Mathematics Teacher Education and Development 1999, Vol. 1, 72-83

Student Constructed Posters: A Tool for Learning and Assessment in Preservice Mathematics Education

Robyn Zevenbergen
Griffith University

This paper reports on the implementation of a four-year project exploring effective and alternative assessment items in a primary mathematics education course. The paper provides a rationale for using posters in preservice education, then discusses the development of criteria for effective posters. It concludes with practical recommendations for the implementation of posters for assessment.

In the current context of teacher education, there is increasing pressure on teacher educators to do more with less, greater accountability, and increasing pressure from employing authorities to produce graduates with desired qualities. The need for practices which produce and document learning outcomes is highly desired. This paper documents a four-year project aimed at developing assessment practices which are sustainable – both practically and economically – and meet the demands of the University, academics, students and employers. The focus of this paper is the evolution of student constructed posters in a preservice mathematics education course where the aim was to have successful assessment tools to document student learning and to provide a tool for effective teacher preparation.

Background Context

In many countries, higher education has come under increasing challenge to ensure a high degree of personal transferability of skills from the university to the workplace (Stefani, 1994). Teacher education is not divorced from this movement and there is increasing pressure on higher education regarding the perceived poor preparation of teachers. In some countries, this has resulted in substantive changes in initial teacher preparation. Overall, such challenges are the results of employer groups who demand teacher education facilities be accountable for producing the teacher characteristics demanded by such employing authorities. In concert with these challenges are the changes within higher education where shrinking resources have forced substantial reductions in the number of staff employed in the sector, large classes and practices driven by economic imperatives rather than pedagogic ones. To this end, there is increasing pressure on teacher education staff to embrace practices which are sustainable yet produce teachers who are seen to have the characteristics desired by employer groups.

Within mathematics teacher education, this is critical given the need to expose students to practices that challenge many of the taken-for-granted practices dominating classroom life. By exposing students to the economically-driven practices of teacher education – namely large classes, with teacher-dominated expositions (i.e., the lecture) and pencil-and-paper testing – students are positioned

within practices that legitimate the more traditional forms of pedagogy and assessment which have dominated past practices in mathematics. In most cases, however, preservice mathematics education attempts to challenge the practices of the past and introduce new models of assessment. However, such practices are in danger of being ideologically over-ridden by the actual assessment regimes adopted within a preservice course. Hence, what is called for are assessment practices which are economically and practically sustainable and expose preservice mathematics teachers to exemplary practices. In so doing, such practices challenge widely-held, conservative beliefs and practices.

In this context, it is essential to develop practices which are sustainable and produce desired learning outcomes for preservice teachers. This paper reports on a project which had three very distinct aims:

(a) to develop skills in preservice teachers which enable them to produce stimulating resources for their students,
(b) to develop the assessment skills of preservice teachers, and
(c) to develop effective and innovative assessment tools within mathematics preservice teacher education.

These aims are undertaken within a context of shrinking resources and increasing workloads and as such, it is an overarching principle that the practice must be manageable and sustainable within such a work environment. This is particularly the case in teacher education where exemplary teaching and assessment practices must be modelled to prospective teachers.

Posters in Higher Education

Posters are a legitimate form of communication in professional arenas. They are valid forums for communication in conferences where short statements of research are expected. They offer a medium that stimulates concise communication and discussion. Gore and Camp (1987) and Baird (1991) have adopted the conference format in their undergraduate psychology courses with great success in terms of both student learning and enjoyment. Posters have been used across a range of disciplines including mathematics (Berry & Houston, 1995), psychology (Gore & Camp, 1987), nurse education (Fowles, 1992; Sorensen & Boland, 1991), and chemistry (Kennedy, 1985). Where students have undertaken posters as a component of their assessment, it has been reported that they have a greater retention in the areas of their poster topic when performance is measured on examinations (Lowry, 1992).

Posters are an excellent medium for developing communication skills particularly where short and concise communication is needed. This is of particular value in teacher education where teachers must be able to communicate across a ranges of mediums so as to include the various learning styles of students in their classrooms. Of even more importance, is that posters offer the potential for teachers to communicate knowledge in forms which differ substantially from the dominant modes of communication. In mathematics, this is typically expository talk dominated by the teacher. Increasingly, it is obvious that such a teaching style does not cater for the diversity across classrooms. The short pithy statements conveyed

through the poster may entice some learners to become involved in the active learning process. Similarly, visual learners are more likely to be stimulated by well-constructed posters, and hence, motivated to learn.

Where posters have been developed in concert with other assessment techniques such as peer assessment (Zevenbergen, forthcoming; Freeman, 1995), students can be active participants in the assessment procedures. For teacher education students, this experience is invaluable in their professional development due to their restricted access to authentic assessment practices within the confines of the university. The practice of peer assessment of posters aids in learning more about the topic chosen by the student; more about other topics chosen by other students; and more about poster construction.

Berry and Houston (1995) found that posters promoted a very positive attitude in their students. They contend that this is due to the challenge to present work succinctly and the different medium for presentation as opposed to the more traditional forms of assessment used in their mathematics courses. They found that the posters stimulated a great deal of productive debate among the students. This they suggest was potentially due to the less formal settings in poster assessment than the formal oral presentations, thus encouraging students to communicate more effectively.

One of the potential areas of concern with the use of posters is the display of incorrect content. Not only is this threatening to the ego of the student/s whose work is on display, but may impact on the misconstruction of incorrect knowledge for those students who are not familiar nor confident with the knowledge displayed. Hence, it is suggested that discussion is an important component of the process so that misconceptions can be allayed (Berry & Houston, 1995).

In undertaking an analysis of peer assessment of various assessment items, Freeman (1995) found that where there was a high degree of subjectivity associated with marking, there was greater scope for varying interpretations of the criteria. In such cases, he strongly advocates that such pieces should be weighted lightly so as not to disadvantage students, particularly when issues of valid and reliable assessment are key components of accountability. In this case, where posters are visual displays and do have a subjective component, then it is necessary to consider how such assessment items will be weighted.

The Project

Posters were introduced into the mathematics education suite of subjects in 1995 and continue to be implemented. An action research approach to their implementation is undertaken with student feedback and focus groups at the completion of each semester. This information is fed back into consecutive implementations so that the posters are continually refined and defined.

At the current stage of the project, the poster has been defined as being "a stand-alone resource containing a maximum of 25 words (excluding heading) which can be used in the classroom" as per the subject outline. A word limit has been imposed as an outcome of the excessive use of words on posters whereby they became more like a reader's digest than a poster. A series of topics has been identified from which students select. The topics are selected on the basis of the problems often posed to preservice teachers. These include:

Area: The difference between area and perimeter
Mass: What is mass? (the difference between mass and weight)
Time: Using 24 hour clocks – representing 24 hour times
Time: Using timetables – adding and subtracting times
Space: The various types of angles [acute, obtuse, etc]
Space: Geometry on a sphere
Number: Subtraction with internal zeros
Number: Operations with fractions
Number: Equivalence of fractions
Ratio: What is the difference between ratio and fractions?
Data: Graphs – using the appropriate graphs to represent data

The current list of topics has arisen out of the students' evaluations and their expressed need for some suggestions for topics due to their early stage of professional development. Students identified that they were not conversant with the topics in mathematics education so early in their course. Topics are negotiable and students can identify other areas of study.

The intention of the poster is two-fold. In the first instance, it is to document the learning of the student. The student must display the selected concept in a concise, innovative and user-friendly manner that demonstrates the appropriate understanding of that concept. The topics are those which are often poorly understood by students and hence poorly taught. Second, through the construction of the poster, students will develop skills, techniques and knowledge about poster construction and effective communication.

A further dimension to the project has evolved, which is peer assessment. This is discussed in-depth in another paper (Zevenbergen, forthcoming), however, it is noteworthy that peer assessment has extended student learning – both in terms of the goals of the project, but also in terms of assessment. Furthermore, it has compelled students to become more critical and reflective about construction and content addressed in the posters. In the early years of the project students only constructed their own posters so their learning was restricted to the content they investigated. Although posters were displayed in common access areas, students did not examine them critically. Through the participation in peer assessment, students have gained substantially more knowledge due to the imposed need to critically reflect and evaluate their peers' posters.

The Posters

For the project to be sustainable within the workloads of the academic staff and the restricted economic conditions of the students, the project has progressively evolved whereby criteria and conditions have been developed. All of the criteria and restrictions were negotiated with students throughout the project. Each year, progressive criteria are developed with the students as they encounter aspects of poster construction and display. These will be discussed in the following sub-sections.

Topics. The posters are the first assessment item in the subject so students have not encountered a significant amount of mathematics education content. Initial

years of the project kept the topics open and students could self-select. However, they proposed the nomination of a number of key topics with scope for individual topics if so desired. This has worked satisfactorily.

Size of posters. The posters currently are to be confined to the size of an A2 sheet. This condition arose from a number of concerns. Firstly, practicality for display was a consideration. Posters which were large and cumbersome were difficult to display – their sheer weight meant that they kept falling off walls. This often resulted in posters being wrecked as they lay crumbled and tramped on in the common areas. As the posters were displayed in common areas and subsequently peer assessed, they needed to be allocated space. Where a consistent size was used, the nominated areas could be estimated and allocated. Secondly, many students assumed that bigger was better, constructing posters which were large but contained little content. Students became distressed with their marks as they believed that their posters were expensive to construct, so therefore had to be good. Furthermore, for practical purposes, as teachers, the equipment in schools (such as laminators and poster stands) will only take A2 cardboard, so it was in their best interests to learn to construct posters which matched the constraints of their future workplaces.

Durability. Restrictions on durability were imposed. As the posters were displayed in a common area – the hallways in the education building – they needed to be able to sustain abuse from other students from all Faculties across the campus. For example, a student constructed a bar graph using chocolate bars – all of which were removed and eaten by other students. When marking occurred, the poster was not of a high standard. Similarly, posters investigating probability with coins often had the coins removed. A common theme for the notion of durability was whether the poster might be laminated so as to avoid being vandalised. This aspect was agreed to be important as in the classroom, similar acts of vandalism are likely to occur. Similarly, students felt that if they put a lot of work into their posters, they would like to preserve them for later lessons on the topics.

Word limits. Restrictions on word limits have been imposed. In the initial stages of the project, no word limits were applied and the first posters were very "wordy". Students commented that such posters defeated the purpose of the posters which was seen to "convey ideas so that kids can see it easily. They don't want to stand there and read all that stuff" (Student comment, 1995).

In subsequent years, marks have been allocated for keeping the poster within the 25 word limit. This has been the source of considerable debate and, among a small group of students, great contention. For some students, they read the 25 word limit to be an essential criteria and that those who violate it should fail. Others see it as a guideline and if it is violated, then it will be considered in light of the depth of violation. This issue cannot be resolved, but I would suggest that it is a very valuable learning tool. It provides the stimulus for challenging the objectivity of "criterion-referenced marking". Even a simple criteria "no more than 25 words" provides the catalyst for lengthy and very productive discussions.

Debate has been very productive. For some students, where decorative words have been used in borders, students have been marked down by peers due to the perceived violation of the word limit. In contrast, others have considered it as

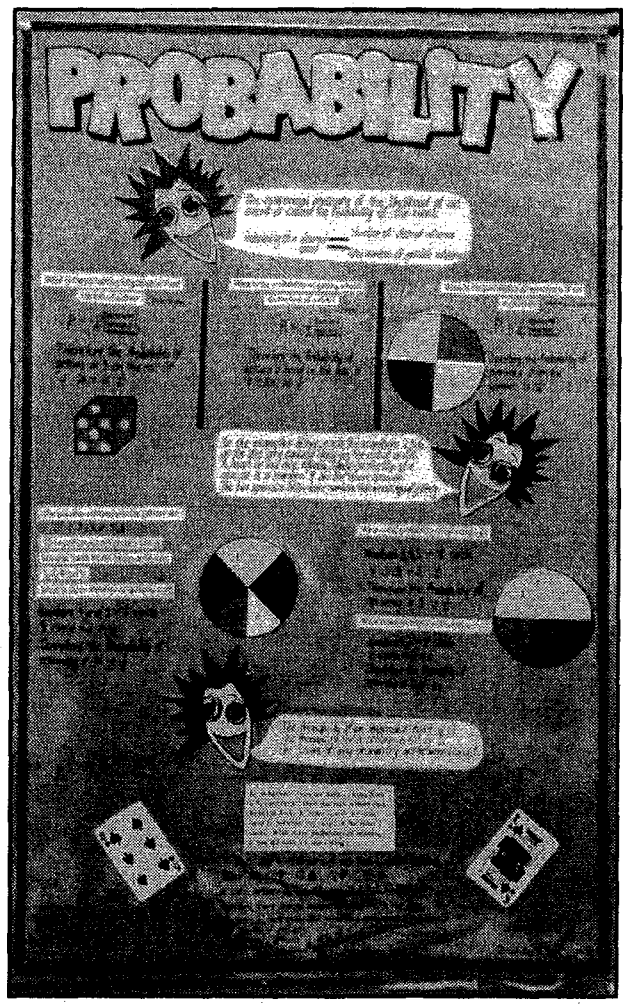

Figure 1. Wordy poster on probability.

artistic and not contributing to the substantive content of the poster and elected to give the poster full marks on this criterion. Another area of contention has centred on the means by which words are counted. In one instance, a poster had a number written in numerals and this was not counted within the word limit, whereas had the word been represented in word form, it would have been counted. The debate generated by the interpretations has been very productive in considering the subjective component of assessment and the limitations of criterion-based assessment – issues which are of importance in mathematics education.

Criteria. Criteria have been evolving over the four years of the project. Three areas for the criteria have been developed. These are related to the main objectives for the poster project – to convey mathematical concepts in a succinct and interesting format.

As the criteria have progressively evolved, they are still broad. In the initial year of the project, students complained that they did not have any models to give them ideas for their posters. In subsequent years, posters have been displayed and have provided the catalyst for discussing and negotiating criteria. This discussion in itself is very productive.

Criteria for the posters have been:

1. *Word limit:* Posters must be 25 words or less, not including the heading.
2. *Mathematical content:* Mathematical content must be correct. Content reflects an effective teaching strategy for the concept/process being addressed. Levels of content and pedagogy similar.
3. *Artistic merit:* The poster must be visually commanding- would students want to go out of their way to look at it?*Elements* to consider include the use of colour, line, shape, texture, space, and succinctness. *Principles* to consider are balance, movement, contrast, emphasis, pattern, and unity.

These criteria have remained relatively consistent for the past two years of the project, indicating their acceptance by the students as valid indicators for the assessment item. In post-project discussions, students have supported the criteria as being acceptable and manageable for them when constructing individual posters and for the subsequent peer assessment.

Students' Reactions to the Posters

The poster process is evaluated very favourably by the students. The overall evaluations provided by the students in the 1998 cohort can be seen in Table 1. From these results, it can be seen that the item is viewed very positively by the students.

The self-reported evaluations indicate that the students perceive the item to be useful in their professional development, learning about the mathematics curriculum and as a novel assessment item.

Most students value the practical component of the assessment item as it is something which can be used during their work in schools. The following comment represents the general comments made by students in this regard:

> The best thing about the posters is that we can get to use them in class. There needs to be more of this sort of assessment at Uni – stuff that we can re-use in schools. There is hardly any assessment which is useful for when we are on pracs. I have used mine and it worked really well. The teacher and kids thought it was great.

As is common among preservice teachers, the emphasis on the practical component is very strong, sometimes to the point of superseding academic aspects of teacher preparation. In this context, the poster serves the concerns of the

Table 1
Student Evaluations of Posters

Student response item	Mean score
The posters were a useful device for my professional development as a teacher.	6.2
The posters were a useful device for learning an aspect of the mathematics curriculum.	6.1
The posters were an effective and interesting assessment item.	6.3

Note. Scores are on likert scale from 1 to 7 where 1 is strongly disagree and 7 is strongly agree.

students and the teaching profession about the lack of links with the practical components of teaching.

Students were also given the opportunity through other forums to express their reactions to the project. Consistently, the evaluations have shown very favourable responses, indicating that the students enjoy and learn from the process (see Table 1), even more so, since the implementation of peer assessment where there is the compulsion to critically examine other posters. In so doing, students are exposed to a broader array of topics and posters which further develops their knowledge about poster construction and mathematics education.

The posters provide evidence of learning in the nominated area chosen. The peer assessment of the posters also provides further evidence of students' understanding of the concepts, poster construction and mathematics education. This is apparent in their feedback comments on the peer assessment. For example, where students have commented critically on incorrect information or poor poster construction, there is further evidence of their understanding. In some cases, students become very familiar with the syllabus documents and comment on the effectiveness of posters for their target group due to the degree of compatibility of the poster with the interests of the students. For example, one student was examining 24 hour clocks and chose Cinderella as the theme for the poster, but another student suggested that this was inappropriate for the upper primary. According to syllabus documents, this is when the concept was most likely to be introduced. She suggested that the poster was not effective on the basis of gender exclusion (boys would not be interested in this story) and that the concept was complex and by the time it would be introduced, most students would not be interested in fairy stories.

In contrast, another student looked at the difference between mass and weight and used Homer Simpson as the focus of a poster. The student had Homer eating doughnuts and weighing less on the moon, and claiming that he could eat even more doughnuts. Peer evaluations of this poster were very favourable and they argued that the use of the Simpsons and Homer's obsession with doughnuts was a very useful tool for helping students with the concept. Most children encountering this concept would have been watching, or knew of, the Simpsons.

The synthesising of content, syllabus frameworks, and target students' interest was an important aspect of mathematics teaching. Through the posters, students had to consider these aspects of mathematics education which were then recognised as important features of the process. This is evidenced in the specific comments made by students:

> I had to learn about focusing the degree of difficulty [of the content area] to match the certain age groups that the concept would be taught to.
>
> By selecting my topic and looking at others, I had to become more familiar with the mathematics frameworks [curriculum planning documents].
>
> Posters showed concepts that were explained in a way that would be appropriate for children for a certain age in certain concept areas.

These comments support the notion that the posters aided in the development of understanding how to teach a mathematical concept and how it relates to the overall mathematics curriculum.

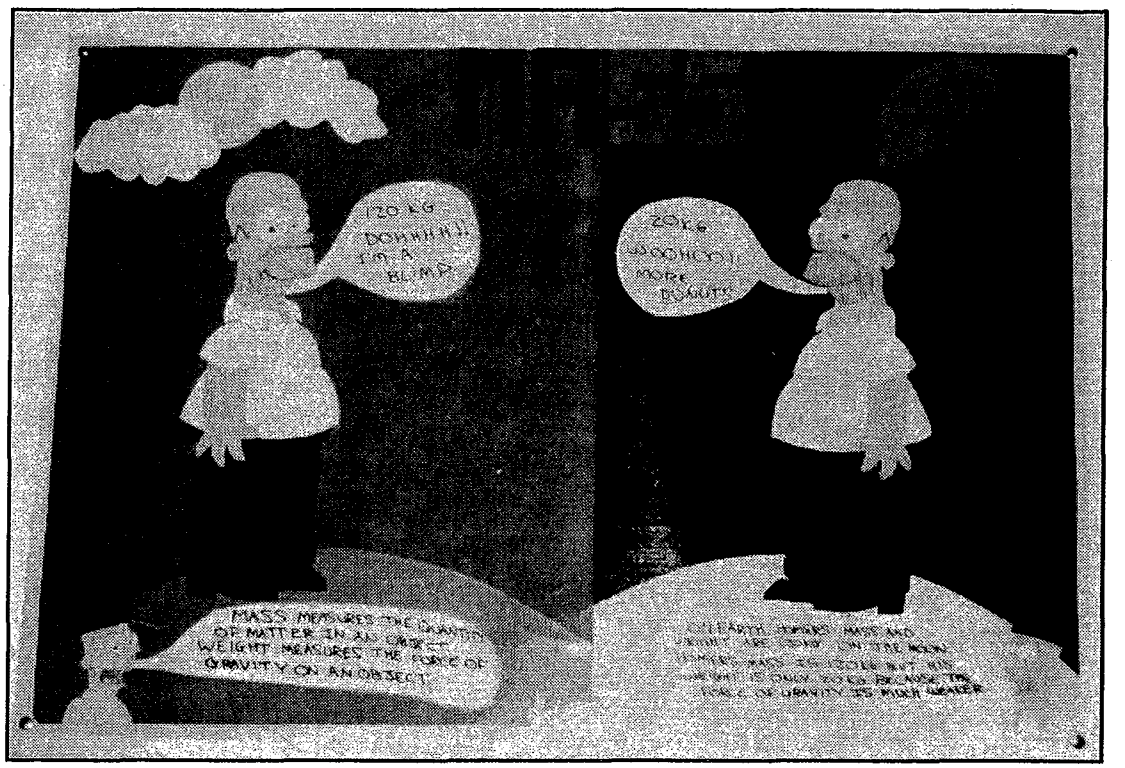

Figure 2. Simpsons poster.

In the comments offered by students, there were two clear areas for noting – mathematics and poster construction. When discussing aspects of the mathematics, the posters allowed students to research one area of the curriculum which was of personal interest. This allowed them to gain knowledge in that area, but the process of peer assessment broadened their experiences to include other concepts as well. Pedagogically, they learned that the same concept could be "taught" in a number of ways. This was a common comment which is not surprising given that the poster project is their first assessment item in their study of mathematics education.

> The posters helped me to see mathematics very differently from how I thought it should be taught. It made me try and find ways of making maths fun. I had to learn to be creative (which I am not yet!). I understood a lot of the other concepts more by looking at the other posters. I could understand them a lot more easily.

> Problems in maths can be simplified and made easier and fun. I wish we had had these sorts of posters when I learnt maths, I think it would have helped me to understand some of the stuff.

The posters provided the impetus for students to learn more about different aspects of mathematics but also different ways in which the same information could be expressed.

The posters were also aimed at developing students' skills for presenting knowledge in novel and effective ways. Students reported that the project enabled many of these skills to be developed – either explicitly or latently. This aspect of

mathematics education is very important given the dominance of teacher expository modes of delivery. Such modes do not often meet the needs of all students and learning styles. The posters encouraged students to consider a variety of means by which their students were more likely to be motivated to learn the concept under consideration.

> It really made me think about ways to get a student's attention.
>
> The visual properties of materials need to be eye catching if they are to be effective.
>
> What I often thought would be a good idea for a poster, did not always work. [By looking at the other posters, I realised] how one idea can be presented in so many different ways.
>
> I learnt how to make maths more interesting, fun, and enjoyable so that the children don't learn to hate maths. I had to incorporate things into the poster to make maths appealing to the students' learning styles – kinaesthetic, visual, auditory.
>
> I really had to think about which way I'd approach [the poster] to get through to the kids' understanding. It had to be super clear, informative and enticing. That was far more difficult than I thought at first.

Other students commented further on the difficulty of the task lying in its challenge to students to rethink the ways in which they had been taught maths, and in many cases, what they also experienced on their practicums. For many students, their experiences were of the traditional chalk-and-talk so the posters encouraged them to rethink their teaching methods.

> I had to think about how to teach the concept in a way which was very different from what I had had at school and when on prac. I really had to think about it as I thought the only way to teach maths was to stand at the front of the class and talk about it.

From the quality of many of the posters, it is apparent that the students have gained some knowledge in their chosen area. The process of peer assessment of the posters, extends their knowledge of mathematics and effective poster construction. From the comments and evaluations offered by the students, the posters appear to be an enjoyable and effective means of assessing both mathematical knowledge and pedagogical techniques. It provides students with a valid set of skills which can be transferred to other areas of the mathematics curriculum and into other curriculum areas. In so doing, it is an effective process for initial teacher preparation.

Practical Points for Managing Posters

As mentioned at the outset of this paper, assessment practices must be viable and manageable within the new context of higher education. The implementation of this project has evolved from small cohorts of 70 to its current enrolment of 180. The physical management of the project requires careful planning if it is to be sustainable. As this project incorporates a peer assessment component, the following suggestions also include considerations for managing this aspect of the project. A number of organisational points are offered:

Students hang their own posters. This requires the allocation of predetermined spaces prior to the date of submission. This project is currently undertaken by allocation of hallway space so that the clusters of ten (or nominated number/s of) posters are clearly defined. This is achieved by placing signs such as 1-10, 11-20 etcetera in clearly marked areas. These need to be kept in a clearly identified sequence so that students can be in little doubt as to where their poster should be placed. It is still surprising how many place them in the wrong space!

Students be assigned numbers. However this is achieved, it is important that at least two weeks prior to the submission of the posters, that students have access to their numbers and those which they will mark. The numbers are for blind marking and discussions, so that posters are discussed (not students). This is an important consideration. Students should not feel personally threatened and anonymity should be guaranteed for assessment. Even when this is clearly indicated, a number of students will seek clarification as they have difficulty in reading and comprehending information. The posting of this information must be done in a way which protects the identity of the students. In this project this was achieved through the linking of an assigned number to a student's ID number. The method adopted was a simple chart outside the office of the convenor which students could peruse at their leisure and seek clarification if needed. The format was developed using a spreadsheet. For ease of student marking, it was decided to assign students to mark the following group of ten. This meant that if the number the student had been given was in the range of 21-30, they marked the posters 31-40. For most students this system worked well. For others, who had difficulty understanding patterns, the procedure was not comprehended. In its own right, this procedure was the focus of a lot of discussion among the students in terms of its inherent mathematical concepts.

Provision of a mark sheet which clearly articulates the criteria. The sheet provides all the relevant information for marking and so acts as a reference point for the students. The provision of the criteria and points for reference as discussed in the early stages of the project serve as a catalyst to remind students of the negotiated meanings of the criteria. Feedback from students indicated that this information helped to keep them focussed on what they needed to look at when marking and may contribute to consistency in marking.

Conclusion

Posters appear to be a successful tool for assessment and learning within mathematics education. They offer an alternative format for students to express learning while providing students with valuable skills for their future careers as teachers. Posters expose students to visual forms for expressing mathematical concepts to their students. In the process, they are compelled to consider novel ways of expressing mathematical concepts in ways which can potentially include their students in the learning process, particularly those who do not benefit from the more traditional methods used in many mathematics classrooms. When combined with peer assessment, this project has exposed students to a variety of mathematical

knowledge and pedagogical knowledge which will be valuable in their future careers.

Perhaps one of the more incidentally rewarding aspects of projects such as this is that it raises the profile of education, but more particularly mathematics education within the site and region. Numerous visitors pass through the public spaces while the posters are on display so that they come to serve as a form of art work. Visitors, including staff from schools and local education authorities are able to see the work of the students. Very positive feedback has been passed on to the senior management of the University which helps to perpetuate a positive image of teacher education.

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Author

Robyn Zevenbergen, School of Education & Professional Studies, Griffith University – Gold Coast, Private Mail Bag 50, Gold Coast Mail Centre, QLD 9726. E-mail: <r.zevenbergen@mailbox.gu.edu.au>