven and included classes from core curriculum areas and also computing-related electives (e.g. Year 11 Business Studies).

Data analysis

The data were analysed using both Rasch and structural equation modeling techniques. Rasch analysis examines the fit between the data and the model by calibrating items and testing how well each item fits the model. Rasch analysis tests that items are ordered in level of ‘difficulty’ along an interval level scale. The computer program Rasch Unidimensional Measurement Models (RUMM) (Andrich, Sheridan, Lyne & Luo, 2000) was used to calculate the comparative locations of the 44 items. Item difficulty locations were measured in logits - logarithmic units based on the logarithmic odds of answering positively. The location of an item is a measure of the degree of affirmation of the item by the respondents. Examination of item location logits was applied to reveal both common and uncommon attributes of classroom ICT learning culture as perceived by the students. While Rasch analysis showed the level of presence of the five factors within the classrooms investigated, it did not reveal the associations between these factors.

The proposed interaction between the five elements of classroom ICT learning culture should be reflected by the extent of covariance between the data from these elements. Confirmatory Factor Analysis (CFA) examines the means, standard deviations of data for factors in a hypothesised model in conjunction with factor data covariance to statistically validate the presence of a factorial structure in the data (Kelloway, 1998; Long, 1983). CFA tests the fit of the data to a hypothesised factorial model and when this fit is good, the data confirms the model. However, CFA cannot test assumptions about the dependency or direction of influence between variables within a model. The strength and nature of interaction between variables was tested by Latent Variable Path Analysis (LVPA) (Bollen, 1989; Kelloway, 1998). This requires development of a structural model in which the dependency between particular variables is specified. Similar to CPA, LVPA tests the fit of the data to a hypothesised model but in addition, tests the fit of data in terms of hypothesised relationships (paths) between variables. CFA and LVPA were conducted by structural equation modeling using *LISREL VIII* (Jörkeskog & Sörbom, 1992).

Subsequently, a series of structural models were proposed in which various combinations of relationships between variables were specified. A series of multiple regression analyses were conducted to assist structural model specification. These revealed associations between variables and the extent of dependency between variables. While this process was useful in informing the overall configuration of the structural models, it did not reveal the direction of influence between variables. This uncertainty was addressed by the inclusion and exclusion of particular paths within the respective models.

In both CFA and LVPA the accuracy of a model is shown by the level of fit between the data and the model. *LISREL VIII* calculates many fit statistics including the Root Mean Square Error Approximation (RMSEA) and the Comparative Fit Index (CFI). The RMSEA and CFI are commonly accepted measures of fit (Kelloway, 1998; Rigdon, 1996). When the RMSEA is less than 0.10, the fit is considered good (Kelloway, 1998), and when below 0.08, very good (Rigdon, 1996). Also the data fits the model very well when the CFI is greater than 0.90 (Kelloway, 1998; Rigdon,1996). The parsimony of structural models is also considered when evaluating structural models. The comparative parsimony of models is shown by the parsimony normed fit index (PNFI). Although higher values for this index indicate a more parsimonious fit, there is no standard for how high. Kelloway (1998) considered it unlikely that the PNFI would ever reach the 0.90 cut-off used for other fit indices and Byrne (1998) suggested even indices above 0.70 were not to be expected.

Results

Individual item locations in logits were calculated by Rasch analysis. The item locations (logits) are included in Appendix 1 for each of the 44 items. Negative logits for an item are due to students perceiving the attribute measured by the item to be relatively common in their classrooms. Conversely, positive logits indicate less commonly perceived classroom attributes. The range of logits for the items comprising each factor and sub-factor show that the five factors and 12 sub-factors of ICT learning culture had varying levels of presence in the classrooms investigated. For example, the logits for the items comprising the sub-factor *class-group ICT learning* were negative due to the students responding in an affirmative manner to these items. In contrast, the positive logits for the sub-factors in *student attitudes towards school* (*improving schoolwork* and *increasing engagement*) had positive values due to less affirmative student responses to the respective items. However, some caution needs to be exercised when interpreting item logits since logits are standardised and not absolute measures. The zero point in a scale of item logits does not show that the students were equally divided between confirmation and non-confirmation of particular attributes. A more thorough examination of the Rasch analysis results is presented later in this report.

Confirmatory factor analysis with *LISREL VIII* revealed that the data fitted the factorial model very well (RMSEA = 0.068; CFI = 0.97). These results show that for the classrooms investigated, the instrument was an accurate measure of classroom ICT learning culture and also that the five factor conceptualisation was a valid representation of classroom ICT learning culture.

Nine structural models were tested by LVPA with varying levels of data to model fit for the analyses that proceeded to convergence (RMSEA 0.087 - 0.130; CFI 0.90 - 0.95; PNFI 0.65 - 0.70). The similarity in these indices is due to the presence of common paths; and the differences between the indices are due to the respective inclusion and exclusion of certain paths. The structural model with the highest fit statistics and the best parsimony was identified. For this model, the data to model fit was good (RMSEA = 0.087 and CFI = 0.95) and the parsimony was most acceptable (PNFI = 0.70). The model is diagrammatically represented in Figure 1.

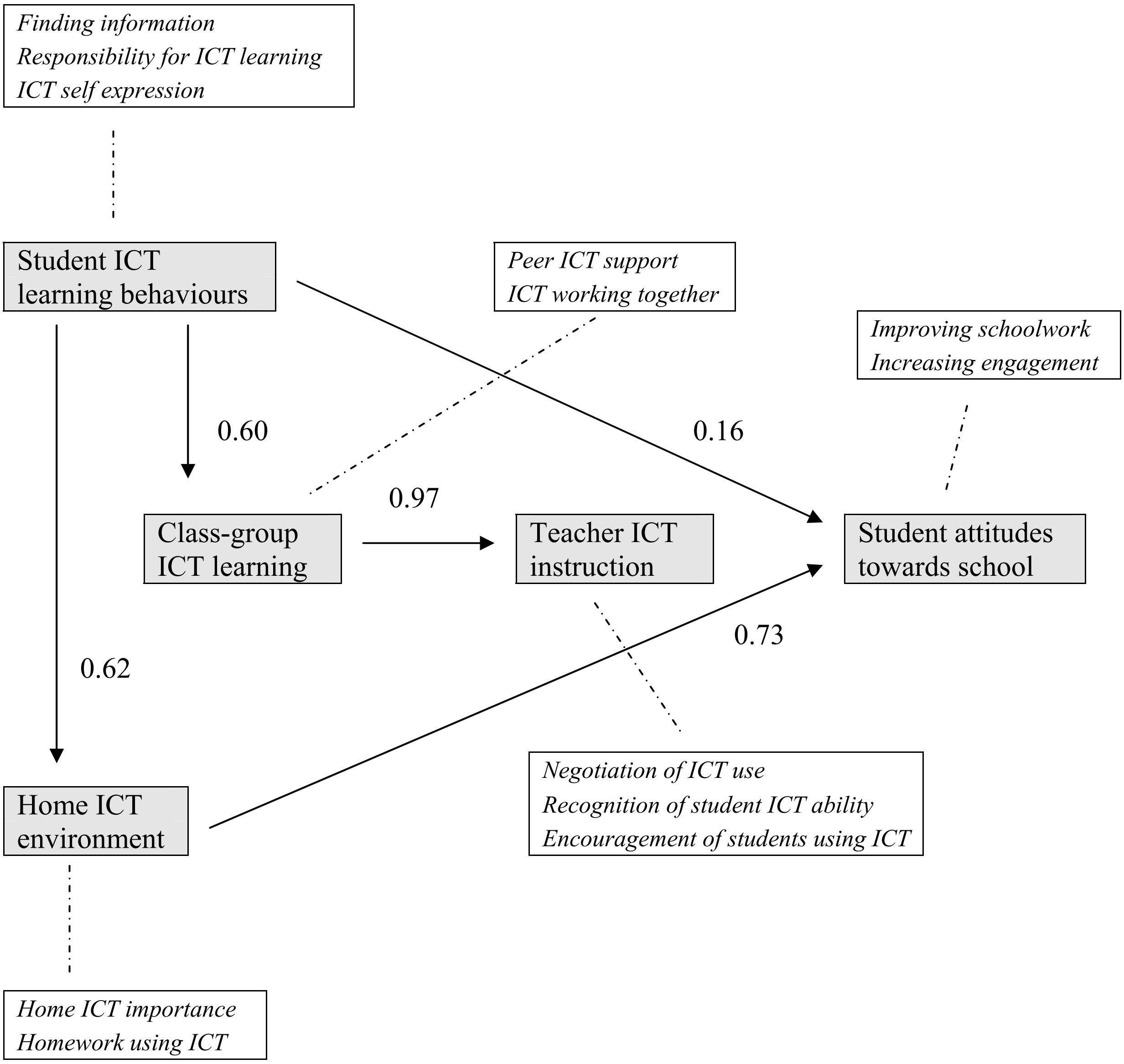

Figure 1: Confirmed structural model of classroom ICT learning culture

The five elements (latent variables) of classroom ICT learning culture are in the highlighted boxes in the centre of the model (e.g. s*tudent ICT learning behaviours*). The respective observed variables that indicate these elements are situated at the top and bottom of the model (e.g. *finding information*, *responsibility for ICT learning* and ICT *self-expression*). The observed variable labels are italicised and these variables are connected to their respective latent variables by the broken lines. The validated paths between the five elements are shown by arrows with the direction of the arrow showing the nature of dependency between two elements. For example, the *home ICT environment* was dependent upon *student ICT learning behaviours*.

The strength of the association between variables was estimated by calculating the beta weight (β) - the standardised effects of each latent variable on another latent variables as specified in the structural model being tested. Beta weight is particularly important since it provides a standardised measure of the strength of association between variables by comparing the variance in two variables independently of other variables that are held constant. The respective beta weights for each path are included alongside each path arrow. For example, *student ICT learning behaviours* has a strong effect on *home ICT environment* as shown by β = 0.62. Beta weights above 0.50 are sufficiently high for predictive purposes (Fraenkel & Wallen, 2002) and even those above 0.10 are considered unusual in Social Science research (Kiess, 2002).

A more detailed examination of the model is provided in the following section of the report in which the results of the Rasch and LVPA analyses are discussed.

Discussion

The following discussion of the empirical results is organised into six sections. The first five sections examine data on the five elements within the LVPA model. Initially, the Rash analysis results are discussed to provide a 'descriptive' view of student perceptions of their ICT learning. Then, the results of structural equation modeling are discussed to examine how each element was confirmed to interact with other elements. The sixth and final section of the discussion focuses on the implications of the findings for curriculum implementation.

Student ICT learning behaviours

Student ICT learning behaviours was indicated by three observed variables concerning attributes of the individual student - *finding information*, *responsibility for own learning*, and *ICT self-expression*.

Being able to find and evaluate information is an integral aspect of problem solving and ICT use has been associated with successful inquiry based learning (Volman & van Eck, 2001; Wheeler, Waite & Bromfield, 2002; Zhang, 2002). The students affirmed their enjoyment and confidence when using computers to find information to enable answering of 'questions' (logits -0.85 to -0.68), but were less certain about computers always providing the 'best' answers (logit +0.11).

Responsibility for learning can be understood as recognition, on the part of the student, of personal individual accountability. Individual accountability requires decreasing the opportunity for diffusion of responsibility that occurs in collaborative learning with ICT (Slavin, 1983). Successful learning of individual students requires meta-cognitive awareness and self-regulation – students thinking about what they know, how they learn and regulating their own learning (Bransford, Donovan & Pellegrino, 2000; Schunk, 1996; Wheeler et al., 2002). The students expressed an understanding of knowing why and how to use computers that evidences taking personal responsibility for using computers in their schoolwork (logits -0.64 to -0.11). They expressed a lower level of certainty about not making mistakes when using computers (logit +0.28).

Computers can develop creativity. Creativity is the ability to come up with new ideas that are surprising, yet intelligible, and also valuable in some way (Boden, 2001). Creative thinking involves the representation in meaning derived from a dialogue between children and their work (Loveless, 2000). Examples of creative ICT learning include the development and management of a personal website, personal writing using a word-processor, and discovering and adapting to new ways of working and studying using electronic environments (Wheeler, et al., 2002). The survey items on *ICT self-expression* were intended to elicit information consistent with the notion of creativity. The students saw personal computer use as providing them with freedom and choice in their learning (logits -0.65 to -0.24). However, they were less sure about computers making their lives more interesting or changing their view of the world (logits +0.24 to +0.46).

Structural equation modeling (LVPA) showed that three of the other four elements were dependent upon *student ICT learning behaviours* with no statistical confirmation of reciprocal dependency. *Student ICT learning behaviours* is an independent attribute of the individual student; independent of the home, the class group, and of the teacher. This finding suggests that the capacity of students to apply ICT in their learning has developed previously and/or separately from the current home and classroom environments. The possibility of this having occurred at school in specialist ICT classes is unlikely since the sample included students from specialist ICT classes. A more probable explanation is that for the sample of students investigated, these behaviours were developed in earlier years of schooling or perhaps from informal use of ICT such as playing computer games. Another issue concerns whether these behaviours require modification, and, if modification is required, identification of the means for doing this. Although the Rasch results indicate the students considered themselves to be generally competent and confident in their ICT learning, it is likely that further learning will be required. However, if this assumption is accepted, it appears that success in further ICT learning may well be dependent upon participation in activities different to those currently experienced in the prevailing home and classroom environments as measured in this study.

Home ICT environment

The effect of family and home on student achievement is well established (Waugh & Cavanagh, 2002; Lingard, 2001; McCall, Smith, Stoll, Thomas, Sammons, Smees, MacBeath, Boyd & MacGilchrist, 2001; Coleman, 1998). The home environment influences student attitudes towards learning and also the culture in schools and individual classrooms (Cavanagh, Waugh & Dellar, 2003). With regard to ICT learning, a recent large British study into the impact of ICT on educational attainment found that children who used computers at home tended to use them more frequently and confidently at school (BECTA, 2002).

The h*ome ICT environment* was indicated by *home ICT importance* and *homework using ICT*. The range of logits for the majority of the items comprising *home ICT importance* were positive as a result of the students not expressing an affirmative view of positive family attitudes towards ICT (logits -0.02 to +0.15) and of the importance of the home ICT environment for their progress at school (logits +0.70 and +0.88). The *homework using ICT* items provided information on parental involvement in their child's ICT learning. The range of logits for these items was from -0.05 to +1.11. While students expected their parents to take an interest in their computer work, they did not affirm that their parents encouraged them to complete homework on the computer, helped them with this homework, or required them to use the computer for homework.

As was noted in the previous section, SEM results showed that the *home ICT environment* was dependent upon the learning behaviours of the individual students in their use of computers. The dependency was strong (ß = 0.62) and there was no confirmed reciprocal effect – the behaviours of students when using computers in their classroom were not dependent on family ICT use or upon parental involvement in using a home computer to complete homework. The items comprising ICT learning behaviours elicited information that focussed on the use of computers to assist the process of learning (e.g. information retrieval and self-regulation) and these behaviours might be considered as evidence of skill in the use of ICT. In contrast, the items comprising *student attitudes towards school* elicited attitudinal rather than behavioural information that did not concern particular ICT skills but that was dependent on the *home ICT environment* (ß = 0.73). Family attitudes towards the use of ICT and parental involvement in students using computers for homework were shown to be influential on the development of positive attitudes towards school in general and not on the development of ICT-specific skills (learning behaviours).

Class-group ICT learning

A social constructivist view of learning emphasises the importance of the social environment on the acquisition and development of knowledge (Good & Brophy, 2000; Blumenfield, Marx, Patrick, Krajcik, & Soloway, 1997; McCarthy, 1994) - the interaction between peers and with the teacher influences student learning. Adoption of a social constructivist view of learning assumes everyone present within the classroom has the capacity to influence the social environment and enable learning. From this perspective, individual students, groups of students as well as the teacher influence learning. The construction of cognitive and attitudinal mental schema within the minds of individual students occurs through discussion of learning and sharing experiences. Confidence and motivation are also a consequence of a supportive classroom social environment. This proposition is consistent with cooperative learning instructional methods (Johnson, Johnson & Stanne, 2000), and also assertions about the effectiveness of caring learning environments (Pena & Amrein, 1999; Battististitch, Solomon, Watson & Schaps, 1997).

Positive learning outcomes that result from embedded collaborative activities with a computer have been demonstrated in health education (Lockyer, Patterson & Harper, 2001), primary science (Tolmie, Howe, Duchak-Tanner & Rattray, 1999), and secondary science (Chiu, 2002). Chiu (2002) demonstrated that students completing a science report assignment with the support of network technology in a team setting learned as well as those who were in an individual setting. The criterion applied was the acquisition of scientific process skills and the development of positive attitudes toward science and using computers. Chiu (2002) noted, that diffusion of responsibility, also called the 'free-rider' effect, often occurs in team learning. Studies regarding gender differences and interactions within a collaborative ICT learning environment and their subsequent impact on learning have likewise been conducted. Tolmie (2002) observed that the female and male students possessed well-established patterns of interaction (or non-interaction) with each other, especially with respect to conflict management. Volman and van Eck (1997) noted that, in collaborative ICT activities, boys appeared to be more task-oriented while girls were more process-oriented. Individual knowledge acquisition obtained mainly through group use of ICT has also been investigated in conjunction with activity theory models. These provide a language for describing and understanding the changes and difficulties that arise in the development of websites (Issroff & Scanlon, 2002).

Class-group ICT learning was indicated by *peer ICT support* and *ICT working together*. The students responded affirmatively to the respective items for these classroom attributes (logits -0.63 to -0.14). They considered that working with peers on computers should be a 'happy' experience and that they learnt best when students worked together and were caring towards one another. The students also reported that they talked with each other about their computer use and shared their knowledge of computer use. They presented a view of classroom ICT learning being characterised by collaboration and concern for others.

Class-group ICT learning was highly dependent upon student *ICT learning behaviours* (ß = 0.60) with no confirmed reciprocal relationship. It appears that the behaviours of the individual student in his/her use of ICT influenced how students participated in group-use of ICT and conversely that the group use did not influence individual use. This finding has implications for the design of ICT learning activities. When the aim of ICT learning is to improve the competency of the individual student, cooperative learning strategies and development of a collaborative and caring classroom environment may not be effective. This explanation is contradictory to previous classroom learning culture research in which the work of the class-group was shown to be strongly influential on the application and achievement of the individual student (Cavanagh, Dellar, Waugh & Romanoski, 2004). It is also inconsistent with the social-constructivist assumptions in cooperative learning theory (Johnson, Johnson & Stanne, 2000). Hence this finding might well be a peculiarity of ICT learning - acquisition of ICT skills and competencies likely develops from individualised use of the technology and by the individual student accepting responsibility for this learning. From this perspective, one computer being shared by several students is probably an ineffective use of this technology for developing individual competency in computer applications.

Teacher ICT instruction

Teacher ICT instruction was indicated by three observed variables - *negotiation of ICT use*, *recognition of student ICT ability*, and *encouragement of students using ICT*. The students considered they could help the teacher plan use of computers, that they should be asked how computers are to be used and that they talked with the teacher about the requirements of computer work (logits -0.11 to -0.09), but were less sure about the whether the teacher listened to their views on how the work should be marked (logit +0.07). The students did not affirm that the teacher provided ICT instruction commensurate with their ability and interests. Whilst the students expressed the expectation of the teacher being aware of their level of competence (logit -0.52), they did not affirm that the work they were asked to do was interesting, 'just right', or met their needs (logits +0.05 to +0.24). Similarly, whilst they expressed that the teacher should make sure they enjoyed computer work, they did not view the teacher as making computer use enjoyable, making them 'feel good' when using computers, or giving them 'special help' when using computers (logits +0.13 to +0.74). The Rasch analysis results on *teacher ICT instruction* show students generally had a negative view of the extent to which the teacher recognised and accommodated their level of ICT competency when designing ICT learning. The structural equation modeling results provide further insights into this finding.

Teacher ICT instruction was highly dependent upon *class-group ICT learning* (ß = 0.97) with no confirmed direct dependency on *student ICT learning behaviours*. The instructional practices of the teacher were influenced by the nature of the social interaction between students rather than by the ability and needs of the individual student. This lack of teacher responsiveness to students was also revealed in previous classroom learning culture research in which this was explained in terms of teachers being predisposed towards use of particular instructional methods (Cavanagh, Dellar, Waugh & Romanoski, 2004). Another explanation of the finding might be the result of shortcomings in teacher knowledge of the technology and how it can be used in the classroom. For example the ImpaCT2 study (BECTA, 2002) found that teachers lacked confidence and experienced difficulty integrating ICT into lessons - ICT was most frequently used for drill and practice. Also, *Teacher ICT instruction* was not confirmed to be dependent on the home ICT environment and this could be further evidence of teacher predisposition towards non-collaboration with stakeholders in instructional decision-making.

The structural equation modelling analysis revealed that *teacher ICT instruction* did not affect any of the other four elements either directly or indirectly. Whilst this is consistent with the previous observation concerning teacher non-collaboration, it also raises questions about the effectiveness of the ICT instruction in developing student ICT skills and positive attitudes towards schooling. The reason for this might be a consequence of student perceptions of how the teacher designed and delivered ICT instruction. It is likely that when students perceive the teacher as unresponsive to their ICT learning needs, this negatively impacts on the outcomes of the instruction and learning.

Student attitudes towards school

Student attitudes towards school was indicated by *improving schoolwork* and *increasing engagement*. There is research evidence of increased student work output resulting from ICT use. Recent studies (Smeets & Mooij, 2001; Tolmie, 2002; Watts, Lloyd & Jackson, 2001; Zandvliet, 1999) have noted marked student productivity improvements as a direct result of ICT usage. One aim of the ImpaCT2 study in the UK (BECTA, 2002) was to analyse the relationship between students' use of ICT and their performance in National Tests and GCS examinations. In almost every case, the study found evidence of a positive relationship between ICT use and educational attainment. Alternatively, Goodison (2002) found only marginal improvement in student productivity as a result of computer use. In this study, the items comprising *improving schoolwork* elicited empirical data on the influence of computer use on productivity. The students did not consider that computers helped them get their work done more quickly or improved the quality of their schoolwork (logits +0.21 and +0.05). This finding is evidence of negative student attitudes towards the utility of ICT within the broader scheme of attaining non-ICT learning outcomes.

The use of computers by students is often portrayed as leading to increased motivation, engagement, and general enhancement of the learning experience (Moundridou & Virvou, 2002; Volman & van Eck, 2001). In particular younger students seem to develop more positive attitudes towards learning as a result of using ICT (Volman & van Eck, 1997) and improvement in tertiary students' outlooks has also been noted (Chan, Hodgkiss & Chan, 2002; Gardner, Sheridan & White, 2002). These assertions were tested by eliciting information on student perceptions of computers *increasing engagement*. The students did not affirm that 'school would be boring without computers' or that more computer use would 'make school better' for them (me) (logits +0.49 and +0.39). This finding brings into question the use of computers for motivational purposes – computer use may be an ineffective classroom incentive or reward.

The LVPA model shows the influences on the development of attitudes towards ICT, productivity and engagement. There was no confirmation of a relationship between *teacher ICT instruction* and s*tudent attitudes towards school* with this being dependent on attributes of the individual student and of the home. S*tudent attitudes towards school* were weakly dependent on student *ICT learning behaviours* (ß = 0.16). This could be due to attitudinal development being reliant upon the student experiencing ICT learning and demonstrating specific behaviours – behaviours lead to attitude formation. It is worth noting that there was no empirical evidence for a reciprocal relationship in which ICT attitudes affected ICT behaviours.

Student attitudes towards school was highly dependent on the *home ICT environment* (ß = 0.73) and this environment also mediated the dependency on *student ICT learning behaviours*. Whilst the importance of the home environment has been empirically associated with positive attitudes towards ICT use at school, it is difficult to identify plausible explanations for this association. One possible explanation is that the attitudes developed about ICT learning in the home environment are applied by the student at school - a positive demeanour towards home use of ICT leads to a positive demeanour towards ICT use at school. This explanation is predicated on the assumption that the home environment is a major influence on student achievement and attitudes at school. Rather than conjecturing about cause-effect relationships between home and school, it might be more appropriate to view the congruency between positive home and school ICT attitudes as an attribute of the individual student - some students have a general positive disposition towards ICT and this will be evidence both at home and school. This view is supported by the empirical finding that the ICT behaviours of students were not dependent upon either home or school factors. It is also consistent with the finding that the home ICT environment mediates the influence of individual learning behaviours on attitudes towards ICT at school.

Implications for curriculum implementation

Firstly, from the perspective of the *Curriculum Framework*, the study has provided evidence that the *Curriculum Framework Major Learning Outcome* concerning ICT was being achieved. Students affirmed being able to 'use ICT' and to recognise 'when and what information is needed, locate and obtain it from a wide range of sources and evaluate, use and share it with others'. The empirical investigation did not produce nor did it elicit evidence of the 'selection' and 'adaptation' of technologies. With regard to the *Core Values*, the students affirmed they showed 'respect and concern for the rights of others' although this was limited to the classroom rather than the wider societal context. In addition, although the students provided some confirmation of using ICT in the 'pursuit of knowledge', this centred upon the processes of obtaining information and evaluating the usefulness of this information rather than on a demonstrated commitment towards using ICT as a vehicle for learning. If 'pursuit of knowledge' is viewed as students having positive attitudes towards learning and valuing learning at school as indicated by productivity and engagement in schoolwork, the empirical results do not show that prevailing classroom ICT learning advances students valuing the pursuit of knowledge.

Secondly, the knowledge of teachers about the curriculum and their capacity to apply the curriculum in the classroom is a major determinant of the fidelity of curriculum implementation. Indeed, the literature on change and innovation emphasises the crucial role that teachers play as both the agents of change and also as the 'adopters' of the innovation (Hall & Hord, 1987, Hall & Loucks, 1981; Hord & Loucks, 1980; Vaughan, 2002). From this perspective, the lack of teacher influence on classroom ICT implementation is a major concern and raises questions about the effectiveness of teacher professional development for ICT curriculum implementation. A concomitant issue is teacher responsibility and accountability for curriculum implementation which will be difficult to achieve when the teacher is not a key player in the ICT learning of the students.

In terms of curriculum adoption, it is more the attributes of the individual student rather than those of the teacher that are affecting decisions about how and when to use the technology. This is a major professional concern since it could be construed as an argument for ICT learning being provided independently of the teacher and possibly not in traditional classroom settings under the control of teachers. In this scenario, curriculum implementation would become a process of resource development and 'diffusion'/dissemination (R, D & D) (Havelock, 1971) with appropriate software being centrally devised and directly distributed to students who then assume responsibility for their own learning. That is, ICT based learning outside of the school and possibly in the home (see Caldwell, 2000). It is worth noting that the R, D and D model is widely applied by business and industry in the design and marketing of new products and also in educational policy development and implementation (Havelock, 1971; O'Neill, Pouder & Bucholtz, 1998; Tinzmann, Jones & Fine, 1990). This use is notwithstanding the acknowledged failure of the approach for effecting sustainable change in organisations and schools (Klein & Speer-Sorra, 1996; O'Neill, Pouder & Bucholtz, 1998). Hargreaves (1995 p.1) provides the timely warning that "we need new guidelines and principles of change that aren't merely borrowed uncritically from the profit-centered business world". So the evidence of teachers being marginalised in classroom ICT learning provided in the current study has implications for how the curriculum is implemented within the broader scheme of the future of schools and schooling.

Thirdly, the learning culture within schools and classrooms is recognised as a significant influence on the implementation of educational innovations. For example, the Australian *Department of Science, Education and Training* (DEST) recently investigated the four most prevalent areas of innovation in schools - literacy in the early years, 'schooling' in the middle years (middle schooling), and mathematics and information and communication technologies across all years (DEST, 2001). The study found that educational change needed to "… affect the practices, culture and structure of schools by restructuring roles and re-organising responsibilities, including those of students and parents" (DEST, 2001 p.2). The study also revealed that successful innovation implementation focused on "creating learning environments that could meet the learning needs of individual students, which, in most cases, involved a more student-centred approach" (DEST, 2001 p.20). Whilst the current study viewed curriculum implementation from this perspective, the results indicated that the classroom social environment was associated less with ICT learning than was anticipated, particularly the elements of class-group learning and teacher instruction. Consequently, there is merit in viewing effective ICT learning as an individualised rather than a cooperative process. This alternative viewpoint isolates the individual student from the class-group and classroom dynamic with the instructional program focussing on individualised instructional strategies such as self-paced and independent learning. However, this is not to criticise collaborative learning strategies *per se*, instead, to suggest they are likely less effective when applied to ICT learning - the utility of ICT use as a means of facilitating cooperative learning amongst students and the general development of social skills is questionable. Also, the instrumental view of ICT in which ICT competency is seen as a 'means' for learning in contrast to a distinct learning outcome ('end') is questionable. So it is possible that the difficulty faced by teachers in integrating ICT learning with other aspects of the instructional program derives from intrinsic features of ICT learning and not from them lacking the knowledge of how to design integrated instruction inclusive of ICT. The point here is that traditional views and theories of the curriculum and instructional design may well be inappropriate for explaining ICT learning and instruction.

The fourth implication of this study concerns the locus of control of ICT learning that appears to reside more with the individual student and the home rather than with the teacher and the school. This is to recognise that the major influences on ICT learning are probably extraneous to the classroom and the teacher. This issue was previously examined in terms of teacher professionalism and the role of schools. An alternative approach is to focus directly on the student's interaction with the technology to consider the extent to which the student has control over what is being learned from using ICT and the implications of the extent of this control. A strong case could be made that too much student control in conjunction with an absence of adult supervision places the student at risk. The obvious example of this is access to Internet pornography. A more general concern is that the ethical and moral responsibilities that schools have towards educating children are not necessarily present in the virtual world of ICT. The societal expectations of education about the enculturation of children that are articulated in mandated curriculum policies might not be realisable when students have a high level of control of their ICT learning. Thus there is a tension between the delivery/ facilitation of ICT learning and the development of the social value systems espoused in the curriculum.

The final matter is that the development of new ICT applications is occurring at a rapid rate and it may well be that our conceptualisation of ICT learning and our understanding of the implications of this for education are not keeping pace. So there is a need for ongoing research into the interaction between ICT, the curriculum and the classroom culture.

Conclusion

The study has demonstrated the utility of quantitative methods for investigating how teachers and students in the classroom implemented the curriculum. The use of Rasch statistics ensured the data from the survey was a valid measure of classroom ICT learning culture and provided descriptive information on student perceptions of the elements of this culture within their classrooms (their own ICT learning behaviours; the home ICT environment; class-group ICT learning; teacher ICT instruction; and their attitudes towards school). *LISREL VIII* structural equation modeling of the data produced a statistically validated path analysis model of classroom ICT learning culture that showed the relationships between the elements of this culture. When the Rasch and structural equation modeling results were conjointly examined, a unique view of ICT learning and classroom culture was revealed.

The major finding of the empirical investigation was that the anticipated affect of teacher ICT instruction on student ICT learning behaviours and on student attitudes towards school was not confirmed. Alternatively, these student behaviours and attitudes were shown be a characteristic of the individual student with the attitudes being mediated by the home ICT environment. This finding was then examined in consideration of the expectations articulated in the local curriculum and the processes of curriculum and ICT implementation. This examination suggested that in the case of ICT, the role of teachers as agents of curriculum implementation and instructors of ICT learning required reconsideration. It was further suggested that this issue has implications for how the ICT curriculum is designed and delivered.

References

Anderson, C.S. (1982) *The search for school climate: a review of the research. Review of Educational Research*, 52(3), 368-420.

Anderson, E.E. & Dexter, S.L. (2000). *School technology leadership: Incidence and impact*. Berkley, California: Center for Research on Information Technology and Organizations. [Online] Available http:/www.crito.uci.edu/tlc/html/findings/html

Andrich, D., Sheridan, B., Lyne, A. & Luo, G. (2000). *RUMM: a windows-based item analysis program employing Rasch unidimensional measurement models*. Perth: Murdoch University.

Battististich, V., Solomon D., Watson, M. & Schaps, E. (1997). Caring school communities. *Educational Psychologist*, 32(3), 137-151.

BECTA. (2002). ImpaCT2. British Educational Communications and Technology Agency. [Online] Available http://www.becta.org.uk/impact2/

Blumenfield, P.C., Marx, R.W., Patrick, H., Krajcik, J., & Soloway, E. (1997). Teaching for understanding. Biddle, B.G., Good, T.L. & Goodson, I. F. (Eds), *International handbook of teachers and teaching*. Dordrecht; Boston: Kluwer

Boden, M. (2001). Creativity and Knowledge. Creativity in Education Craft, A.B., Jeffrey, B. & Leibling, M.(Eds). *Creativity in Education*. London, UK: Continuum Press.

Boland, T., Cavanagh, R.F. & Dellar, G.B. (2001). *Evaluation of school restructuring intended to create a middle schooling culture* Paper presented at the 2001 Annual Conference of the Australian Association for Research in Education: Fremantle.

Bollen, K.A. (1989). *Structural equations with latent variables*. New York, NY: John Wiley and Sons

Bransford, J.D., Donovan, S.M. & Pellegrino, J.W. (2000). *How people Learn:Brain, Mind, Experience and School*. Washington, DC: National Academy Press.

Byrne, B.M. (1998). Structural equation modelling with LISREL, PRELIS, and SIMPLIS: Basic concepts, applications and programming. Mahwah, NJ: Lawrence Erlbaum.

Caldwell, B.J. (2000). Scenarios for leadership and abandonment in the transformation of schools. *School Effectiveness and School Improvement*, 11(4), 475-499.

Cavanagh, R. F., Dellar, G. B., Ellett, C. D. & Rugutt, J.K. (2000). *Development of an instrument for investigating classroom culture*. Paper presented at the 2000 Annual Meeting of the American Educational Research Association.

Cavanagh, R.F. & Dellar, G.B. (2003). Organisational and learning community conceptions of schools: implications for understanding and researching school improvement. Waugh, R.F. (Ed). *New advances in educational psychology*. New York: Nova Science.

Cavanagh, R.F., Dellar, G.B.& Romanoski, J.T. (2004). *Measuring student perceptions of classroom information and communication technology learning culture*. Paper presented at the American Educational Research Association 2004 Annual Meeting: San Diego.

Cavanagh, R.F., Dellar, G.B., Romanoski, J. & Waugh, R.F. (2004). *Conjoint use of Rasch and correlational analyses in learning environment instrument development*. Paper presented at the American Educational Research Association 2004 Annual Meeting: San Diego.

Cavanagh, R.F., Romanoski, J., Harris, M., Giddings, G.J. & Dellar, G.B. (2003). *Development and validation of a Rasch Model scale to measure student information and communication technology learning outcomes, behaviours and attitudes*. Paper presented at the 2003 Annual Meeting of the Australian Association for Research in Education: Auckland.

Cavanagh, R.F., Waugh, R.F. & Dellar, G.B. (2003). *The culture, outcomes and improvement of secondary school classrooms*. Paper presented at the 2003 Annual Meeting of the American Educational Research Association: Chicago.

Chan, B.K.K., Hodgkiss, I.J. & Chan, R.Y.P. (2002). A distributed learning model for freshwater ecology practical classes. *Journal of Computer Assisted Learning*, 18(3).

Chiu, C.H. (2002). The effects of collaborative teamwork on secondary science. *Journal of Computer Assisted Learning*, 18(3).

Coleman, P. (1998). *Parent, student and teacher collaboration: the power of three*. California : Corwin Press Inc.

Curriculum Council. (1997). *Curriculum Framework*. Perth: Curriculum Council of Western Australia.

Dalin, P., Rolff, H. & Kleekamp, B. (1993). *Changing the school culture*. London: Cassell.

DEST. (2001). *School innovation pathway to the knowledge society*. [On-line] Available http://www.dest.gov.au/schools/publications/2001/innovation/index.htm

Fraenkel, J.R. & Wallen, N.E. (2003). How to design and evaluate research methods in education (5th ed.). Boston: McGraw-Hill.

Fullan, M.G. (1993). *Change forces probing the depths of educational reform*. London: The Falmer Press.

Gardner, L., Sheridan, D. & White, D. (2002). A web-based learning and assessment system to support flexible education. *Journal of Computer Assisted Learning*, 18(2).

Glickman, C.D. (1992). The essence of school renewal: The prose has begun. *Educational Leadership*, 50(1).

Good, T. L. & Brophy, J. E. (2000). *Looking in classrooms* (8th ed.). New York, NY: Addison Wesley.

Goodison, T.A. (2002). Learning with ICT at primary level: pupils' perceptions. *Journal of Computer Assisted Learning*, 18(3).

Hall, G.E. & Loucks, S.F. (1981). *The Concept of Innovation Configurations : An Approach to Addressing Program Adaptation. (R & D Report No. 3116*). Center for Teacher Education. Austin: The University of Texas, Research and Development.

Hall, G.E., & Hord, S. M. (1987). *Change in schools facilitating the process*. NY: State University of New York Press.

Halsall, R. (1998). School improvement: an overview of key findings and messages. Halsall, R. (Ed). *Teacher research and school improvement: opening doors from the inside*. Buckingham: Open University press.

Hargreaves, A. (1995). Renewal in the age of paradox. *Educational Leadership,* 52(7).

Harris, A. (2001). Contemporary perspectives on school effectiveness and school improvement. Harris, A. & Bennett, N. (Eds). *School effectiveness and improvement: alternative perspectives*. London: Continuum.

Havelock, R.G. (1971). The utilisation of educational research and development. *British Journal of Educational Technology*, 2(2), 84-97.

Hord, S.M. & Loucks, S.F. (1980). *A Concerns-Based Model for the Delivery of Inservice. Research and Development*. Center for Teacher Education. Austin: The University of Texas, Research and Development.

Issroff, K. & Scanlon, E. (2002). Using technology in higher education: An activity theory perspective. *Journal of Computer Assisted Learning*, 18(1).

Johnson, D.W., Johnson, R.T. & Stanne, M.B. (2000). *Cooperative learning methods: A meta-analysis*. Minneapolis: Cooperative Learning Center. [On-line] Available http://www.clcrc.com/pages/cl-methods.html

Jöreskog, K.G. & Sörbom, D. (1992). *LISREL VIII: Analysis of liner structural relations*. Mooresville, In: Scientific Software.

Kelloway, E.K. (1998). *Using LISREL for structural equation modeling: A researcher's guide*. Thousand Oaks, Ca: Sage Publications, Inc.

Kiess, H. (2002). Statistical concepts for the behavioral sciences (3rd ed.). Boston: Allyn & Bacon.

Klein, K.J. & Speer-Sorra, J. (1996). The challenge of innovation implementation. *Academy of Management Review*, 21(4) 1055-1080.

Latham, A. (1998). Strategic information systems planning: a necessary evil for schools? *Journal of Applied Management Studies*, 7(2), 267-275.

Lingard, B. (2001). Some lessons for educational researchers: repositioning research in education and education in research. *The Australian Educational Researcher*, 28(3), 1-46.

Lockyer, L., Patterson, J. & Harper, B. (2002). ICT in higher education: evaluating outcomes for health education. *Journal of Computer Assisted Learning*, 17(3).

Long, J.S. (1983). *Confirmatory factor analysis: A preface to LISREL*. Beverly Hills,CA: Sage Publications.

Loveless, A. (2000). Creativity, visual literacy and information and communications technology. Watson, D.M & Downes, T. (Eds). *Communications and Networking in Education: Learning in a Networked Society*. Norwell, MA: Kluwer Academic Press.

Maxwell, T. W. & Thomas, A. R. (1991). School climate and school culture. *Journal of Educational Administration*, 29(2), 72-82.

McCall, J., Smith, I., Stoll, L., Thomas, S., Sammons, P., Smees, R., MacBeath, J., Boyd, B. & MacGilchrist, B. (2001). Views of pupils, parents and teachers: vital indicators of effectiveness and for

improvement. MacBeath, J. & Mortimore, P. (Eds). *Improving school effectiveness*. Buckingham: Open University press.
McCarthy, S. (1994). Authors, text and talk: The internalisation of dialogue fromsocial interaction during writing. *Reading Research Quarterly*, 29, 201-231.
Moundridou, M. & Virvou, M. (2002). Evaluating the persona effect of an interface agent in a tutoring system. *Journal of Computer Assisted Learning*, 18(3).
Newmann, F.M. & Associates. (1996). *Authentic achievement: Restructuring schools for intellectual quality*. San Francisco: Jossey-Bass.
Newmann, F.M. & Wehlage, G.G. (1993). Five standards of authentic instruction. *Educational Leadership*. 50(7).
O'Neill, H.M., Pouder, R.W. & Bucholtz, A.K. (1998). Patterns in the diffusion of strategies across organisations: insights from the innovation diffusion literature. *Academy of Management Review*, 23(1), 96-113.
Pena, R.A. & Amrein, A.L. (1999). Classroom management and caring: a primer for administrators and teachers. *International Electronic Journal for Leadership in Learning*, 3(24).
Queensland Department of Education. (2001). *The Queensland school reform longitudinal study: teachers' summary*. Brisbane: The State of Queensland (Department of Education).
Rigdon, E.E. (1996). CFI versus RMSEA: A comparison of two fit indices for structural equation modeling. *Structural Equation Modeling,* 3(4), 369-379.
Schunk, D. (1996). *Learning theories: An educational perspective* (2nd ed.). Columbus, OH: Merrill.
Sergiovanni, T. J. (1992). Why we should seek substitutes for leadership. *Educational Leadership*. 49(5), 41-45.
Slavin, R.E. (1983). *Cooperative learning*. New York, NY: Longman Publishing.
Smeets, E. & Mooij, T. (2001). Pupil-centred learning, ICT, and teacher behaviour: observations in educational practice. *British Journal of Educational Technology*, 32(4), 403-417.
Stoll, L. & Mortimer, P. (1995). *Viewpoint no 2: School effectiveness and school improvement*. London: Institute of Education.
Tinzmann, M.B., Jones, B.F. & Fine, C. (1990). *What are some approaches to reform? New and old definitions of change*. North Central Regional Education Laboratory. Available [online} http://www.ncrel.org/sdrs/areas/rpl_esys/reform.htm
Tolmie, A. (2002). Examining learning in relation to the contexts of use of ICT. *Journal of Computer Assisted Learning*, 17(3).
Tolmie, A., Howe, C.J., Duchak-Tanner, V., & Rattray, C. (1999) *Explicit and implicit support for procedural learning within collaborative group work in science*. Ninth European Conference on Developmental Psychology: Spetses, Greece.
Vaughan, W., (2002) Professional Development and the Adoption and Implementation of New Innovations: Do Teacher Concerns Matter? *International Electronic Journal For Leadership in Learning*, 6(5).
Volman, M. & van Eck, E., (1997). Gender-related effects of information and computer literacy education. *Journal of Curriculum Studies,* 29(3), 315-328.
Watts, M., Lloyd, C. & Jackson, C. (2001). ICT in the literacy hour: Studying a classroom innovation. *Research in Education*, 66 (84).
Waugh, R.F. & Cavanagh, R.F. (2002). Measuring parent receptivity towards the classroom environment using a Rasch measurement model. *Journal of Learning Environments Research*, 5(3), 329-352.
Wheeler, S., Waite, S.J., & Bromfield, C. (2002). Promoting creative thinking through the use of ICT. *Journal of Computer Assisted Learning*, 18(3).
Zandvliet, D.B. (1999). *The physical and psychological environment associated with classrooms using information technologies: a cross-national study.* Doctoral dissertation, Curtin University of Technology, Perth, Western Australia.
Zhang, J. (2002). Incorporating ICT into K-12 schools: China's perspective in the global backgrounds. *TechTrends*, 46(4), 49.

Appendix 1: Questionnaire factors, sub-factors, items and item difficulties

		Logits
Student ICT learning behaviours		
	Finding information	
1.	Using the computer helps me find the right answers to questions	-0.85
2.	I use the computer to find answers to questions	-0.79
3.	I enjoy using the computer to find answers to questions	-0.68
4.	Using the computer gives the best answers to questions	+0.11
	Responsibility for own learning	
5.	Using the computer lets me learn in different ways from other types of schoolwork	-0.65
6.	By working alone, I find new ways to use the computer	-0.37
7.	I think about how I use the computer	-0.32
8.	I never start work on the computer until I am sure about what I will be doing	-0.11
9.	I need to be able to use computers	-0.11
10.	I rarely make mistakes using computers	+0.28
	ICT self-expression	
11.	Using the computer gives me freedom to do what pleases me	-0.65
12.	The computer lets me escape from things that are boring or not interesting	-0.24
13.	My life has become more interesting by using the computer.	+0.24
14.	I see the world differently when I use the computer	+0.46
Class-group ICT learning		
	Peer ICT support	
15.	Working together on computers should be a happy experience for everyone	-0.63
16.	Learning on computers works best when students show care for each other	-0.39
	ICT working together	
17.	We talk about what we are doing on the computer	-0.27
18.	The best learning with computers happens when students work together	-0.17
19.	We share out computer knowledge	-0.14
Teacher ICT instruction		
	Negotiation of ICT use	
20.	Students should be asked by the teacher in deciding how computers will be used	-0.11
21.	We talk with the teacher about what is required in computer work	-0.11
22.	Students can help the teacher plan how computers will be used	-0.09
23.	The teacher listens to our views on marking our computer work	+0.07
	Recognition of student ICT ability	
24.	My teacher should know what I can do and can't do on the computer	-0.52
25.	The work the teacher asks me to do on the computer is interesting for me	+0.05
26.	The work the teacher asks me to do on the computer is just right for me	+0.24
27.	The work the teacher asks me to do on the computer meets my own needs	+0.24
	Encouragement of students using ICT	
28.	Teachers must make sure all students enjoy computer work	-0.34
29.	The teacher makes sure I enjoy using the computer	+0.13
30.	The teacher makes me feel good when I use the computer	+0.33
31.	The teacher gives me special help with the computer	+0.74

Home ICT environment

Home ICT importance

32.	Having a computer at home is important for my family	-0.02
33.	My family is finding new ways to use computers	+0.15
34.	Every family should have at least one computer	+0.15
35.	Students who do well at school have parents who take an interest in their computer work	+0.70
36.	Students who do well at school come from homes with computers	+0.88
	Homework using ICT	
37.	My parent(s) should take an interest in my computer work	-0.05
38.	My parent(s) encourage me to complete homework on a computer	+0.32
39.	My parent(s) help me to use a computer to complete homework	+0.47
40.	My parent(s) make me use a computer for homework	+1.11

Student attitudes towards school

Improving schoolwork

41.	Computers improve the quality of my schoolwork	+0.05
42.	Computers help me get my work done more quickly	+0.21
	Increasing engagement	
43.	More time using computers would make school better for me	+0.39
44.	School would be boring without computers	+0.49