

Final Report

Developing Primary Teacher Education Students' Professional Capacities for Children's Diverse Mathematics Achievement and Learning Needs

2010



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Executive Summary

The aim of this project was to enhance primary teacher education students' capacities as mathematics teachers to cater for the diverse achievement and learning needs of primary school children. The term 'diversity', as used in this project, encompassed children's age and achievement levels, interests, backgrounds, learning styles, learning and social skills, rates of learning, and learning environments. In particular, there was intent to have as sub-foci Indigenous children and children in regional, rural and remote locations of Western Australia.

The project was based upon two action research cycles within the Bachelor of Education (Primary and Early Childhood) programs at Curtin University of Technology. Cycle One (Semester 2, 2008) involved approximately 265 students of the total cohort of approximately 500 students, with Cycle Two (Semester 1, 2009) involving an additional 110 students. Authentic learning/assessment tasks, used as a tool for learning, included: analyses of children's work samples on 'rich'/open-ended mathematics tasks; planning and implementation of a teaching intervention for a child with an identified mathematics difficulty; design of a web-quest with an integrated mathematics component; poster presentations and interview discussions with members of the education profession; preparation of a mathematics teaching portfolio with a specific focus on catering for diversity, and in particular diversity in the context of Indigenous children, use of technology, and programming; and portfolio interviews with members of the education profession.

First-year students, in the intervention and analysis of children's work tasks, demonstrated capacities to identify diverse mathematics knowledge, skills, and learning needs of individual children. The second-year students, for the Web-quest and analysis of children's work tasks, demonstrated similar capacities, and also demonstrated skills to plan learning activities for children that include diverse mathematical representations and contexts designed to cater for diverse achievement levels, interests, and learning styles. The fourth-year students' mathematics teaching portfolios demonstrated an array of learner-oriented, planning, teaching, assessment, and cultural factors that are relevant for catering for diversity.

Students' post-semester ideas for catering for diversity expanded from their pre-semester ideas. Pre-semester ideas for all three groups were focused on using ability grouping and considering learning styles or multiple intelligences. Their post-semester ideas demonstrated a wider array of strategies and factors, including: using a variety of groupings; using open-ended tasks; extending or simplifying tasks; using a range of materials; considering children's interests, cultural and social backgrounds; and being reflective and flexible as a teacher.

The end of semester mathematics showcases were a particularly successful aspect of the project in that they were evaluated by the students and the guest interviewers to have much impact upon learning. They served as a catalyst to synthesise, articulate and think critically about learning, and then to develop professional confidence and empowerment through an authentic conversation with members of the profession.

The project focus (catering for diversity in mathematics learning and teaching) and student clientele (primary teacher education students) both make the project approach and outcomes amenable to other programs and institutions. A CD resource developed for primary/early childhood teacher education students and



teacher educators provides examples of the authentic learning and assessment tasks.

1 Project Overview

This report outlines the Australian Learning and Teaching Council (ALTC) funded project conducted at Curtin University of Technology 2008-2009 titled, 'Developing primary teacher education students' professional capacities for children's diverse mathematics achievement and learning needs'.

Aims

The main aim of the project was to enhance primary teacher education students' capacities as mathematics teachers to cater for the diverse achievement and learning needs of primary school children. The term 'diversity', as used in this project, encompassed children's age and achievement levels, interests, backgrounds, learning styles, learning and social skills, rates of learning, and learning environments. In particular, there was intent to have as sub-foci Indigenous children and children in regional, rural and remote locations of Western Australia.

In its main focus on mathematics education, the project addressed an area of continuing concern in teacher education in Australia – the need to develop primary teacher education students' professional capacities as effective mathematics teachers. With a sub-focus on Indigenous mathematics learning, along with the integration of regional, rural and remote schools, the project also addressed a continuing concern in teacher education in Australia of the preparation, attraction and retention of teachers to regional, rural and remote schools. In addition, the project examined innovative learning and assessment practices and the use of new technologies for learning and communication.

Background and Rationale

Development of mathematics teaching capacities of primary teacher education students

An ongoing problem facing primary mathematics teacher education is the challenge of preparing teachers to 'break the cycle of tradition' of mathematics teaching and learning practices that centre on memorisation of facts, and practice of pre-set meaningless procedures that promote a view of mathematics as lacking creativity, imagination, or critical thought (Frid & Sparrow, 2007). Research over recent decades indicates that "teachers continue to teach much like their forbears did" (Hiebert, 2003, p. 11), with an emphasis on teaching procedures rather than conceptual understandings. In addition, Angus, Olney and Ainley (2007) reported that primary teachers indicated a lack of preparedness to teach mathematics. To move forward in mathematics education therefore requires substantial learning by primary teacher education students with regard to their capacities and confidence to plan for and implement 'non-traditional' effective mathematics learning experiences.

The project extended previous work of the project team in using technology and using authentic assessment tasks to engage primary teacher education students in learning activities that reflect the realities of their professional roles as teachers in schools. It extended this previous work by targeting an area that was identified by recent graduates as one of their major challenges as early career teachers – catering for the diverse mathematics achievement levels and learning needs of children in a classroom (Frid & Sparrow, 2007). A related study also identified 'learning to cater for diversity' as an essential need of a primary teacher education program (Frid, Smith, Sparrow, & Trinidad, 2008). This research surveyed graduates in their first four years of teaching and found that, to maintain ongoing employment,



most graduates were required to change year level taught, school or living location, sometimes more than once in the same year. Few graduates, even in non-metropolitan locations, were employed in permanent, stable positions.

Indigenous mathematics learning

An aspect of diversity with regard to children's learning needs is that of cultural background, which in Australia necessarily includes Indigenous cultural groups. Mathematics is a way for groups to "understand and make sense of their environment and their practices through identifying patterns that assist in organisation" (Perso, 2003a, p. 11). Thus, although Western mathematics is the mathematics taught in schools throughout the world, traditional Indigenous cultures have what are often distinctly different ways of making sense of, organising, and acting in their environments. They have different 'world views' and related social practices that impact upon what is valued and used as knowledge, mathematical or otherwise. For example, Australian Aboriginal people use genealogical patterns to make sense of their world; that is, "ordered ways of naming and construing the relationships of natural things according to perceived ancestral or familial linkages" (Watson & Chambers, 1989, p. 30). In comparison, many other cultural groups use number patterns based on counting and measurement, with a focus on 'quantity' rather than 'relationship' (Perso, 2003b). The values of Western society are thereby embedded in the teaching and learning of Western mathematics, while the mathematics that exists in other cultures is implicitly made inferior because generally it is not taught. Hence, curriculum developers and classroom teachers have the challenge of providing children with mathematics learning experiences that are culturally and cognitively suited to support achievement of desired learning goals, be they goals derived from non-Western mathematics or Western mathematics. In this regard it is acknowledged that there is a potential for more than one form of mathematics to be included in a school's curricula, and that choices could be determined by the local community.

In addition to the mathematical content often differing between cultural groups, the styles of teaching and learning are also often not taken into account. Examples include: the nature and role of questioning, for determining what children know and understand in comparison to finding out about people; the emphasis in mathematics on exactness and correct answers, which can lead to a teacher's identification of a child's errors as a form of rebuke; and the use of verbal, expository, 'chalk and talk' teaching, in comparison to learning via observation and imitation (Perso, 2003a).

Thus, there is a need for teachers, and hence teacher education students, to have capacities to develop mathematical pedagogies and mathematical content appropriate to the diversity of world views, learning values, and learning styles of Indigenous children. This project included these components of mathematics learning and teaching as aspects of teacher education students' development of professional capacities to cater for diverse achievement and learning needs.

Teaching in regional, rural, and remote schools

Skilbeck and Connell (2003) noted that a fundamental issue in teacher education in Australia is that it is predominantly metropolitan in character, "mostly carried out in large, metropolitan institutions" (p. 20). More recently, Lyons, Cooksey, Panizzon, Parnell and Pegg (2006) reported that nationally within Australia "teachers tended to gain employment in locations similar to those in which they lived while undertaking pre-service education" (p. v). While there is undoubtedly a need for universities to further develop teacher education programs that are accessible to students in non-metropolitan locations, it is also the reality that teacher education students in metropolitan locations need opportunities to develop their awareness, appreciation



and professional knowledge related to rural schools. That is, there is a need to infuse a 'rural connection' into teacher education programs in metropolitan universities in practical, cost-efficient and sustainable ways.

At a national level, there have been many reports of teacher shortages in rural and remote areas (e.g. Committee for the Review of Teaching and Teacher Education, 2003; Lyons, Cooksey, Panizzon, Parnell & Pegg, 2006; MCEETYA, 2003), "with mathematics, science and ICT vacancies hard to fill in all states and territories" (MCEETYA, 2003, p. 20). The issues pertaining to incentives and disincentives for employment in non-metropolitan areas are complex and encompass a broad range of financial, social, personal and professional factors, including: cost of living, resources, isolation, professional preparation, community interactions, support networks, and the nature of teaching experiences in rural communities (Boylan, 2003; Frid, Sparrow, Trinidad, Treagust, & McCrory, 2006; Gibson, 1994). This project did not aim to tackle these complex, broad issues, for to do so in a comprehensive way would require large-scale systematic and political initiatives.

However, it is noted here that within metropolitan based education programs in Australia, incentives to encourage teacher education students to take up employment in non-metropolitan schools upon graduation have focused on relatively few individuals via financial sponsorship or support for completing student teaching placements in a rural location (e.g. Nelligan, 2006). There have been other recruitment-oriented efforts developed within teacher education programs in recent years, for example rural excursions, promotional videos, or rural education units (e.g. Gregson, Waters, & Gruppetta, 2006). However, these efforts have not addressed the issue in an integrated way that targets a majority of students within an undergraduate program. Although this project did not address the broad spectrum of issues in a comprehensive way, it was an initial step in working with a cohort of metropolitan-based teacher education students to develop their awareness and appreciation of non-metropolitan teaching contexts; that is, a 'rural connection'.

Objectives and Definition of Terms

Objectives

- (i) Design and implement authentic learning/assessment tasks for primary teacher education students that focus upon developing students' professional knowledge and skills for teaching mathematics to diverse groups of children.
- (ii) Develop primary teacher education students' capacities to use ICT as an educational tool for communication and for enhancing children's mathematics learning.
- (iii) Expose metropolitan-based primary teacher education students to children in regional, rural and remote schools, and thereby develop their awareness and appreciation of teaching in these areas.
- (iv) Develop primary teacher education students' capacities to develop mathematics curricula that incorporate mathematics content and pedagogy appropriate for Indigenous children.
- (v) Evaluate the effectiveness of the learning/assessment tasks in terms of the primary teacher education students' professional knowledge related to mathematics teaching and learning.
- (vi) Use evaluation results to review and revise the original learning/assessment tasks for ongoing use in BEd programs.
- (vii) Disseminate the project processes and findings to other teacher education and professional education programs.



Definition of terms

Primary teacher education students – Students enrolled in a Bachelor of Education (Primary or Early Childhood) degree at Curtin University of Technology (Bentley Campus, Perth).

Authentic learning/assessment tasks – Learning and assessment activities that reflect the realities of teachers' professional roles in schools. In this project the tasks focused on: examining and assessing children's work samples with regard to evidence of the children's mathematics knowledge and skills; using this assessment information to plan learning activities to support the children's ongoing mathematics learning; and planning mathematics lessons and programs that cater for diverse mathematics achievement levels and learning needs.

Diverse groups of children – This includes: children of different ages; children in one classroom who vary in year level and/or mathematics achievement level; children with a variety of learning needs related to interests, backgrounds, learning styles, learning and social skills, and rates of learning; children from a wide range of school locations in WA, including metropolitan, regional, rural and remote schools; and children of Indigenous backgrounds.

Regional, rural and remote schools – In the context of Western Australia, this refers to all schools outside the Perth metropolitan area, since all localities outside Perth are categorised by MCEETYA classifications as provincial or remote zones (in particular, because these communities have a population less than 100,000 and/or are geographically distant from a major population centre).

ICT (Information and Communication Technologies) – Computer and internet based mechanisms by which information and communication can be facilitated. In this project, the main technological objects and tools will be digital photos/images, interactive whiteboards, blogs, email, WebCT/Blackboard, and internet-based learning activities.

Project Context and Participants

The project involved both Primary and Early Childhood teacher education students in the Bachelor of Education (Primary and Early Childhood) degrees at Curtin University of Technology (School of Education, Bentley Campus, Perth). The degrees are four-year teacher education undergraduate programs with total fulltime student enrolments of about 300 and 200, respectively. Approximately 375 of these students were involved in the project. The involvement of some of the early childhood students extended the project beyond its initial plans, but was necessary because primary and early childhood students were concurrently enrolled in units within the project. Most of the students in the project were from the Perth metropolitan area, with very few who had lived or worked in non-metropolitan areas of Western Australia.

2 Project Framework and Approach

Adult Learning Theory

Since the project focused on the learning of teacher education students, it was framed by adult learning theory. That is, in designing appropriate support for teacher education students' learning as mathematics teachers, consideration was given to how adults learn. Adult learning theory, as proposed by Knowles (1984), emphasises that adults are self-directed learners whose need to learn arises from the interests and challenges of their everyday lives. Further, since adults bring a



broad range of experiences, beliefs, values, and ways of functioning to any learning situation, teaching processes that emphasise reflection, self-direction, articulation, scaffolding, and collaboration need to be explicitly recognised and attended to when planning curricula for adults. Learning must be embedded in “contexts that reflect the way knowledge will be useful in real life” (Collins, 1988, p. 2), or what might otherwise be referred to as situated cognition (Herrington & Oliver, 1995). Key features of related learning environments must include: coaching and *scaffolding* that provide skills, strategies, and cognitive links; *collaboration* to support personal as well as social construction of knowledge; *reflection* to enable meaningful and purposeful learning; *articulation* to consolidate knowledge and foster communication skills; and *integration* of learning and assessment tasks (Herrington & Oliver, 1995). These features were aspects of the teaching and formal assessments of the project (e.g. using authentic assessment tasks).

Authentic Assessment

Authentic activities and related assessment “involve ‘ill-structured’ challenges and roles that help students rehearse for the complex ambiguities of the ‘game’ of adult and professional life” (Wiggins, 1990, p. 3). They are not a new approach to teaching and assessment, however their adoption in universities and schools only gained momentum in the 1980s (Madaus & Dwyer, 1999). A move towards authentic assessment can enhance learning and teaching by providing both students and teachers with a purpose and clarity for engagement in and mastery of complex tasks.

Darling-Hammond, Ancess and Falk (1995) (cited in Wiggins, 1989) identified four common characteristics of authentic assessment. Authentic assessments:

- are designed to be truly representative of performance in a field
- seek to evaluate ‘essentials’ of performance against well articulated performance standards
- help students to develop the capacity to evaluate their own work against public standards, hence ‘self-assessment’ plays an important role
- most often require students to present their work publicly and orally, signalling the importance of their work.

These characteristics were further explicated by Bergen (1993) (cited in Frey and Schmitt, 2007) who identified the qualities of ‘good’ authentic assessment tasks to be that they:

- are often group based activities
- measure many facets at the same time
- reflect the complex roles of the real world.

Authentic learning and assessment activities formed a basis for development of the curriculum within the teacher education units of this project.

Using ‘Rich’ Tasks in Mathematics Learning

‘Rich’ mathematics tasks are characterised by being open-ended in nature so that they have more than one possible answer and/or more than one possible pathway to obtain an answer (Downton, Knight, Clarke, & Lewis, 2006). In this way they are particularly appropriate for groups of children of mixed achievement levels. They foster “higher level thinking because they encourage students to develop their problem solving expertise at the same time as they are acquiring mathematical skills” (Sullivan & Lilburn, 1995, p. 4). The open-ended nature of rich mathematics tasks ensures all children in a classroom can ‘make a start’, using a range of methods or approaches, and thus rich mathematics tasks are efficient and effective



learning and assessment activities to cater for diversity in achievement levels and other mathematics learning needs. In addition, because they provide contexts in which children can show understandings of mathematics concepts and connections between concepts, as well as mathematics skills, teachers can use children's responses to decide what specific help children need to progress in their learning (Downton et al., 2006). Rich mathematics tasks were used in this project to obtain diverse examples of children's mathematical thinking and skills pertaining to some specific mathematics concepts.

Integrating Project Priorities

The effective integration of the priorities of this project required conceptualising and designing the project in ways that naturally and cohesively incorporated the focal priorities of mathematics learning and teaching, catering for diversity, Indigenous mathematics learning and teaching, and developing awareness of regional, rural and remote schools. To strategically achieve a focus on both examining and planning for the mathematics learning of diverse samples of children, the project 'collaborated' with teachers in non-metropolitan schools/classrooms to obtain 'stories' of their experiences and work samples from children of a range of ages and achievement levels living in a range of geographical, economic, social and cultural environments. The project also had an 'integration' component as a strategic aspect of its design in that there was specific planning to integrate between the mathematics education and technology education units in the teacher education students' programs via a focus on the integration of technology into mathematics learning and assessment activities.

The project was also strategic in that it provided an avenue by which more than a minority of students in a metropolitan based teacher education program were provided with an opportunity learn about children and teachers in regional, rural and remote schools. As already outlined, this project did not aim to address comprehensively the issue of the supply of teachers in regional, rural and remote locations. Rather, while recognising the financial and logistical constraints of a metropolitan based teacher education program, it aimed to provide a practical connection to non-metropolitan schools in ways that could provide relevant learning opportunities for the teacher education students.

3 Methodology

The project was based upon action research methodology, using a global iterative cycle: plan, act, observe, reflect (Arhar, Holly, & Kasten, 2001; Mills, 2007). A previous 'reflect' component conducted by the project team guided the 'plan' component of an initial action cycle in that this project was a 'plan' with aims that were derived from needs in teacher education, formal and informal student and program evaluations within the BEd programs, and the approach and framework that underlies the project. There were two action research cycles in which authentic learning/assessment tasks and the collaboration and communication aspects of the project were developed, implemented, and evaluated.

Action Research: Cycle One

First and second year teacher education students participated in this cycle in Semester 2, 2008, with learning and assessment tasks in core units as outlined in Table 1. Each unit had major assessment tasks focused on catering for children's diversity in mathematics learning.



Table 1
Student groups, units, and learning/assessment tasks for Semester 2, 2008 (Cycle One)

Student group/Unit	Learning/assessment task
<i>First-year students (N=155)</i> Ed136 Introduction to the English and Mathematics Learning Areas Ed134 Reflective Practice II	Analysis of children's work samples on a rich mathematics task: 'Draw a map' - Draw a map of how to get from where you live to school. Plan and implement a short intervention for a child with an identified mathematics learning difficulty.
<i>Second-year students (N=110)</i> Ed239 Mathematics Education I Ed237 Technology and Enterprise Learning Area	Analysis of children's work samples on a rich mathematics task: 'Fraction one-third' - Tell me everything you know about the fraction one-third. Design a Web-quest with an integrated mathematics component.
<i>First- and Second-year students</i>	Mathematics Showcase and interviews with members of the profession.

The mathematics education units for each student group (Ed136 and Ed239) used rich mathematics tasks as vehicles by which to obtain work samples from children from a range of year levels and schools. The work samples were made available to students through password accessed blogs on which were posted scanned images of the work samples. The teacher education students then worked collaboratively with one another in examining children's work samples to determine what they indicate about the children's mathematics learning and what they need to be taught to progress in their learning. Blogs were used as a vehicle by which to facilitate this process. As a formal, summative assessment task the teacher education students then prepared a sequence of two lessons designed to progress a child or group of children in their mathematics learning.

The other units for the two student groups (Ed134 and Ed237) each linked to the teacher education students' learning in the mathematics education units by use of an authentic learning task with a focus on the mathematics learning area. In Ed134 the teacher education students worked with one of the children in their practicum classroom with an identified mathematics learning difficulty such as a basic concept understanding or skill weakness (for example, understanding place value or multiplying 2-digit numbers). Then they planned and implemented a short intervention of learning activities for the child. In Ed237 the teacher education students designed a mathematics Web-quest for a group of children.

For all the teacher education students, a poster display showcase at the end of the semester (as part of the formal university examination period) served as a professional sharing opportunity by which the teacher education students reported on their learning as mathematics teachers and participated in a form of professional 'interview'. Attendees at the showcase, who conducted formal 'interviews' as part of the teacher education students' formal assessment for the semester, included staff teaching in the BEd programs, academic staff from teacher education programs at other Perth universities, academic staff from other degree programs at the university



who might want to implement similar curricula or assessment activities, and a selection of local school teachers and principals. Thus, the showcase was designed to provide opportunity for the teacher education students to reflect upon and synthesise their learning as mathematics teachers, and then communicate their learning to an authentic professional audience (see Appendix A for an outline of the showcase presentation and interview discussion requirements).

The Showcase also served as a forum for the project team to reflect upon and evaluate Cycle One of the project. The written interview assessments completed by the attendees provided external feedback on the teacher education student learning outcomes, while a written feedback/evaluation form completed by the attendees provided feedback on the showcase overall (see Appendices B and C). The teacher education students were also part of this feedback process in that they also completed a written reflection/feedback form about their perspectives on their learning related to catering for diversity and their learning through the showcase authentic assessment task (see Appendix A). The university formal evaluation of units, eVALUate, was also used for feedback on the teacher education students' learning.

Action Research: Cycle Two

Fourth-year teacher education students participated in this cycle in Semester 1, 2009, with learning and assessment tasks as outlined in Table 2. Development of a mathematics teaching portfolio had been a component of the fourth-year mathematics education unit in previous years, and in this cycle of the project the previous design and implementation of this authentic assessment task was extended to target more explicitly the issue of catering for children's diverse mathematics achievement and learning needs. In particular, the mathematics teaching portfolio was revised to include an item specifically focused on catering for the mathematics learning of Indigenous children. Technology in mathematics teaching and learning had previously been included in the portfolio, but now the teacher education students were required to demonstrate how they were able to use technology to cater for diverse mathematics achievement and learning needs. The diversity focus was also specifically targeted within the students' preparation of a mathematics program/plan. Further, in weekly workshops 'diversity' was highlighted when considering how the content, processes, or achievement level of mathematics learning activities could be adapted to cater for diversity.

The end-of-semester showcase and related feedback/evaluation processes were similar to that of Cycle One (see Appendices D, E, and F). In this way, as with Cycle One, data related to the teacher education students' learning outcomes and feedback from external potential users of the project outcomes and deliverables was obtained.



Table 2
Student group, units, and learning/assessment tasks for Semester 1, 2009 (Cycle Two)

Student group/Unit	Learning/assessment tasks
<i>Fourth-year students (N=110)</i> Ed440 Mathematics Education II	'Indigenous mathematics learning' and 'technology for diversity' mathematics teaching portfolio items; mathematics program/planning that caters for student diversity
<i>Fourth-year students</i>	Mathematics Teaching Portfolio Showcase with interviews with members of the profession.

4 Project Outcomes – Using and Advancing Existing Knowledge

Teacher Education Students' Capacities to Cater for Diverse Mathematics Achievement and Learning Needs

The effectiveness of the learning/assessment tasks was evaluated by examination of work produced by the students', by student self-assessment/reflections, and by feedback from the showcase interviewers/assessors. 'Effectiveness' was determined by evidence that the students had attained the project aim of developing their capacities to cater for children's diverse mathematics learning and achievement needs. Initial data as a baseline for later comparison of students' knowledge about 'diversity' were obtained via a short written response survey completed by students at the beginning of each semester (see Appendix G).

Student assessment task products

Mathematics intervention task (first-year students): Students' written assignment submissions as well as the assessment sheets completed by the showcase interviewers indicated students successfully: identified particular mathematics concepts and skills a child needed to develop; planned some short lessons; and worked flexibly in short teaching periods with the child, supporting the child in making progress in mathematics learning.

'Draw a map' work sample analysis (first-year students): Students varied in the degree to which they were able to identify, in a comprehensive and/or correct way, particular mathematics knowledge and skills that were in evidence in the children's work. Their comments focused on a wide range of features of the work samples, indicating they had noticed the many and varying ways children of different ages and experiences draw maps (see Appendix H for some samples). In comparison, their suggested ideas for follow-up learning activities for the children were limited in scope, focused mostly on developing 'bird's eye view' concepts. It might be that this focus on bird's eye view was related to the students' confidence and teaching experience because bird's eye view concepts and skills had been attended to in a class workshops when some sample maps were analysed. They therefore had bird's eye view as a model to follow that they knew would be appropriate. However, in spite of this apparent limitation in their thinking as a developing mathematics teacher, the showcase interviewers were impressed with how these students articulated their ideas and learning about children's mathematics learning, and indicated they saw the students' understanding of children's learning to be appropriate for 'beginning' teachers.



'Fraction one-third' work sample analysis (second-year students): Students demonstrated skill and insight in their analysis of what children displayed of their knowledge of the fraction one-third, and noted a wide range of differences as well as some commonalities between the children (see Appendix I for some samples). In spite of this evidence that students had identified differences in children's learning, the follow-up lesson plans focused mostly on developing basic understandings of the concept of a 'fraction' (i.e. one of a number of equal sized parts). However, these plans included the multiple representations in which fractions need to be understood (e.g. in the contexts of length, area, collections of objects), showing professional knowledge that catering for children's diverse learning needs in mathematics involves presenting mathematics in a variety of ways. The showcase interviewers were impressed with how these students articulated in a comprehensive and integrated way their ideas and learning about children's mathematics learning.

Web-quest (second-year students): Although the mathematics components of the students' web-quests were not required to be extensive, they included a range of mathematical concepts and processes in measurement, number, chance and data, and geometry, and they demonstrated capacities to use technology effectively to support children's mathematics learning. Many of the activities the students designed were focused on children designing and building such things as a garden, playground, restaurant, zoo enclosure, or resort. Other activities commonly included aspects of chance and data by involving surveys or data collection, and subsequent graphing and reporting of such things as sizes of fish, food nutrition information, family occupations, or solar system and planet distances and sizes. Thus, the mathematics components of the web-quests used technology to integrate mathematics activities into a range of real world contexts and investigations. In this process mathematics itself was developed in an integrated way because the various mathematics content areas (measurement, chance and data, number, and geometry) were included.

Mathematics teaching portfolios (fourth-year students): Across their entire portfolios, as well as within the items of focus for this project (i.e., technology, Indigenous, and program items), students demonstrated knowledge of a range of factors and strategies to be considered when catering for diversity, along with specific examples of classroom practices/activities for implementing their ideas (for examples, see Appendices J and K, as well as the CD resource.) For their programs they demonstrated how tasks could be altered to be open-ended or extended to include a wider range of potential mathematics concepts or processes, or how they could be structured or more directed to simplify the mathematics concepts and skills, or how assessing student learning could incorporate a range of techniques such as written reports, digital photos or other visual reports, oral reports, or performance-based tasks. The showcase interviewers assessed the students, overall, as having demonstrated capacities for connecting theory and practice with regard to mathematics teaching.

Student self-assessment/reflections

As part of the showcase assessment, each semester students completed short written responses to questions designed to identify their knowledge about catering for diversity in mathematics achievement and learning needs. This data indicated students had broadened their perspectives on the nature of diversity and broadened their range of specific ideas for catering for diversity (see Appendix L). In particular, they had moved beyond 'learning styles' as a main criterion to categorise diversity, and had moved beyond 'ability groups' as a main strategy to cater for diversity.



The students all completed written pre- and post-showcase reflections about their learning in preparation for the Showcase and in their experiences in completing the showcase interviews (see Appendices A and E). These responses indicated they saw the showcase process as highly effective as an assessment task to develop metacognition, critical thinking, professional confidence, and capacities for articulating professional knowledge. They made many comments about the authentic nature of the interviews as a forum for discussing and presenting their ideas as well as a forum for new learning. Almost all students explicitly stated the showcase discussion/interview was valuable and worthwhile as a professional endeavour.

Showcase interviewer feedback

The showcase interviewers were asked to provide written feedback on their views of the value of the showcase process for supporting and assessing teacher education students' professional learning. The features they noted as most relevant included that the process: is contextual and authentic and thereby gives meaning to university learning activities; develops ownership of and capacities to articulate and elaborate knowledge, beliefs and values; requires students to be accountable for their knowledge; and supports learning through discussion, interaction, and an exchange and sharing of ideas. In addition, they noted the process was a professional learning experience for themselves. It provided them with: insights into their own professional knowledge and practices; an opportunity to learn as a teacher mentor; and opportunities to learn new things because the students had innovative ideas, particularly for integrating technology into mathematics learning.

Teacher Education Students' Capacities to Develop Mathematics Curricula that Incorporate Content and Pedagogy Appropriate for Indigenous Children

Aspects of teaching mathematics to Indigenous children were included within the three mathematics education units of the project, through examination of how Indigenous children might bring to their mathematics different ways of learning, interests, and goals that differ to non-Indigenous children. Although this aspect of the project was not developed for all students to the full extent of the original plans, a foundation was built for further curriculum development. For the fourth-year students this aspect of the project was explicitly fostered through development of an Indigenous item in their mathematics teaching portfolio. These items provided evidence that students had researched within the professional literature and developed a range of ideas and principles to consider when teaching mathematics to Indigenous children (e.g. see Appendix K). What is also noteworthy is that many also stated in their portfolio self-assessment that they also were now aware that they had much more to learn about teaching mathematics to Indigenous children. This outcome is relevant in that it indicates the students' professional awareness of Indigenous educational issues had increased. It was not an area they had identified prior to developing their portfolio as prominent in the context of 'catering for diversity'.

Developing Primary Teacher Education Students' Capacities to use ICT as an Educational Tool for Communication and for Enhancing Children's Mathematics Learning

The blog sites provided a mechanism for using technology for communication and professional sharing, and in this way exposed students to their potential as a collaborative communication tool. However, the interactive and learning potential of these sites was not fully developed due to the limited timeframe in which they were



used. To create the sites and upload the children's work samples was more time-consuming than anticipated, leading to a reduced timeframe in which the students were able to make use of the sites for professional communication and dialogue. Although there were many comments posted to the sites, there then was limited opportunity to use initial postings as avenues for ongoing professional dialogue and learning. However, examples of relevant comments on the children's work samples that were posted to the blog sites have been included in the CD resource for future use in BEd programs (also see Appendices H and I).

The Web-quests (second-year students) and technology portfolio items (fourth-year students) created by students showed evidence of effective use of technology for supporting children's mathematics learning. The Web-quests demonstrated how aspects of mathematics learning could be included in engaging, integrated ways into learning activities across the curriculum. Many of the mathematics activities focused on the number strand in mathematics, although there were also examples within measurement, space, and chance and data (also see previous section on student assessment task products).

The technology portfolio items included a range of ways of using technology to support children's mathematics learning, including the use of calculators, digital cameras, specific websites, particular software programs, Wii games, and GPS tools. What was not in strong evidence in the final items, although it was a main objective for the student learning related to that portfolio item, was that students had developed breadth in their understandings for how the technology could be used effectively to cater for students' diverse learning and achievement needs. Their ideas concerning diversity were often limited to aspects of student interests and motivation, or what they called 'learning styles' but what they understood as 'learning styles' was not well articulated. However, overall, their portfolio items demonstrated a range of ways in which technology can be used to enhance mathematics learning.

Developing Teacher Education Students' Awareness and Appreciation of Teaching in Regional, Rural, and Remote Schools

The initial plans for Cycle One of the project (Semester 2, 2008) were to put the students directly in contact via technology (e.g. email and the blog sites) with the teachers and children at the non-metropolitan schools from which the rich mathematics work samples had been obtained. However, the ethics processes completed for the project (through the university and the state Department of Education) necessitated that this component of the plans be altered because the permission forms signed by parents to allow use of the children's work samples required that neither the children nor the schools be identified.

The work samples posted on the blog sites were from non-metropolitan children. Some students noted in their blog comments for the *Draw a map* activity that some of the children must live in a country area because the content of their maps reflected features of non-urban environments such as gravel roads, crops in a field, houses located outside of town, or a row of shops typical of a small community. It cannot however be claimed that by this exposure to children's maps the students would have developed their awareness or appreciation of teaching in these non-metropolitan areas. Hence, the *Voices from the Bush* component of the project was developed for Cycle Two.

The 'Voices from the Bush' component of Cycle Two of the project (Semester 1, 2009) was created to ensure the second phase of the project explicitly exposed students to living and teaching in non-metropolitan areas. Students were provided,



via weekly emails from three remote teachers to the project leader, with stories and details about living and teaching in a remote location. They shared accounts of: their programming and planning for multi-age classrooms; attending to the learning needs of their Indigenous children; mathematics and literacy teaching and the children's related learning; developing teaching activities to integrate learning into the local context and children's interests; and what it is like to live and work in a small, remote community. These accounts have been edited and organised as a resource for future use in the teacher education programs (see CD).

5 Project Outcomes and Approach – Potential for Implementation in Other Institutions

The project focus (catering for diversity in mathematics learning and teaching) and student clientele (primary teacher education students) both make the project approach and outcomes amenable to other institutions, as well as to other programs or parts of programs within Curtin University. This is due to the global, generic nature of the focus within the discipline of mathematics education and other subject areas in primary school, along with the global, generic nature of the approach as a professional learning endeavour for both staff and students.

Project Outcomes

Mathematics education is a core component of any Bachelor of Education program for teaching in primary schools. Hence, the CD resource developed as part of the project is suitable for use in any Bachelor of Education program in Australia, and except for the 'Voices from the Bush' component would be appropriate for use outside the Australian context. This potential use is due to the generic nature of the mathematics focused on in this resource, specifically in the children's work samples and the content of the mathematics teaching portfolios.

The authentic learning and assessment tasks developed for the project also could be used in BEd programs elsewhere, directly as developed for this project or in adapted forms. Further, the showcase interviews, as authentic assessment activities, have potential for use in disciplines other than education, particularly disciplines with distinct professional communities into which the students will enter after graduation. This would include a wide range of degree programs in health science, science, engineering, social sciences, and the arts.

Finally, it is noted that outcomes of the project pertaining to the enhancement of students' learning regarding catering for diversity have potential for development in other components of a bachelor or education degree. An initial natural, logical expansion would be to design similar 'diversity-focused' authentic activities and assessment for use within units for the literacy/English learning areas of primary school.

Project Approach

The overall project approach can serve as a framework for curriculum development and professional learning in almost any undergraduate degree program in any institution, particularly for degrees with core units that run concurrently. More specifically, the process that is outlined in Figure 1 can serve to guide the design of future projects. It is also noted here that the process outlined in Figure 1 is not 'new'; it is consistent with what research into professional development and learning in education has found to be effective (Sparrow & Frid, 2002).



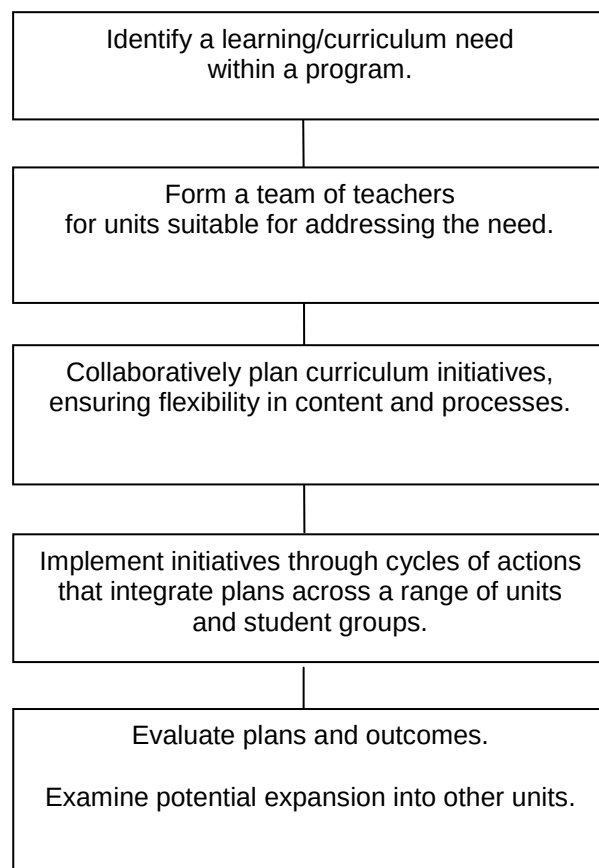


Figure 1. *The project curriculum development process*

6 Success of the Project – Supportive and Impeding Factors

Factors Critical to the Success of the Project

Critical to the success of the project overall and the approach taken to its development were:

- the key aim of the project (catering for diversity in mathematics learning) provided a *focus while also having sufficient breadth* to allow ongoing *creativity and flexibility in the design and implementation* of weekly learning activities for the students. This was particularly true within the mathematics education units (Ed136, Ed239, and Ed440)
- the project design of *two similar cycles implemented* with different groups of students at different points in their degree programs provided opportunity for the project to develop teaching ideas and resources for use with all students in a degree program. This structure also ensured the project had *impact across a degree program* rather than in only a small component
- the project *objectives were connected and integrative in nature*, thereby providing opportunity for *development of authentic learning/assessment tasks* for students related to the objectives. Specifically, this concerned the objectives pertaining to teacher education students' professional learning as mathematics teachers, children's mathematics learning, Indigenous mathematics learning, using technology in mathematics learning/teaching, and non-metropolitan teaching as an aspect of diversity



- the project was built upon what were *identified needs* within: the specific degree programs; university programs overall; and broader education and societal contexts. This gave the project *ongoing purpose* and provided *motivation for both staff and student engagement* in the project activities
- the project, although venturing into new endeavours, was *built upon strengths of the project team* (mathematics education). This supported successes by providing a *foundation upon which to build new endeavours and scaffold the professional learning* of staff, rather than requiring staff to tackle new things unprepared.

Factors that Impeded the Success of the Project

Factors that impeded the success of the project were mostly factors not under the control of the project team and mostly related to staffing and workload issues. These included:

- the original project plan was developed for the related teaching to be completed by fulltime academic staff who had made contributions to the project proposal and who had committed to being a part of the project. Unanticipated staffing and workload changes necessitated employment of a number of sessional staff in place of some of the original project team members. This impacted upon implementation of some aspects of the project. However, due to the flexible nature of the project, components of these aspects were implemented in smaller ways as adaptations of the original plans
- efforts to employ an Indigenous teacher/educator who could provide on-site and first-hand experience into the issues of addressing the diverse needs of Indigenous students were not successful. It was decided not to seek an Indigenous consultant and to decrease the extent to which the project would on a weekly basis integrate an Indigenous perspective. Thus, although this focus was greatly decreased, the flexibility of the project design allowed for it to be developed in a different although not as extensive way
- staffing challenges were also significant for the employment of a technology consultant/assistant in a continuing way, as well-qualified people with an education expertise are in demand for a range of other employment opportunities. The time needed in Cycle One to complete the technology support was underestimated (e.g., for scanning the children's work samples, preparing the blog sites with the work samples, and supporting students to learn how to use blogging). Thus, two main lessons learned from these challenges are that technology use needs to be given additional time allocations in initial project plans and a budget needs to consider a suitable salary level to attract and retain suitably qualified technology personnel.

7 Dissemination of Project Outcomes

Project Materials

As a product of the project, a CD resource (titled *Children's Diverse Mathematics Needs*) for primary/early childhood teacher education students and teacher educators was prepared that contains the items outlined below that each have a focus on catering for children's diverse achievement and learning needs in mathematics. The CD is available free of charge from: Associate Professor Sandra Frid, School of Education, Curtin University of Technology, GPO Box U1987, Perth, WA, 6845, Tel. (08)9266-2173, S.Frid@curtin.edu.au.

Additional project material of value to other teacher educators includes: student assessment tasks; showcase interview questions, assessment proformas and



feedback sheets; and student survey and reflection proformas. Project material can be accessed on the ALTC Exchange: <http://www.altcexchange.edu.au/> on a profile under the name of Dr Sandra Frid and entitled 'Mathematics Diversity Project'.

Children's mathematics work samples

This component of the CD is a collection of work samples from pre-primary to year 7 children for the 'Draw a map' and the 'Fraction one-third' rich mathematics tasks. Some samples are accompanied by comments from teacher education students on what the samples indicate about children's mathematics understandings and skills. These components of the CD are a resource for future authentic learning and assessment tasks for teacher education students. They provide examples of a wide range of children's mathematical thinking and achievement, and thereby provide a resource for examining the diversity of ways children understand mathematics and demonstrate related skills.

Sample mathematics teaching portfolio items

This component of the CD consists of sample mathematics teaching portfolios completed by fourth-year teacher education students. The portfolios include the following items that have a focus on catering for children's diverse mathematics achievement and learning needs: philosophy of mathematics learning and teaching; two-week program/plan; assessment item; technology item; Indigenous mathematics learning and teaching; and a report of a trial with children of an aspect of the portfolio. These sample portfolios are a resource for teacher education students and teacher educators in that they are models of the development through educational research and scholarly literature of curriculum ideas and related mathematics teaching practices. At the same time they provide models of possible content and communication formats for future teacher education students in the development of their own teaching portfolios.

'Voices from the Bush' vignettes

This component of the CD is a collection of mini-stories of classroom and teaching/living activities in three remote schools. The vignettes are examples of authentic situations and experiences in non-metropolitan locations that can be used as discussion prompts to examine how teachers living and teaching in non-metropolitan communities learn from and cater for 'different' situations and children's learning needs. As such, they are a resource for teacher educators for use for learning/teaching in pre-service education.

Activities, Presentations, and Publications

- Three mathematics showcases (two in November 2008 and one in June 2009) when educators and educational leaders participated as interviewers/assessors for students involved in the project as students presented and discussed their learning related to catering for diversity in children's mathematics learning.
- Two presentations to tertiary educators at the 2009 Teaching and Learning Forum in Perth (January 2009).
- Presentation at the Western Australian Institute for Educational Research Annual Research Forum (August 2009).

In planning for the two presentations at the 2009 Teaching and Learning Forum it became clear that features of the design and implementation of the teaching aspects of the project had relevance beyond the specific disciplines of mathematics education and teacher education. In particular, features concerning authentic learning and assessment activities and involvement of external members of the profession have potential significance to a wide range of professional programs at a



university. Similarly, features of 'feedback' to support student critical thinking/reflection and learning have relevance to a wide range of university programs. Hence, these two presentations were planned with a focus on university learning and teaching in a broad context, rather than the specific context of teacher education.

Accessing Project Material

Project material can be accessed on the ALTC Exchange:

<http://www.altcexchange.edu.au/> on a profile under the name of Dr Sandra Frid and entitled 'Mathematics Diversity Project'.

8 Linkages to Other ALTC Projects

Science for early childhood teacher education students (ECTES): Collaboration between teacher educators, scientists and engineers

The project was designed to make specific linkages in the Bachelor of Education (Primary) degree between the mathematics education, technology education, and professional practice components of the degree. An additional linkage that emerged during the project resulted from the broadening of the project to include the Bachelor of Education (Early Childhood) students because some of these students were involved in the ALTC project, 'Science for early childhood teacher education students (ECTES): Collaboration between teacher educators, scientists and engineers (CG8-724). Although this was not a major development in relation to the total number of students involved (approximately 40), it enhanced their professional learning by providing an opportunity to develop mathematics and science teaching programs for an upcoming school internship in ways that integrated their learning in both disciplines. The project teams organised two occasions when the science team visited classes for the mathematics project.

This integration of the students' professional learning is continuing in Semester 2, 2009 and will be fostered again in 2010 in the students' final year of their Bachelor of Education degree. In addition, there will be an ongoing resource for use in the Early Childhood degree, as a book being prepared for publication as part of the science project will include the integration of mathematics learning into early childhood science learning activities. Staff from this project are contributing to the content of the mathematics aspects of the science book.



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Appendix A – Cycle One Showcase Presentation and Interview Discussion Assessment Requirements

First-Year Students

Mapping Mathematics Poster Discussion Session

You will have your 'posters' displayed, and you and your group members will be 'interviewed' by at least one guest assessor/interviewer in a form of roundtable discussion. The guests will be given in advance sample questions, but they will also include related questions of a similar nature or that invite elaboration upon what you say. Thus, the 'discussion' will be a form of professional conversation or dialogue. The guest assessors will be asked to give some final written assessment comments that will be submitted to the unit lecturers.

Sample Poster Discussion/Interview Questions

1. From analysing children's 'Map to School' work samples, what have you learned about the mathematical thinking and skills of children of a range of ages?
2. What will you include in learning activities to support children in developing understandings of mathematics concepts and skills?
3. What have you learned this semester about catering for the diverse mathematics learning needs you will encounter with any group of children?

Interviews for the Mathematics Intervention Plan and Implementation

For these short interviews, the students have been asked to review their work and learning for the short mathematics intervention they completed with a child. Specifically, they are expected to be able to respond to any of the following questions regarding the mathematics intervention:

1. How did you identify the student you worked with? Was it 'mathematics based' or were there other factors considered that had an impact on the child's learning? How did you use that information in planning your intervention?
2. How did you use curriculum documents and associated resources like *First Steps in Mathematics* in identifying the mathematics the student already knew and needed to know next? What sort of activities did you plan in order to help the student?
3. Did the student learn what you hoped he/she would learn? Why did the intervention activities work, or not work, as well as hoped? What evidence do you have to show that the activities helped the student?
4. Given the short time frame for this project, to what extent would the student have benefited had you been able to work with him/her for longer? What would you do next to help the student?
5. What are your views about this process of identifying individual student weaknesses and then designing an intervention plan to help?



Mapping Mathematics Showcase Reflection

Part A: Pre-Showcase/Interview Reflection

(to be completed individually *in advance* of the Professional Learning Showcase and Interview on 13 November)

1. Outline ways in which your assignment work in ED136 and/or ED134 has helped you to consolidate your learning as a mathematics teacher? (Be specific and use examples to clarify your statements.)
 - (a) **ED136**
 - Exploring Mathematics (Assessment A)
 - Mapping Mathematics (Assessment B)
 - Preparation of poster for the showcase interview/discussion (Assessment C)
 - (b) **ED134**
 - Lesson Plan (Assessment 1)
 - Teacher as Researcher – Plan and Report (Assessment 2)
 - Preparation for the showcase maths intervention interview (Assessment 3)

Part B: Post-Showcase/Interview Reflection

(to be completed immediately after your discussion/interview session)

1. What are your initial reactions to your experiences today?
2. What have you **learned** from participating in the interviews/discussions?
3. What would you do differently if you were to do another showcase presentation and/or mathematics intervention interview next week? Give reasons for your answer.

Second-Year Students

Poster/Interview/Discussion Session

You will have your 'posters' displayed, and you and your group members will be 'interviewed' by at least one guest assessor/interviewer in a form of roundtable discussion. The guests will be given in advance the sample 'interview' questions, but they will also include related questions of a similar nature or that invite elaboration upon what you say. Thus, the 'interview' will be a form of professional discussion or dialogue. The guest interviewers will be asked to give some final written assessment comments that will be submitted to the unit lecturers.

Sample Poster Discussion/Interview Questions

1. What do you think are important principles to implement in the classroom in relation to developing children's mental computation understandings and skills?
2. Many people have a poor understanding of fractions. What are reasons for this situation, and how would you overcome this in your classroom?
3. How would you define 'number sense' and how would you ensure your students develop good number sense?
4. What do you think is the place and role of calculators in primary school mathematics?
5. What are your thoughts on teaching standard written calculation algorithms in primary school?



6. What have you learned about catering for the diverse mathematics learning needs you will encounter with any group of children?

Professional Learning Showcase Reflection

Part A: Pre-Showcase/Interview Reflection

(to be completed individually *in advance* of the Professional Learning Showcase on 13 November)

1. Outline three ways that preparing your showcase poster and preparing for the discussion/interview sessions has helped you to consolidate your learning as a mathematics teacher? (be specific and use examples to clarify your statements)

Part B: Post-Showcase Reflection

(to be completed immediately after your discussion/interview session)

1. What are your initial reactions to your experiences today participating in the Showcase and discussion/interview process?
2. What have you learned from participating in the showcase discussions/interviews?
3. What would you do differently if you were to do another 'interview' next week? Give reasons for your answer.



Appendix B – Cycle One Showcase Interview Assessment Sheet

To the Assessor/Interviewer:

Use the statements in the table below to guide your assessment of the student. You might find it useful to circle or underline statements or components of statement that you see as applying to the student's responses to your questions. This could also include an indication of areas that are 'developing', or are 'well developed'. Then, add any comments you wish to make in the space at the bottom.

The student's responses to your question(s):
are general in nature; the responses would be stronger with use of explanations to justify statements made and/or use of specific examples to add clarity
are succinct yet comprehensive; they show knowledge of principles for effective mathematics learning and teaching
make effective use of <i>specific</i> mathematics examples to show how teaching/learning ideas are put into practice with children
show the student has 'ownership' of the ideas through a capacity to articulate what they think/know, why they think that way, and how one can put the ideas into practice with children

Additional comments/feedback to the student:

Assessor/Interviewer Name _____

Signature _____



Appendix C – Cycle One Showcase Interviewer Feedback Sheet

Mathematics Showcase Day Guest Assessor/Interviewer Feedback

13 November 2008

Thank you for your attendance today and for your contribution to the Education students' assessment program and experiences as developing teachers.

We would appreciate it if you could complete the following brief set of questions. Your responses will assist us in refining our pre-service programs, particularly within mathematics education.

1. Have you participated in the past in this sort of interview?
No Yes (If yes, how often?)

Please comment on your overall assessment of the first- and second-year students' professional knowledge as mathematics teachers (i.e., students who have relatively little experience so far in a classroom).

2. What are your views on how this sort of interview/assessment *supports* pre-service teachers' learning and preparation for mathematics teaching? (Please be specific.)
3. What are your views on how effective this sort of interview/assessment is in *assessing* pre-service teachers' professional learning as mathematics teachers? (Please be specific.)
4. Please comment on how well the students have developed in their professional knowledge concerning catering for diverse mathematics learning needs in a primary school classroom.
5. What suggestions do you have for improving the development and/or processes of this sort of showcase day?
6. Would you be willing to participate in the future as an assessor/interviewer?



Appendix D – Cycle Two Student Interview Questions

1. Tell me about your philosophy of mathematics teaching and how it is in evidence throughout your portfolio.
2. Suppose I want to hire a new teacher who has particular strengths as a mathematics teacher. Why would I hire you over someone else who might be applying for the job?
3. Tell me about your sample program and how you see it as providing evidence of your excellence in mathematics teaching.
4. How does your portfolio demonstrate your commitment and capacities in catering for the diverse learning needs you will encounter with any group of children?
5. What have you learned about effective mathematics teaching through developing an Indigenous item for your portfolio, and how is this in evidence throughout your portfolio?
6. How would you convince a parent or another teacher who has a very 'traditional' view of mathematics teaching that you could implement alternative mathematics activities that would enhance children's mathematics learning?



Appendix E – Cycle Two Showcase Student Reflection Assessment

Part A: Pre-Interview Professional Reflection

(To be completed **in advance** of the Portfolio Interviews on 11 June.)

Outline what you have learned about each of the following through your experiences in Ed440 and preparation of your mathematics teaching portfolio.

1. The process of portfolio development.
2. Catering for diverse learning and achievement needs in mathematics (be as **specific** as possible in your statements, and include examples).
3. Catering for Indigenous students' mathematics learning and achievement needs (please mention, if applicable, anything you learned from the teachers' stories through *Voices from the Bush*).

Part B: Post-Interview Professional Reflection

(To be completed shortly **after** your interview, **before submitting** your portfolio for final assessment.)

4. What are your **initial reactions** to your experiences today participating in the interview process? Give reasons for your comments.
5. What have you learned **about yourself as a mathematics teacher** from participating in the interviews? Give examples to support your comments.



Appendix F – Cycle Two Showcase Interview Assessment Sheet

To the Assessor/Interviewer:

Use the statements in each of the main three columns of the table below to guide your overall assessment of the student. You might find it useful to circle/underline statements in this table that you see as applying to the student's responses to your questions. Then, place a circle around the description and relative number on the line/scale below the table to indicate your overall assessment. (e.g. *Competent 4*).

	• Competent	Excellent	Outstanding
*Demonstrates knowledge of how to:	Engage students in purposeful and appropriate mathematics learning experiences.	Competent, <i>plus</i> : Cater for diverse mathematics student learning needs through application of a wide range of curriculum, teaching and assessment practices	Excellent, <i>plus</i> : Use <i>exemplary</i> mathematics education practices that reflect insight into current evidence-based trends in mathematics education.
Response to Interview Questions	Knows content of portfolio and can talk about the individual items.	Makes use of the portfolio items in a connected, inter-related way. Displays a sense of 'ownership' of ideas by use of appropriate examples and demonstration of both breadth and depth to the outlines of ideas as presented in the portfolio (i.e. is able to 'go beyond' the concise summaries in the portfolio).	Uses portfolio to demonstrate breadth as well depth in one's overall knowledge within mathematics education. Provides elaborated responses that add new and/or innovative dimensions to the discussion. Displays originality, innovation and potential leadership as a mathematics educator.

* adapted from Government of Western Australian Department of Education and Training (2004). *Competency Framework for Teachers*. Perth: DET.

Final overall assessment: (place a circle on the number along the scale)

Performance Rating Scale										
Needs Development				Competent		Excellent		Outstanding		
0	1	2	3	4	5	6	7	8	9	10

Additional comments/feedback to the student: (If needed, the reverse side of this sheet may also be used for comments.)



Appendix G – Pre-Semester Diversity Survey

1. What do you understand the term **diversity** to mean?

2. List three ways in which **diversity** can be catered for in a primary school mathematics classroom.

3. List three examples of how you have seen **diverse learning needs** catered for in a primary school mathematics classroom.



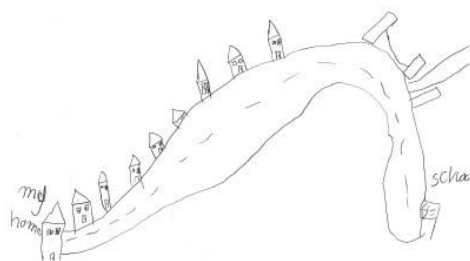
Appendix H – Sample ‘Draw a Map’ Children’s Work Samples and Teacher Education Students’ Comments

Trent – Year 5/6 class



From this work sample we can see Trent probably lives in the country. He appears to have some knowledge of direction as he has clearly mapped N, S, E, and W on his map in relation to the school. In his key he shows fences which suggests he knows the area quite well, enough to map out boundaries. He has also included gravel and bitumen roads in the areas around his home, which suggests he has taken notice of changes in surfaces as they drive along. Trent has also included a cubby and 'Lawrence's house', which we can only assume is a friend's house that he visits regularly enough to know where it is in relation to his surroundings. Trent, being a year 5/6 student, is currently trying to grasp the concept of a bird's eye view, which is shown in his drawing of the crops, however most of his drawing is done from a side view. The trees, houses and even the fences are all at a side view. Some trees are straight, however as he goes around the corners of his roads, the trees are slanted. I thought it was also interesting that the pickets for his fences are sometimes pointing upwards or to the side, and other times downwards, which indicates he has not yet grasped bird's eye view.

Megan – PP/Year 1

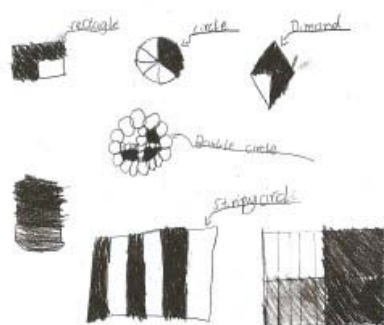


Megan draws the road to school in bird's eye view she while draws the rest of her map in a linear view. Megan also represents that there is a curve on the road she takes to school. I'd like to ask Megan if the school is close to her home or is the one road representing distance.



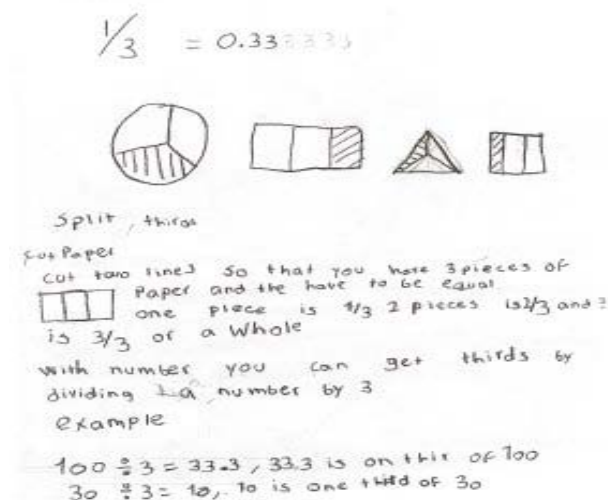
Appendix I – Sample ‘Fraction One-Third’ Children’s Work Samples and Teacher Education Students’ Comments

Teegan – Year 3



Teegan misunderstands the concept of $\frac{1}{3}$. She seems to be trying to demonstrate that three parts are shaded and one left blank. However, most of the examples actually demonstrate $\frac{3}{4}$. This suggests that she may still think of the '1' and the '3' both as whole number, not as part of a whole. The concept is developing but Teegan needs to be clearly shown that $\frac{1}{3}$ is part of a whole.

Breanna – Year 7



Breanna seems competent with her understanding of fractions. She knows that to divide into thirds there must be three equal pieces. Also, rather than using numbers that are multiples of three, she explains that a third can be found by dividing any number by three – including decimal notation for her answer. She demonstrates knowledge of a third in symbols, drawings and with paper in the form of a concrete object.

Appendix J – Factors and Strategies Identified by Students in Portfolio Technology Items for Using Technology to Cater for Diversity in Mathematics Achievement and Learning Needs

Main Factor/Strategy	Sub- Factor/Strategy
Student Factors	• Motivation • Learning styles • Special needs • Personal control of learning • Improving attitudes and confidence
Planning Factors	• Differing achievement levels • Differing rates of learning • Using realistic problems and situations • Providing support and feedback
Teaching Strategies	• Use/adaptability for individual and group work • Provides variety in teaching strategies • Open-ended tasks • Use to simplify or extend tasks/problems
Assessment Strategies	• Provides for a variety of evidence • Learning styles



Appendix K – Factors and Strategies Identified by Students in Portfolio Indigenous Items for Catering for Diversity in Mathematics Achievement and Learning Needs

Strategy/Factor
Develop mathematics activities that have purpose and/or local relevance
Recognise that learning preferences might include observation, imitation, modelling, repetition and demonstration (rather than talking or listening)
Develop mathematics activities that are practical and focus on doing things, kinaesthetic activities, and use of hands/on materials
Make explicit the meanings of mathematical language, and consider ESL needs
Use working with peers and cooperative work, rather than competition
Have a focus on developing relationships with students
Develop curriculum that has cultural relevance and recognises Indigenous world views
Develop communication and collaboration with the community
Be careful about making generalisations about 'differences' between Indigenous and non-Indigenous children, and about 'differences' between different Indigenous groups.



Appendix L – Students’ Pre- and Post-Semester Ideas for Catering for Diversity in Mathematics Achievement and Learning Needs

Second-year students’ main ideas for catering for diversity in mathematics achievement and learning needs

Pre-Semester (July 2008)	Post-Semester (November 2008)
• Different teaching strategies • Multiple intelligences and learning styles • Be flexible and reflective as a teacher • Variety of resources available • Use education assistants and parents to help children • Ability groups • Open-ended tasks	• Use concrete materials and visual mathematical representations • Open-ended tasks • Variety of teaching strategies • Consider learning styles • Be reflective and flexible as a teacher • Use children’s interests • Simplify and extend tasks • Variety in groupings (individual, small group and whole class activities) • Attend to the role of students’ attitudes, motivation and confidence in mathematics • Recognise cultural, ethnic and social backgrounds

First-year students’ main ideas for catering for diversity in mathematics achievement and learning needs

Pre-Semester (July 2008)	Post-Semester (November 2008)
• Plan for special needs and gifted children • Learning styles • Peer tutoring • Ability groups • One-on-one teaching to address needs	• Variety in groupings (individual, small group and whole class activities; mixed and same ability groupings) • Investigations, not just routine ‘calculations’ • Variety in teaching strategies and types of activities • Simplify and extend tasks • Use concrete materials and games • Plan for different learning styles • Give clear directions and explanations



Fourth-year students' main ideas for catering for diversity in mathematics achievement and learning needs

Pre-Semester (March 2009)	Post-Semester (June 2009)
• Variety in activities (e.g., open-ended, real world applications, games) • Multiple intelligences and learning styles • Variety in assessment methods • Variety in groupings (mixed ability, same ability; individual, small groups) • Variety in materials • Use children's interests	• Variety in materials • Open-ended tasks • Variety of teaching strategies • Variety in assessment methods • Learning styles and multiple intelligences • Be reflective and flexible as a teacher; now your children • Use children's interests • Simplify and extend tasks • Variety in groupings (individual, small group and whole class activities) • Use technology • Recognise the role of students' attitudes, motivation and confidence in mathematics • Recognise cultural, ethnic and social backgrounds

