Researching Numeracy Teaching and Learning with ICT: Facing the Problems of Innovation

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This paper presents an overview of the research project being reported on in this symposium. I outline the goals and aims of the research, our understanding of the term 'numeracy' and the potential role of technology to support numeracy learning for all students but with a focus on disadvantaged learners in particular. I sketch the research process to date and mention some of the difficulties we are facing.

The research project sought to engage with key policy initiatives in Queensland (Department of Education, Queensland, 1994): an emphasis on the acquisition of numeracy skills in schools; and the increased and relevant use of ICT in the curriculum. At the same time we wanted to engage critically with issues of concern in the mathematics education community across the globe, including: how is 'numeracy' framed; what fruitful function can ICT serve in students' learning; and can we effect a more equitable access to success in mathematics learning? To these ends we designed a programme of research drawing on theoretical perspectives that address equity, and that seeks to identify practice that we considered warranted dissemination around other schools. As I will describe below, we have faced a number of substantial difficulties not unfamiliar to researchers in the community.

Aims of the research

The project has four aims:

to document the ways in which ICT is used within schools and the home in numeracy learning;

to identify new forms of numeracy, particularly those that arise from the use of ICT mediated learning;

to identify the ways in which ICT can be used to enhance numeracy learning in schools;

to develop, implement and evaluate guidelines for teaching innovation that will support and enhance numeracy learning for students most at risk of failure in school numeracy and/or mathematics.

The research is addressing the first aim by using focused case studies (Stake, 1995) across a range of sites and social/cultural backgrounds. The project draws on the outcomes of national and international research that documents the ways in which ICT enhances numeracy learning and takes into account issues of the 'digital divide' (Carvin, 2000). Little is known as to how ICT is used to support numeracy learning in schools and homes, particularly in relation to differential access and outcomes. The project aims to document how ICT is used in the homes, how it is used in schools, and to note differences in access and usage among different social, cultural and geographical groups.

The case studies are also intended to give us access to practices in schools that address the second aim. In the rhetoric of 'New Times' we consider it important that we ensure that ICT use in schools is driven by learning goals and not the converse.

The third aim is concerned with issues of learning. Using an ethnographic approach, classroom practice is being examined in terms of teaching practices (through a Bernsteinian (e.g. 2000) analysis) and learning behaviours (through a socio-cultural analysis) in order to propose key elements of effective practice.

The importance of numeracy in determining social and economic outcomes of young people, our concern expressed in the fourth aim, and the national economy has been documented. It is well known that some students are more at risk of failing or of poor performance in numeracy than their peers and that social class and other forms of socio-economic disadvantage are critical elements in differential access to symbolic power. This project focuses on developing strategies for enhancing performance of those most at risk – indigenous students, students in remote or geographically isolated regions and working-class students. Gender will be integrated into these categories since this compounds the differential access and success in numeracy and ICT.

'Numeracy'

In past times where there was a strong emphasis on pencil-and-paper calculations, numeracy was a mental activity involving operations on numbers. Today we would want to build on a notion that numerical practices involve

> abilities which include interpreting, applying and communicating mathematical information in commonly encountered situations to enable full, critical and effective participation in a wide range of life roles (Department of Education, Queensland, Australia, 1994, p. 9, in Kanes, 2003, p. 82).

Kanes (2003) proposes that to understand numeracy we should examine it through three themes:

> the theme of visibility is about how we formalise and control numerical knowledge; the theme of useability is about its use; and the theme of constructibility is about its origins both as a cultural-historical phenomenon and as an individual attainment. (p. 84)

We also suggest that conceptualisations of numeracy need to recognise the new ways of working and understanding brought about by, and realised through, ICT. Zevenbergen (1995, 2001) has shown that numeracy is a skill that has many facets, but that it is also dynamic. She argues strongly that the demands on school leavers and workers are very different in the current economic, social and political climate and that new conceptualisations of numeracy are needed. We therefore define numeracy as a social practice that arises from and gives rise to particular activities. Since our focus is on numeracy practices in schools we examine its useability by identifying what actually happens in schools when numeracy activities are designed and implemented using ICT.

Technology

While there is a significant body of research that advocates the affordances of use of ICT to enhance learning in numeracy and other curriculum areas, a number of researchers alert educators and policy makers to the constraints of its use. Existing research suggests that 2/3 of the population is likely to access ICT and the internet in their homes (Revenaugh, 2000). Such studies, however, fail to recognise *who* has access and what *type* of access or programs are used in the homes. In the emerging studies related to the "digital divide", studies of home/school computer use have raised some serious questions in terms of equity. In generic studies in education Downes (1997), suggested that, in terms of equity, the experiences of children in the home position them differentially so that those who have greater access to particular forms of computers and programs will have greater

potential for success. Furthermore, it has been proposed by some feminist writers that technology has potential for the new means for gendered differentiation (Kenway & Nixon, 1999; Spender, 1995). Others have recognised the problems with access due to low incomes (Damarin, 2000; Revenaugh, 2000). In recognising the importance of supporting socially, culturally and economically disadvantaged students' access to computers in schools, limited research exists that identifies key difficulties, strategies or principles for effective use of computers in schools (Mergendoller, 2000), and even less in mathematics. Our project takes note of differential access issues and of the need for more effective examples of ICT use in numeracy practice in schools and we hope to contribute to theory and practice in these.

Research so far

The project to date has involved 6 schools scattered across Queensland. The schools were selected to participate on the basis of the demographics of the communities they serve. Communities in rural/remote and urban areas, with members from socially, culturally and linguistically diverse backgrounds, including Indigenous people, are participating in the project. Classrooms from the final years of primary schooling are the specific focus. In some cases these are single year classes, in other cases, they are multi-age.

The original plan was to conduct a broad survey of practices, but after reflecting on preliminary interviews with teachers, we decided to adopt an approach consistent with the notion of research as design (Kelly, 2003). Rather than simply describing what might be occurring in communities and schools regarding the deployment of ICTs for numeracy, we decided to plan a specific intervention with the teachers. The intervention was based on the curriculum innovation in Queensland known as rich tasks (Department of Education, Queensland, 1994). According to Education Queensland, the tasks should be built around assessible activities that are intellectually challenging and have real-world value. In each of the school sites teachers devised different rich tasks to implement with their students.

In 2003, the data consisted of video taped lessons – this was actually completed by the teachers due in part to the remote location of some schools - supplemented with observations from the research team. The data have provided insights into the complex system of relationships between pedagogical practices and the particular school settings. In the following papers by Zevenbergen, Renshaw, and Judd, accounts of the analysis of these lessons are presented. Renshaw addresses the first two goals in his sociocultural analysis of a task in one school, demonstrating a rich classroom task differentially approached by students with different access to computers at home. Zevenbergen addresses the third and fourth goals in illustrating how teachers' actions can support the development of procedural or conceptual knowledge, whilst also indicating possible connections with socio-economic backgrounds.

The problems of innovation

We were aware from the start of our project that constraints on teachers are such that it would perhaps not be easy to find the kinds of practices we were looking for. One example of the practices we were hoping to find is given in Chris Judd's paper in this symposium, in which he describes a rich task using a Microworld in which different forms of scaffolding were required to support students in deep learning.

Research indicates a number of factors that are likely to be constraining teachers in innovating. First, low academic achievement often goes together with behaviour issues and teachers are reluctant to do innovative things with these classes/students. Further, there is an assumption that students whose basic mathematics skills are not good need more of the same activities of the kind they have failed before, namely exposition followed by plenty of practice of algorithms, again militating against imaginative work. Then, it has to be said that one does not often see innovative work using technology in any area of maths, with any groups of students. If there is a suitable software package that is easy to use and appears to be fairly fail-safe some teachers will use it. Those teachers who have managed to overcome barriers both cognitive and affective concerning computer use may use content-free software like spreadsheets and dynamic geometries but there are not many teachers in this position. Most teachers are worried about being seen to be less competent in computer use than their students and fear the loss of power and status if students see they know more than their teachers. Resources is also an issue that gets in the way of teachers developing ways of using technology to support students' learning. If there is a computer suite it may not be easy to book it. Indeed it is it unlikely that a teacher would be able to move there in the middle of a lesson if she/he feels that ICT will support what she/he is doing at that moment. In the situation where there are computers in every classroom, there may not be enough to be able to turn to them whenever the teacher wants or for her/him to plan for their use.

In the next part of our research, we, the researchers, will play a more active role in the data collection in the hope that it will reveal more of the activities and tasks that teachers use for numeracy learning through ICT, and that it will give us the kinds of data to which we can apply the techniques of analysis (Bernsteinian and sociocultural) that we have intended for this project.

References

Bernstein, B. (2000). *Pedagogy, symbolic control and identity. Theory, research, critique* (2nd ed.). New York: Rowman & Littlefield.

Carvin, A. (2000). Mind the gap: The digital divide as the civil rights issue of the new millenium. *Multimedia in Schools, Feb*, 56-58.

Damarin, S. K. (2000). The 'Digital Divide' versus Digital Differences: Principles for equitable use of technology in education. *Educational Technology, 40*(4), 17-22.

Department of Education, Queensland. (1994). *Literacy and numeracy strategy: 1994-98*. Brisbane: Department of Education, Queensland.

Downes, T. (1997). A matter of equity: Computers in Australian homes. *Australian Educational Computing, 12*(2), 7-13.

Kanes, C. (2003). Developing numeracy. In J. Stevenson (Ed.), *Developing vocational expertise: Principles and issues in vocational education* (pp. 81-109). Crows Nest: Allen & Unwin.

Kelly, A (2003) Research as design. *Educational Researcher, 32*(1) ,3-5.

Kenway, J., & Nixon, H. (1999). Cyberfeminisms, cyberliteracies and educational cyberspheres. *Educational Theory, 49*(4), 457-474.

Mergendoller, J. R. (2000). Technology and Learning: A Critical Assessment. *Principal, 79*(3), 5-9.

Revenaugh, M. (2000). Toward a 24/7 Learning Community. *Educational-Leadership, 58*(2), 25-28.

Spender, D. (1995). *Nattering on the net: Women, power and cyberspace*. North Melbourne: Spinifex Press.

Stake, R. E. (1995). *The art of case study research*. London: Sage.

Zevenbergen, R. (1995). Towards a socially critical numeracy. *Critical Forum, 3*(1&2), 82-102.

Zevenbergen, R. (2001). Numeracy: Youth and New Times., *Second Annual Conference for the Middle Years of Schooling Association* . Brisbane: Middle Years Schooling Association.