

Identifying Teacher Education Students' Views of Quality Mathematics Teaching

Peter Sullivan
Australian Catholic University

Judith Mousley
Deakin University

This report arises from a project which uses an interactive multimedia resource to support learning about teaching mathematics. As one of a range of data collection instruments, pre-service teacher education students completed a card sorting task (using Q sort technique) before and after using the resource. The technique provided data to supplement other more general qualitative data. Results indicate that use of the resource helped focus students' attention on some key characteristics of quality mathematics teaching, and that the instrument was useful as one of a range of sources for qualitative data.

Learning About Teaching From the Study of Particular Examples

Initial education students bring to their courses a wealth of experience and some firm ideas about what good teachers do. It is necessary for teacher educators not only to build on those experiences but also to stimulate critical reflection on them. Discussion of abstract concepts and generalisations or the presentation of theories in the absence of practical contexts may simply result in the reinforcement of pre-conceptions about teaching. The basic proposition which underlies this project, of which this report is a part, is that the study of particular exemplars of quality practice can both stimulate reflection on key components of teaching and allow prior conceptions to be challenged.

In 1995, pre-service students used an interactive multimedia (IMM) resource to observe and analyse teaching exemplars. This was a work requirement of a second year undergraduate course on the study of mathematics teaching. Interaction with the resource was in small groups, for approximately 20 hours. Study and discussion of particular cases were used to prepare the students for, and to supplement, practicum experience. Merseth and Lacey (1993) suggest that the use of teaching exemplars in this way can develop skills of critical analysis and problem solving, can represent the complexity of teaching situations, can foster multiple perspectives and levels of analysis, and can offer students opportunity to engage directly in their own education. The course of study also included more conventional components such as reviews of the literature, lectures, and tutorials on aspects of mathematics teaching.

Prior to the development of the IMM resource, this project identified and developed a framework for describing elements of quality teaching. It used analysis of recent literature and a survey of 200 practitioners, teacher educators and other education professionals from several countries (Sullivan & Mousley, 1994). Full lessons which exemplified the components of quality teaching were partially scripted, then taught and videotaped. These tapes were examined using several techniques, including a qualitative analysis of unstructured reviews of the lessons by over 30 experienced teacher educators (see Mousley, Sullivan, & Gervasoni, 1994), then transferred to CD-ROM disc. An IMM-computer environment was authored to provide flexible access to all aspects of the lessons.

Merseth and Lacey (1993) argue that the potential of multimedia includes the possibility of introducing the complexity of teaching to novices, and that the non linear capability distinguishes multimedia from conventional videotape since they allow the use of multiple perspectives and opportunities to review situations. The IMM resource under study includes videotapes of a mathematics lesson, other video records such as pre and post lesson interviews with the teachers, procedural documents and readings associated

with the lessons, graphic representations of data, and other appropriate resources. It is an extensive information bank which can be accessed in flexible ways to support detailed classroom observation and analysis. Indexing and the interactive nature of the program allow scenarios to be accessed and linked to other data, enabling users to focus on specific teaching skills, moments of interaction, selected sets of incidents, sequences of events, links between written theory and action, and so on.

The larger project aims to evaluate the effectiveness of this approach in stimulating analysis of aspects of teaching. In 1995, data were sought through structured survey items, the writing of lesson critiques, responses to formulated scenarios, unstructured interview items, observation of students' interactions with each other and with the program as they worked, journals maintained throughout the process, and reflective essays written after the completion of the program.

This paper presents the results for one particular instrument and discusses both the results and the effectiveness of the instrument.

Identifying Teacher Education Students' Views of Quality Mathematics Teaching

The particular research tool reported here—a card sort—was used to provide some fixed data about beliefs of the student teachers prior to their interaction with the IMM resource and after their use of the resource. The procedure used was an adaptation of the Q-sort technique (Sax, 1979; Best & Kahn, 1986) which had been structured for intensive work with few persons. In this process, statements are written on cards and respondents are asked to place each card, in piles, along an 11 point linear scale from a strong negative to strong positive response. A variation on this procedure was used by Peltó (1970), who asked his subjects to arrange factors written on cards in a priority order, to determine the most influential member of a community. He then sought explanations on the reasons for such a choice of rankings. The sorting of factors written on cards has also been used to determine extremes for a semantic differential instrument (Clarke, 1989).

The advantages of using a similar procedure for this investigation were that:

- a) the presented factors or components could be determined by teacher education students themselves, to maximise the understandability and communicability of the terminology;
- b) it facilitated the arrangement and ranking of factors more readily than could be done with a written list;
- c) it allowed the inclusion of various components from the investigation and to test, by non-inclusion, least important components ;
- d) in addition to ranking, it allowed the subjects to distinguish between ranks; and
- e) it facilitated comparisons of the perceived components prior to interactions with the resource with those after interactions with the resource.

The first step was to conduct interviews with teacher education students who were similar in background to the subjects of the study. They were asked to indicate what factors they saw as the features of quality teaching. Some of these students were interviewed in small groups, others were interviewed individually. The ideas presented by the students were separated into discrete categories and recorded.

Independently of this process, the researchers themselves determined a number of factors and wrote these down in separate categories. These factors included points identified in the original survey of teacher educators and used as a basis for the development of the IMM resource. From these collective ideas a single set of cards was prepared, each of which showed one factor seen as a key feature of quality teaching.

These cards were presented to the students during an interview which was seeking views of components of quality teaching through a range of question types. The purpose of the cards was explained to the students, as was the source of the factors contained on the cards. The students were asked to arrange the cards in order, from most important to

least important. They were told it was possible to have equal placings. After they had arranged the cards in order, they were asked to indicate a point below which the cards were of very little or no significance to them. These cards were then separated out. The students were then asked to explain their understanding of the top five cards in their list, and also to indicate what influenced them to choose those five cards in particular.

The descriptors on the cards used were as follows:

control and management	monitoring student understanding
communicate with students on their own level	flexibility
discipline	meaningful and relevant
good communication skills	telling children on what they are being assessed
good organisation	creativity
getting the children to think for themselves	providing clear work examples for the c'n to copy
respect needs of children	lesson fun for students
inspire children to create and succeed	confident, caring, but strict
variety	catering for all abilities
clear explanations of what to do	ability to develop rapport with students
saying children's names when asking questions	approachability
honesty	encouragement
open body language	

Figure 1: *Factors used as the basis of the Q-Sort technique*

The main purpose of collecting data in this way was to provide a foundational base against which other data collected in response to more open-ended items could be established and verified. It also allowed comparison between the subjects and appreciation of the significance of each of the factors whether determined through open-ended type responses or through structured instruments, such as this one. A further use of the instrument was to try to obtain more substantive basic data which could be compared both prior to, and subsequent to, interactions with the resource. The intention of this structured data collection was to both enrich and triangulate data sought on unstructured items. It is certainly not suggested that such instruments be used on their own, but only to the extent that they support other data. One advantage of using the cards in this way is that it provides a meaningful prompt for the subjects and it also allows more substantial links to be made between what the subjects believe to be key factors and the terminology used by the researchers.

In the project overall, ten undergraduate teacher education students used the IMM resource as a trial group, and were the focus of the study. For this instrument data from only eight students are available. One student did not rank the cards ("They are all important") and merely sorted the cards into categories. One other student had one component of the data missing and so their data are not included in the analysis.

In order to convey the type of data available and the results themselves, the results from four of the eight available data sets are presented in Tables 1 and 2. The data presented are from the interview prior to interaction with the resource, and also from the interview after completion of the resource but prior to teaching practice. The highest ten ranked cards are listed in each case. Dot points (•) are used to indicate cards which were given a particular rank. A forward slash (/) is used to indicate cards which are assigned equivalent ranks. Also presented are the explanations given to the interviewer on the meaning of some of these cards and the justification for their selection. The cards which were not ranked in the top ten cards prior to the interactions but were included after the interaction with the resource are shown in italics.

Table 1: Responses of students N and M to the Q-Sort technique

	N	M
Pre interaction factors	<ul style="list-style-type: none"> • Inspire students to create and succeed / Control and management / Good organization / Catering for all abilities / Getting the children to think for themselves • Meaningful and relevant / Good communication skills / Discipline / Encouragement / Creativity / Respect needs of children 	<ul style="list-style-type: none"> • Clear explanations of what to do • Good organization • Encouragement • Variety / Flexibility • Good communication skills • Providing clear worked examples for the children to copy • Getting the children to think for themselves • Meaningful and relevant • Communicate with students on their own level
Explanation of pre interaction factors	<p>Well the whole point of kids being at school is to 'inspire' them. You've got to be able to 'manage and control' them, 'good organization' and 'cater for their abilities' so they're going to be 'inspired to create and succeed'. So they're ... not going to turn around and get to high school and say I hate school ... So sort of 'cater for their abilities' but, and 'getting them to think for themselves' because that's the whole point, I mean they're not going to learn if you're just going to get up there and tell them everything.</p>	<p>Clear explanation of what the children are to do' because I feel that if they haven't got that then they get confused and frustrated and, ah, they won't do as well in the lesson.</p> <p>Ah, 'organization' ... because you're more confident, you know what to do, and that shows to the children.</p> <p>Encouragement, because once you encourage a child if they answer a question correctly you praise them and then they feel good about themselves and they're more likely to respond again.</p>
Post interaction factors	<ul style="list-style-type: none"> • Monitoring student understanding / Good communication skills / Encouragement / • Catering for all abilities / Good organization / Flexibility / Control and management / Meaningful and relevant / Creativity / Getting the children to think for themselves / Clear explanations of what to do / Open body language 	<ul style="list-style-type: none"> • Good organization • Clear explanations of what to do / Getting the children to think for themselves • Variety • Catering for all abilities / Monitoring student understanding • Meaningful and relevant • Communicate with students on their own level / Good communication skills • Encouragement / Inspire students to create and succeed
Explanation of post interaction factors	<p>'Monitoring student understanding' . That's evaluating what was taught and also evaluating how you have taught it.</p> <p>'Getting children to think for themselves', ... they are there to think for themselves. ... if they think for themselves it shows they have an understanding of what is going on.</p> <p>'Clear explanation of what to do', .. she or he can understand what they're teaching.</p> <p>'Flexibility', ... being able to change the lesson if it's going on the wrong track.</p>	<p>On my first teaching round I found that the lessons that were organised and that I had spent time on were definitely a lot more successful than the ones I had planned the night before or the recess before.</p> <p>And again, if you're organised you are able to give 'clear explanations to the children of what you expect of them' and that helps them because then they're not confused and all that.</p> <p>'Variety' so they don't get bored and restless with the lesson.</p>

Table 2: Responses of students A and K to the Q-Sort technique

	A	K
Pre interaction factors	<ul style="list-style-type: none"> • Catering for all abilities / Encouragement • Good organization / Lesson fun for students / Flexibility • Clear explanations of what to do / Providing clear worked examples for the children to copy / Open body language • Meaningful and relevant / variety / creativity / honesty 	<ul style="list-style-type: none"> • Lesson fun for students / Variety / Good organisation / Creativity • Good communication skills / Confident, caring but strict / Communicate with student on their own level / Catering for all abilities • Honesty / Encouragement / Providing clear worked examples for the children to copy • Meaningful and relevant / Clear explanations of what to do
Explanation of pre interaction factors	<p>Well, 'catering for all abilities' means that you can't have a lesson where some students find it really easy and they can just breeze through it, and others find it really hard. 'Good organization', I think that's just planning everything, having a developed plan, just so you know what you're talking about.</p> <p>'Lesson fun for students', ah, they're not going to enjoy it if they have to just sit there and take notes, ...</p> <p>And with 'flexibility', like, just say you're catering for all abilities. You've got to be able to not just stick to the one thing, you've got to be able to plan for the students who are good and for the students who may not finish as quickly.</p>	<p>Lesson fun for students so that they've got interesting lessons.</p> <p>'Variety' so that they're not doing the same old boring lesson everyday like for maths, not doing tables or multiplication or that.</p> <p>Ah, 'good organisation', so that I'm organised, the teacher's organised and knows exactly how it's going to shape out so she answers any questions and she's able to work through it.</p> <p>'Creativity', making the lesson fun and exciting.</p> <p>And, 'catering for all abilities' not just going after the high level ability in your class, catering for everybody, of every level.</p>
Post interaction factors	<ul style="list-style-type: none"> • Good organization / Good communication skills • Getting the children to think for themselves / Clear explanations of what to do / Providing clear worked examples for the children to copy • Creativity / Variety / Control and Management / Respect needs of children / • Catering for all abilities 	<ul style="list-style-type: none"> • Catering for all abilities / Meaningful and relevant / Getting the children to think for themselves • Variety / Flexibility / Lesson fun for students / Good organisation / Good communication skills / Communicate with students on their own level • Encouragement / Monitoring student understanding / Inspire students to create and succeed
Explanation of post interaction factors	<p>'Good organisation' means that you are well prepared for class. And you know what you are talking about and so that ties in with 'good communication skills' so you can teach the students clearly. 'Getting students to think for themselves' means that you are not up there just to dictate to them, you have got to allow them to basically think for themselves, to work it out, without just giving them the answers all the time. 'Clear explanations of what to do' so the children know what they have to do so you are all sure of that. And 'providing clear worked examples for the children to copy' they can, the teacher can do one or two so the children know how to set it out and how to go about working it out, but then they can do them for themselves.</p>	<p>'Catering for all abilities' so you provide the lesson so that you've got the 'slow' ones and the 'strong' ones.</p> <p>'Meaningful and relevant', again, so that they think it has purpose. That you are not just saying it and then forget it.</p> <p>'Getting the children to think for themselves' so that they feel that they are involved in the lesson, so that their lessons they have got to provide the answers to the questions.</p> <p>'Communication on their own level' so that you are not talking above them, so that they are able to understand.</p> <p>'Good organisation', you don't, so that when you get in the class, you don't want to have to be running backwards and forwards, and losing all the children.</p>

Space does not allow full presentation of the data, but these are a fair indication of the results overall. The following discussion refers to the information from all eight subjects.

One advantage of collecting data in this way is that it is possible to formulate overall impressions of the beliefs of the subjects. It is clear that considerable care should be exercised before generalising from this group to any other, and indeed that is not the intention of the subsequent analysis. It is also recognised that the numbers of participants is relatively small. However, a summary of the data as a whole gives insights into both the beliefs of these students and impact of the resource.

There was a somewhat unexpected commonality in the responses prior to any interaction with the resource, which also happened to be prior to any teacher education studies. The students had predominantly studied only units in the discipline major and minors up to this phase of their course.

Table 3 presents those cards which were selected by at least half of the students before and after the interactions with the resource.

Table 3: Common factors selected by the students

Factor	Pre	Post
catering for all abilities	5	7
clear explanations of what to do	5	5
control and management	5	4
creativity	7	5
encouragement	7	6
getting children to think for themselves	4	6
good communication skills	4	6
good organisation	8	8
inspire children to create and succeed	5	4
meaningful and relevant	5	4
variety	5	4

One impression gained is that there is stability and indeed good sense in this ranking of factors prior to any teacher education studies. Not only was the list of factors, predominantly suggested by such students themselves, both comprehensive and meaningful, but the ranking of the factors overall is compatible with what we might expect that experienced practitioners might believe. Even though these beginning teacher education students have significant experience with classroom teaching, these experiences may well be generally productive and oriented toward a desirable teaching ethos.

A further impression is that even after significant student-focussed input, there was little change to individual students' impressions as well as students' impressions overall. To the extent that there was a change, this was in a direction compatible with the goals of the resource. The cards which were selected after interaction with the resource, but not beforehand, by more than one student were *Clear explanations of what to do* (by 3 students), *Getting children to think for themselves* (3), *Communicating with students on their own level* (2), *Discipline* (2), *Flexibility* (2), *Good communication skills* (2), and *Open body language* (2). To the extent that there has been a change, it has been in the direction of a focus towards clarity and good communication and also towards getting the children to think for themselves. As it happens in the lesson presented in the resource the teacher explains clearly what the students should be doing, and communicates effectively with the children.

One apparently contradictory point is that a good number of the students selected both *Giving clear explanations* and *Getting the children to think for themselves* among their factors. In the lesson illustrated in the IMM program, the teacher pays particular attention to the clarity of the instructions about the processes which the children should follow while working in groups, deciding how to record their answers and

communicating their findings. However, the teacher does not tell the children how to do any of the mathematics. In other words she makes it clear that mathematically they need to think for themselves, but she provide them ample support on procedural matters.

It is interesting to examine which cards were never or only seldom selected. *Telling children on what they are being assessed*, and *Saying children's names when asking questions* were selected by nobody either before or after. Only one student selected *Monitoring student understanding* and *Open body language*. before using the resource. Afterwards only one selected *Ability to develop rapport with students*, *Confident and caring but strict*, and *Honesty*.

Summary

There were two components to the use of this technique in this way. One was to examine the impact of the multimedia resource via the responses of students to this card sort. It appeared that these teacher education students had well formed views of the task of teaching at the start of their course. These views were generally appropriate, but it illustrates that the task of challenging rather than merely reproducing or reinforcing the status quo is complex and developmental. Because the resource engages the students directly in reflection on, and discussion of, specific examples of teaching, it has the potential to foster this longer term consideration of teaching processes by the students themselves.

It seems from these data that student teacher's beliefs about the important components of teaching are stable. To the extent that there was a trend in the changes in beliefs observed, the influence seems to have been in the desired direction of good communication and the transferring of responsibility for learning to the students themselves.

A second purpose of this paper was to examine the use of such an instrument as a data collection tool. It seems that it is an effective tool that could be used to support other qualitative data. It is certainly not argued that such a tool should be used by itself for data collection. However, it does make a meaningful contribution to qualitative research which can facilitate the sharing of research results with readers. In the case here, readers are invited to form their own impressions of the significance of the cards which we used, and readers can gain some insights into the meaning attributed to the cards by the subjects of the study. Given that these aspects of the data are presented and clear, readers can interpret these data in the light of their own background, or in the light of teacher education students with whom they may be familiar. In this case the data provide a substantive base for communication, which can be used as a baseline for discussion of other, less directed qualitative data.

It seems that the cart-sort technique is worth trialing further as a tool for investigating students' beliefs about teaching and learning, as well as how they might change as a result of a particular learning experience.

References

- Barnett, C. (1991, Apr.). *Case Methods: A promising vehicle for expanding the pedagogical knowledge base in mathematics*. Paper presented at the annual meeting of the American Educational Research Association, Chicago.
- Best, J., & Kahn, J. V. (1986). *Research in education*. New Jersey: Prentice Hall.
- Carlson, H. L., & Falk, D. R. (1991). Effectiveness of interactive videodisc instructional programs in elementary teacher education. *Journal of Educational Technology Systems*, 19 (2), 151-63.
- Dgasy, G. (1991). A comparison of methods for providing evaluative feedback to practicum students on segments of teaching. *Proceedings of the Rural Education Symposium* (pp. 77-89) Nashville: Association for Rural Education.

- Jacobson, L., & Hafner, L. R. (1991, June). *Using interactive videodisc technology to enhance assessor training*. Paper presented to the annual conference of the International Personnel Management Association Assessment Council, Chicago.
- Lortie, D. C. (1975). *School teacher: A sociological study*. Chicago: University of Chicago Press.
- Merseth, K. K., & Lacey, C. A. (1993). Weaving stronger fabric: The pedagogical promise of hypermedia and case methods in teacher education. *Teacher and Teacher Education*, 9(3), 283-299.
- Mousley, J., & Clements, M. A. (1990). The culture of mathematics classrooms. In M. A. Clements (Ed.) *Whither mathematics?* (pp. 397-406) Melbourne: Mathematical Association of Victoria.
- Mousley, J., Sullivan, P., & Clements, M. A. (1991). Student teachers' perceptions of the way mathematics is taught in their teaching practice schools. In *Proceedings of the 1991 conference of the Mathematics Education Lecturers' Association*. Perth: MELA.
- Mousley, J., Sullivan, P., & Gervasoni, A. (1994). The analysis of teaching: Constraints in lesson description and critique. In G. Bell, B. Wright, N. Leeson, & J. Geake (Eds.), *Challenges in mathematics education: Constraints on construction* (pp. 437-444). Lismore: Mathematics Education Research Group of Australia.
- Pape, S., & McIntyre, D. J. (February, 1992). *Utilising video protocols to enhance teacher reflective thinking*. Paper presented at the annual meeting of The Association of Teacher Educators, Orlando.
- Sullivan, P., & Mousley, J. (1994). Quality mathematics teaching: Describing some key components. *Mathematics Education Research Journal*, 6 (1), 4-22.
- Sax, G. (1979). *Foundations of Educational Research*. New Jersey: Prentice Hall.
- Widen W. C., & Roth, G. L. (1992). Instructional technologies in the workforce. *Journal of Industrial Teacher Education*, 29 (2) 65-85.