Assessment in mathematics: A multimedia resource for preservice teachers

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It is commonly accepted that teachers teach the way they were taught and that innovation is difficult to achieve. Teacher education courses often involve tasks that require students to process knowledge that is unconnected to situations in which the new knowledge will be applied. Consequently, the knowledge and abilities that are learnt have little chance of transfer to real classroom situations.

In an attempt to overcome this problem, the theoretical framework of situated cognition or situated learning has been used in this project to design an interactive multimedia resource that allows preservice teachers to become aware of different assessment strategies in mathematics education and how to apply them. The resource enables users to encounter the authentic use of a range of assessment strategies and to view their interpretations from multiple perspectives which include the teacher's decision-making processes, the child's thinking, expert opinion and written documentation.

The interactive multimedia package described in this paper goes some way towards providing perspectives on mathematics education that may provide students with the confidence to implement approaches that are appropriate for assessing the range of outcomes that are valued in the learning of mathematics.

A staff-room conversation ...

Student Teacher:	This is my lesson plan for tomorrow. I'll need to think about assessing the way the students solve problems?
Teacher:	And how do you think you might do that?
Student Teacher:	Well, I could try putting them in groups and using a checklist but I'm not sure that will work. When I was in school the teacher would simply give us a test. I think I'll do that.
Teacher:	Why not give it a go? Perhaps you could list some approaches that you think the students might use when they solve the problems and make a checklist up that way.
Student Teacher:	Well, I'd feel safer using a test. I'm not sure what strategies they might use. I haven't actually seen anyone using a checklist in class before.

This script is contrived but, we contest, not unique. It is accepted wisdom in teacher education circles that teachers teach the way they were taught and that innovative approaches are not widely employed.

Several writers have expressed concern that despite the emphasis in teacher education courses on 'reformist' methods of teaching mathematics, teachers revert to methods of teaching derived solely from their own experiences as students (Ball, 1994; Lampert & Ball, 1990). Others have noted that preservice teachers' experiences in classrooms during their practicum have proved inadequate because often students observe teaching 'driven by texts and tests', or are ill equipped to detect the subtle differences between quality and mediocre teaching (Mousley & Sullivan, 1995). Despite the variety of innovative and effective assessment techniques, teachers generally continue to limit their means of assessment to a narrow range of pencil-and-paper methods (NCTM, 1995; AEC, 1991).

The reasons, as we see it, stem from the belief that much of what goes on in teacher education courses involve tasks

that require students to process knowledge that is not linked to situations in which the new knowledge will be applied. Consequently, the knowledge and abilities that are learnt have little chance of transfer to real classroom situations. The problem then becomes one of creating links between what the learners know and the situations in which they plan to use it.

There are many ways in which these links can be made. It would appear that teaching practice is a useful way of enabling student teachers to apply knowledge gained from their teacher-training courses. Unfortunately, given a scenario similar to the one described above, this situation may not provide an environment where a student teacher can explore and experiment with theoretical approaches in a real context.

An environment that enables exploration can be provided by multimedia. Recent advances in computer technology allow for the storage of large amounts of data in the form of visual, audio and text formats. These formats allow for multiple perspectives and representations of ideas to be easily accessible and interactive.

The approach that we have taken is to use current theories of learning, in particular the notion of situated cognition or situated learning, as a framework for designing interactive multimedia that allows student teachers to become not only aware of different assessment strategies in mathematics education, but also to gain the conditional knowledge of when it is appropriate to apply them in the real context of the classroom.

Situated cognition

Until the invention of schools, nearly all formal knowledge and skill was transferred through apprenticeships (Collins, 1988). Agricultural skills, trades, medicine, law and the arts were all taught by the master who handed on the required skills to the apprentice (Collins, Brown, & Newman, 1989). In the mid-to-late nineteen eighties, teachers and researchers in education began to investigate the notion of apprenticeships and to try to distinguish those characteristics which were critical to its success. Their aim was to begin the process of developing a theoretical perspective for successful learning based on the apprenticeship model, that cognitive science had, to date, not been able to explain.

Brown, Collins and Duguid (1989) were the first to use the ideas to produce a proposal for a model of instruction that has implications for classroom practice. Their theory was first expounded in the article: 'Situated cognition and the culture of learning' which appeared in the Educational Researcher in 1989. Collins (1988) defines situated learning as: 'the notion of learning knowledge and skills in contexts that reflect the way the knowledge will be useful in real life' (p.2). In proposing their model of situated cognition, Brown et al. (1989) argue that meaningful learning will only take place if it is embedded in the social and physical context within which it will be used. A critical aspect of the situated learning model is the notion of the apprentice observing the 'community of practice'. Lave and Wenger (1991) proposed that participation in a culture of practice can, in the first instance, be observation from the boundary or 'legitimate peripheral participation'. As learning and involvement in the culture increase, the participant moves from the role of observer to fully functioning agent.

McLellan (1994) summarises the key components of the situated learning model as: apprenticeship, collaboration, reflection, coaching, multiple practice, and articulation of learning skills (p. 7). However, the model is constantly evolving and recent contributions of various theorists and researchers, including the original authors of the model, have expanded and refined the notion to a much more comprehensive and far-reaching framework for classroom application. Many of these authors and theorists believe that useable knowledge is best gained in learning environments which feature the following characteristics (Herrington & Oliver, 1995):

- Authentic context that allows for the natural complexity of the real world
- Authentic activities
- Access to expert performances and the modelling of processes
- Multiple roles and perspectives
- Collaboration to support the cooperative construction of knowledge
- Coaching and scaffolding which provides the skills, strategies and links that the students are initially unable to provide to complete the task

- Reflection to enable abstractions to be formed
- Articulation to enable tacit knowledge to be made explicit
- Integrated assessment of learning within the tasks.

As such, situated learning has implications not only for classroom practice, but also for the design of interactive multimedia. These characteristics have been incorporated into a multimedia program designed to provide a situated learning context in which students can investigate assessment strategies in mathematics education.

Design and production of the interactive multimedia package

The package consists of the following elements:

1. A CD-ROM on the issue of assessment in mathematics education. The disc consists of an instructional shell through which preservice and inservice teachers can interact with:
    - Video clips of teachers using various assessment techniques within their classrooms, with original sound
    - Video clips of teachers reflecting and discussing the merits of their approach
    - Video clips of children discussing their feelings and thoughts
    - Interviews with experts in the field providing theoretical perspectives
    - Reflections by student teachers on the assessment approach
    - Text descriptions of each assessment categories
    - Teacher and student work samples
    - A problem-based notebook which provides a variety of challenging tasks within which to examine the resource
2. An instruction book for facilitators on how to use and implement the resource.

Users of the interactive multimedia package are able to pursue their own investigations of the resource, and examine 20-25 assessment strategies from a variety of perspectives: the classroom interaction, the teacher's decision-making processes, the child's thinking, expert opinion and written documentation. A short video sequence of 1-2 minutes of the assessment example is available, supplemented with a video of the teacher's reflections on the use of the assessment type, and a video of a student's thoughts on the task (if appropriate). A transcript of an interview with a mathematics education expert is also available, as well as a description and discussion of the strategy, a comment from a preservice teacher, and scanned examples of any samples of students' work. The interface of the interactive multimedia program resembles a classroom with videos, text and other elements accessible through clickable images (see Figure 1 below).

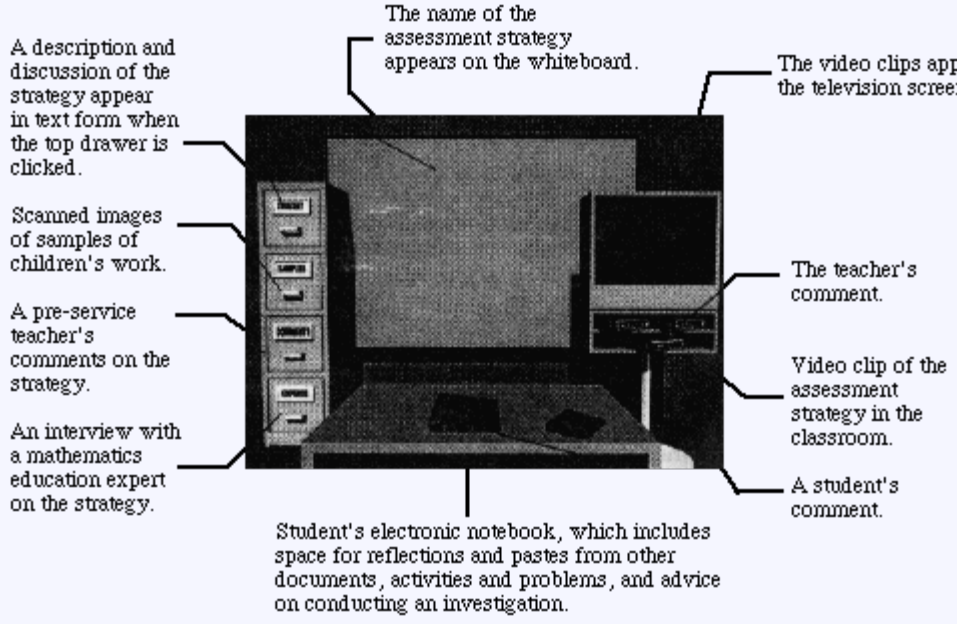

Figure 1: Interface of the multimedia program

The instruction book for facilitators suggests ways that the resource can be used and advises on the role of the lecturer. A number of challenging activities are provided which enable students to make an initial exploration into the package. The package is not designed for students to progress in a linear fashion, but attempts to stimulate students' to ask their own questions and instigate their own investigations.

The assessment strategies

Assessment strategies were identified from the literature and discussions with colleagues. The strategies included on the disc are:

- ✔ Checklists
- ✔ Oral reports
- ✔ Portfolios
- ✔ Problem solving test
- ✔ Multiple choice test
- ✔ Projective assessment
- ✔ Newman Error analysis
- ✔ Oral Questioning: fact recall
- ✔ Attitude test
- ✔ Anecdotal records
- ✔ Written report, eg., project or investigation
- ✔ Pencil and paper test
- ✔ Practical test
- ✔ Self assessment through journals
- ✔ Interviewing or conferencing
- ✔ Oral Questioning: higher order
- ✔ Using open-ended questions
- ✔ Students writing their own questions

These strategies are grouped within broader categories of assessment such as teacher observations, teacher questioning, testing, interviewing, student reporting and student self assessment.

Filming the video scenes

The video clips were filmed in K-12 classroom in Perth and show a range of public and private schools, male and female teachers. All the teachers involved in the project had sufficient experience with the assessment techniques enabling them to adequately model the techniques with their students and provide practical and thoughtful reflections on their use. All teachers and students completed consent forms and copyright clearance for any materials that had been used in the filming.

Twelve mornings were scheduled in eleven different schools to videotape the central video scenes of the assessment types in the classroom. The video recordings of the teachers' and students' comments also needed to be taped immediately after the video so that their thoughts on the task were fresh in their minds. If any materials were integral to the scene they were collected for scanning.

The video equipment was minimal, consisting of a betacam camera, a tripod, three lights and a portable microphone. The crew consisted of two people: the video producer and a sound recordist. The video sequences were filmed in the teacher's normal classroom, but some reorganisation was often required for the teacher to retain the same room for the whole morning. The scenes were shot and edited in most cases within a week of filming.

Technical considerations

The development of a multimedia program containing a large number of discrete media elements posed a series of technical problems which needed to be addressed at the design and development stage. The ideal delivery medium for a program of this nature was judged to be CD-ROM. Network delivery could not be considered due to the high data transfer rates required for the effective display of the video media elements. The program itself would require a large memory store for the many Quicktime movies and graphical images involved. In fact, the program requirements could easily have exceeded the 650 Mbyte storage capacity of a CD-ROM. The large number of video sequences created the

need for careful planning of appropriate media elements to ensure that the finished product did not exceed the capacity of the CD-ROM. For example, some planned audio files were replaced by text facsimiles to reduce the storage demands.

At the same time, the project needed to consider the advantages of a dual-platform delivery system. While the initial programming and graphics design was to be carried out using a Macintosh system, we recognised that in some instances, potential users may wish to use the program on other platforms. It was recognised that developing a dual platform product would increase its potential use and application beyond the immediate setting. A decision was taken to apply standard programming techniques and to use processes and extensions in the development that were compatible with cross platform delivery.

Conclusion

Freeman (1995) states that in order to understand classroom practice 'it is imperative to examine how participants - teachers, students, parents and others involved in schools and classrooms - construe their worlds, the action they take and the way they explain those actions to themselves and others' (p. 581). The interactive multimedia package described in this paper goes some way towards providing perspectives on mathematics education that may provide students with the confidence to implement approaches that are appropriate for assessing the range of outcomes that are valued in the learning of mathematics.

References

Australian Education Council (1991). *A national statement on mathematics for Australian schools*. Carlton, Vic: Author.

Ball, D. L. (1994, April). Mathematics and teaching through hypermedia. Paper presented at the 72nd Annual Meeting of the National Council of Teachers of Mathematics, Indianapolis.

Brown, J. S., Collins, A. & Duguid, P. (1989). Situated cognition and the culture of learning. *Educational Researcher*, 18(1), 32-42.

Collins, A. (1988). *Cognitive apprenticeship and instructional technology* (Technical Report No. 6899). BBN Labs Inc., Cambridge, MA.

Collins, A., Brown, J. S. & Newman, S.E. (1989). Cognitive apprenticeship: Teaching the crafts of reading, writing, and mathematics. In L. B. Resnick (Ed.), *Knowing, learning and instruction: Essays in honour of Robert Glaser*, pp. 453-494. Hillsdale, NJ: LEA.

Freeman, D. (1995). Asking 'good' questions: Perspectives from qualitative research on practice, knowledge, and understanding in teacher education. *Tesol Quarterly*, 29(3), 581-585.

Herrington, J. & Oliver, R. (1995). Critical characteristics of situated learning: Implications for the instructional design of multimedia. In J. Pearce & A. Ellis (Eds.), *Learning with technology*, pp. 253-262. Parkville, Vic: University of Melbourne.

Lampert, M. & Ball, D. L. (1990). *Using hypermedia technology to support a new pedagogy of teacher education*. (Issue paper 90-5). National Center for Research on Teacher Education.

Lave, J. & Wenger, E. (1991). *Situated learning: Legitimate peripheral participation*. Cambridge: Cambridge University Press.

McLellan, H. (1994). Situated learning: Continuing the conversation. *Educational Technology*, 34(10), 7-8.

Mousley, J. & Sullivan, P. (1995). *Learning about teaching*. Geelong: Deakin University: ACU.

National Council of Teachers of Mathematics (1995). *Assessment standards for school mathematics*. Reston, VA: Author.

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