Culture-fair assessment: Addressing equity issues in the context of Primary Mathematics Teaching and Learning

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Abstract

This presentation provides the background and context to the important issue of assessment and equity in relation to Indigenous students in Australia. It draws on the research from an ARC Linkage project that is examining questions about the validity and fairness of assessment. Ways forward are suggested by attending to assessment questions in relation to equity and culture-fair assessment. Patterns of under-achievement by Indigenous students are reflected in national benchmark data (NAPLAN) and international testing programs like the Trends in International Mathematics and Science Study (TIMSS 2003) and the Program for International Student Assessment (PISA). The approaches developed view equity, in relation to assessment, as more of a sociocultural issue than a technical matter. They highlight how teachers need to distinguish the 'funds of knowledge' that Indigenous students draw on and how teachers need to adopt culturally responsive pedagogy to open up the curriculum and assessment practice to allow for different ways of knowing and being.

Introduction

This paper is based on an Australian Research Council (ARC) Linkage research project, examining equity issues as they relate to the validity and fairness of assessment practices. The aims are to provide greater understanding about how to build more equitable assessment practices to address the major problem of underperforming Aboriginal and Torres Strait Islander (ATSI) students in regional and remote Australia, and to identify ways forward by attending to culture-fair assessment (Berlack, 2001).

The research adopts a sociocultural perspective on learning, which views learning as occurring as part of our everyday experience as we participate in the world. This theory of learning does not view a separation between contexts where learning occurs, and contexts for everyday life; rather these are seen as different opportunities for learning (Murphy et al., 2008). It is important to underscore this shift in view to the participants, the activities that they engage in, and the actions that they undertake using the resources and tools available. It moves away from the view that sees the individual as the sole determinant of learning and allows for consideration of the impact of different contexts. As Murphy and colleagues (2008, p. 7) stress when they cite McDermott (1996) '… we can only learn what is around to learn.'

Rationale for the study

Patterns of under-achievement by Indigenous students are reflected in national benchmark data and international testing programs like the Trends in International Mathematics and Science Study (TIMSS, 2003) and the Program for International Student Assessment (PISA). Inequity in Australian education has occurred in the relationship between social background, and achievement, and participation in post-compulsory schooling (McGaw, 2007). A trend of underperformance has continued over the past six years as evident from the comparative analyses of the PISA results, first administered in 2000, again in 2003, and in 2006. There is consistent data across all levels – school, state, national and international – to conclude that Australian schools are not addressing equity issues effectively (Sullivan, Tobias & McDonough, 2006) with Indigenous children scoring significantly lower than non-Indigenous children (Lokan, Ford & Greenwood, 1997).

Research focus

This research is particularly timely and necessary against the background of Australia's under-achievement in terms of equity for Indigenous students and the lack of an informed strategy in the education sector to counter this trend. The key research questions are:

- What are the properties of teacher-constructed mathematics **assessment tasks** that are culture-fair?
- What are the **culture-relevant assessment practices,** as enacted in classrooms using these mathematics tasks with a significant number of ATSI students?
- Does the use of culture-fair mathematics assessment tasks lead to **improved learning for ATSI students** as measured by the National Statements for Learning, the national Numeracy Benchmarks and Years 3 and 5 numeracy testing?
- In a standards-referenced context, how can teachers **develop their assessment capacity** so that more appropriate support and assistance is given to Indigenous students to improve their learning?

Research design

This project is using National Assessment Program – Literacy and Numeracy (NAPLAN) numeracy data for ATSI students in Years 3 and 5 to analyse current teaching and assessment practices. The case study uses eight Catholic and Independent schools from Northern Queensland which have a relatively higher proportion of ATSI students than schools in the south. The focus is on primary Year 4 and middle school Year 6 classes. The numeracy data for each school is being used to identify exemplary teaching and learning practices and the areas requiring support. The extent to which these teaching and assessment practices are effective in promoting achievement for ATSI students is being analysed and interpreted using qualitative and quantitative data analysis. National numeracy data is also being used to measure success and is supplemented by additional measures of achievement from the assessment and learning tasks, developed, moderated and reported.

The project is a 'design experiment' (Kelly, 2003) that involves several cycles of design and development of assessment tasks and eight case studies to identify theoretical principles and design implications for application of culture-fair assessment practice, both within and beyond the immediate study.

In this first phase of this study there are three schools: two teachers from two schools (a Year 4 and Year 6 teacher from each, one of the latter has a Year 6/7 class) and four teachers from the third school (two Year 4 and two Year 6 teachers). The eight teachers were asked to select students (preferably Indigenous) on whom to focus. The total number of Indigenous students is 22 (fourteen Year 4 students and eight Year 6 students).

Phases of the project

The first phase is focused on establishing and developing the culture-fair assessment tasks and culture-relevant pedagogic practices with these initial three schools. This process requires the iterative development of culture-fair assessment tasks, the culture-fair learning and assessment task development resources, and professional development of the teachers and the community. The intent is to develop principles by:

- comprehensive review and synthesis of relevant literature

- analysis and design of the assessment tasks through collaboration with the teacher sample, the mathematics specialists (professional developers) and the Indigenous colleagues
- quality assurance of assessment tasks in collaboration with the teachers and assessment specialists
- documentation of the implementation of the assessment tasks
- collection of artefacts and student work
- analysis of online teacher exchanges
- student and teacher interviews.

The second phase of the research project involves the extension of the development and implementation of the culture-fair assessment tasks and culture-relevant pedagogic practices to include a further five schools.

The final phase in year three involves an evaluation of the implementation of the culture-fair assessment tasks, the culture-relevant pedagogic practices and the learning outcomes.

Data collection

In this first phase, the collection and analysis of data focuses on the effectiveness of the development program in building teachers' capacity to use and develop assessment tasks that are more culture-fair. Data is being collected and analysed from the following sources: semi-structured, telephone interviews of teachers; achievement data (2008 NAPLAN results); ethnographic observations; focus group interviews of students; collection of artefacts; and recordings of conversations of students and teachers via a software package.

NAPLAN data analysis

The analysis of 2008 NAPLAN Numeracy Test data focused on the results of Years 3 and 5 across the three schools. In Year 3 there were 83 students who sat the test: 13 per cent of these students (11 students) identified as being Indigenous. The results in Table 1 indicate that eight out of the 11 Indigenous students (73 per cent) who sat the test received scores that placed them in Bands 2–3. That is, they were at or above the national minimum standard (Band 2) with four students in Band 2 and four in Band 3. Three out of the 11 students (27 per cent) were in Band 1, below the national minimum standard.

There were 72 non-Indigenous students who sat the test. In the non-Indigenous cohort there were three students (4 per cent) who achieved scores at Band 1, 96 per cent at Bands 2–6 with the majority at Band 3 (35 per cent), followed by Band 4 (26per cent). This represents a significant difference between Indigenous and non-Indigenous students' results across Year 3.

In Year 5 there were 80 students who sat the NAPLAN Numeracy Test in 2008. Six or 7.5 per cent of these students were Indigenous and each achieved the national minimum standard (Band 4). Fifty per cent of the students were in Band 5 and 33.3 per cent were in Band 6. It should be noted that the two students who were placed in Band 6 achieved scores of 28 and 26 respectively and the highest score achieved by any student in the cohort was 36. These results raise interesting questions for the research that are yet to be explored.

There were 74 non-Indigenous Year 5 students who sat the NAPLAN Numeracy Test last year. Six of these students (8 per cent) achieved at Band 3, below the national minimum standard. The remaining 92 per cent achieved at Bands 4–8 with 80 per cent achieving at Bands 4–6, 31 per cent at Band 5, 26 per cent at Band 4 and 23 per cent at Band 6.

The Indigenous students performed slightly better than the non-Indigenous students when the Year 5 results for Indigenous and non-Indigenous students were compared. This is in contrast to Year 3 where the Indigenous students' results were significantly lower than the non-Indigenous students' results.

Table 1: Year 3 Indigenous Students

School	Number of students	Ages	Raw Scores /35	NMCY Bands (Band 2 = National Minimum Standard)
School 1	5	7 years 7 months – 8 years 6 months	12– 18	Band 2 (2 students) Band 3 (3 students)
School 2	5	7 years 9.5months – 8 years 9 months	9–15	Band 1 (2 students) Band 2 (2 students) Band 3 (1 student)
School 3	1	8 years – 8.5 months	9	Band 1 (1 student)

Table 2: Year 5 Indigenous Students

School	Number of Students	Ages	Raw Scores /40	NMCY Band (Band 4 = National Minimum Standard)
School 2	4	9 years 6 months – 10 years 7 months	18 - 26	5 (3 students) 6 (1 student)
School 3	2	9 years 8 months – 10 years 4 ½ months	15 - 28	4 (1 student) 6 (1 student)

On average, Indigenous students were 25 percentage points behind the Queensland averages in the number of students who correctly answered each type of maths question (Table 3). When analysing performance in terms of the Numeracy strand, both Indigenous and non-Indigenous students performed best in space questions, followed by number, and lastly measurement, data and chance questions.

Interestingly, the gap column reverses this order and shows that the smallest gap exists between the performance of Indigenous and non-Indigenous students in measurement, data and chance questions. Indigenous students outperformed the Queensland average by 8 per cent in a measurement, data and chance question (Question 29) and the next smallest gap existed in number questions (28 per cent), followed by space questions (28.6 per cent).

Interestingly in the Year 5 results, the data indicates that on average the Indigenous students outperformed the Queensland averages in space and measurement, data and chance questions. They were 5.75 percentage points behind the Queensland average in number questions. Both Indigenous and non-Indigenous students performed best in space questions, followed by measurement, data and chance, and lastly number questions.

Although the sample size is small these results highlight some interesting differences to those reported in the literature and other studies, where the performance of Indigenous students is reported to be lower than what this analysis of last year's NAPLAN data has revealed. At this stage of the project the research team will collect ethnographic data in relation to the individual Indigenous students to investigate more deeply their performance, particularly in relation to those students who have performed really well.

The research team is presently negotiating with the three schools to organise for students who were in Years 3 and 5 in 2008 to resit the NAPLAN test. From analysing the results of the resitting it will be possible to determine how many students may have improved, how many may have flat-lined and how many may have regressed. Also from these results the research team will identify, together with the teachers, practices and properties of assessment tasks that have been implemented to effect change.

Table 3: Year 3 Indigenous Students' Results

Numeracy strand	% Indigenous students who answered questions correctly	% Queensland students who answered questions correctly	Gap
Space	38.8%	67.4%	28.6%
Number	35%	63%	28%
Measurement, Data & Chance	34.65%	54.45%	19.8%

Table 4: Year 5 Indigenous Students' Results

Type of maths question	% Indigenous students who answered questions correctly	% Queensland students who answered questions correctly	Gap * denotes better performance by Indigenous students
Space	58.3%	54.17%	4.13% *
Measurement, Data & Chance	54.2%	53.2%	1.00% *
Number	41.75%	47.5%	5.75%

The professional development program

A series of professional development sessions have been organised for the teachers. The principal investigators developed the program based on identified needs (Warren & de Vries, 2007). The focus of each session aligns with the Numeracy strands: number; chance and data; and patterns and algebra.

Teachers also participate in workshops (every six weeks) designed to develop their skills in the use of a software package developed by HeuLab, entitled Fun With Construction™ (FWC). This is an interactive digital web-board that enables students and teachers to use virtual construction tools such as compasses or protractors. It is a teaching tool and includes the facility to record students' and/or teachers' conversations as they are using the program. This will provide invaluable data for the students' learning processes and problem-solving strategies. The technical consultant has established a wiki on the website for this project and each teacher has access to this site, to files and resources developed specifically for this project (http://arc1.wikispaces.com/).

Indigenous protocols and procedures

At the first of the mathematics professional development sessions, the Indigenous Senior Education Officer led a discussion designed to raise teachers' awareness of Indigenous culture and, in particular, the cultural protocols and practices they need to be aware of when interacting with Indigenous students and families.

In the articulation of teachers' understanding of the cultural protocols and practices, the primacy of relationships, and the need for teachers to build relationships with the families of their Indigenous students, were emphasised. This led to a discussion of the 'whole school approach' that involves two-way interaction between the school and community. That is, the school venturing out to participate in the community and members of the community participating in the life of the school. Indigenous protocols, practices and the whole school approach were presented as pillars that support the school's curriculum.

Table 5: Indigenous cultural protocols and practices aligned to Catholic education policy in Northern Queensland

Cultural protocols and practices
Equal Opportunity – each child is given the opportunity to become an effective learner
Include the community – invite Indigenous community to conduct welcome to country or acknowledgement of country at school functions; build relationships by sharing personal stories
Acknowledge different perspectives in communication – includes languages, knowledge and ways of working
Acknowledge Indigenous culture – traditional, lore (values and beliefs), intellectual and moral property and cultural rights
Maintain connections with Indigenous communities – engage traditional owners and elders; collaborate with Indigenous staff members as a resource
Honour cultural dates and events – no segregation of rituals and family relationships; respect community celebrations such as NAIDOC
Acknowledge cultural dates and events – Celebrate history, NAIDOC; use Indigenous resources, ATSI flags; invite Indigenous storytelling

When asked to explain how these cultural protocols and practices were enacted in practice, teachers were able to provide clear examples. Some of these included:

- Maintain interconnections such as acknowledging the close community between school family and home family
- Be culturally aware: an example given was to ensure that after funerals there is no reference to names of the people who have died, honour the mourning process, and acknowledge that the older brother takes the role of protector of the younger
- Include community through community projects such as the class café where Indigenous family members visit the school
- Recognise cultural differences in terms of the language used at home and adopt different modes of communication such as email, letters and oral language
- Be aware of particular behaviours such as in welcoming, eye contact, body stance.

Structure of the program

The teacher development program involves regular visits to the project schools by visiting mathematics specialists and members of the research team. In February 2009, the principal investigator from Association for Independent Schools Queensland (AISQ) led the first maths session on effective strategies for teaching the topic of number to Year 4 and Year 6 students, and included a focus on pedagogical strategies for Indigenous students. Given space limitations only this session will be discussed here in detail.

The importance of changing pedagogy to incorporate hands-on games and activities, to make use of eye contact and to increase the use of oral language to engage ATSI students in the learning of maths – rather than simply teaching didactically from the textbook – were emphasised. It was acknowledged that students (especially in the early years) need to see and hear the words, feel the sound of the language, and their parents need to be aware that this helps them to learn.

Particular focus was given to the NAPLAN Numeracy Test and the development of teaching strategies to effectively prepare all students for this test. Awareness was raised about how NAPLAN test writers work within a framework that must include written literacy and numeracy incorporating reading, comprehension, oracy (such as discussion), numeracy (such as calculation, graphics), or visual literacy or numeracy (such as diagrams, graphics, etc.). The language used in NAPLAN tests can be difficult for students to decode and understand and examples were given such as test items that are often phrased in the negative, rather than the positive which is used in the classroom and in textbooks. It was suggested that teachers teach using the language used in NAPLAN tests. The issue of cultural inclusivity in relation to the NAPLAN tests was also addressed as currently they are not inclusive and this impacts on the Indigenous and LOTE students' performance.

Difficulty understanding test language and interpreting the graphics results in poor performance for all students. The graphical representations that appear routinely in numeracy testing have been analysed by Diezmann et al. (2009) and include the following:

- Axis language – vertical or horizontal axes
  Number lines, temperature gauge, number tracks
- Opposed position language – vertical and horizontal axis
  Grids, calendars, graphs
- Retinal list language – rotated shapes
  Marks not related to position
- Connection language
  Tree diagrams, network diagrams e.g. flow charts
- Map language
  Road maps, topographic maps, scale in maps (Year 7 students often have difficulty with scales in maps)
- Miscellaneous language
  Venn diagrams (often tested), circle graphs e.g. clocks

A study of graphical representations of the mathematics tests in Years 3 and 5 over the past 11 years identified that opposed position language was used in 67 per cent of tests and axis language was used in 11 per cent of tests (De Vries, 2009). These statistics highlight the necessity for students to learn how to read and interpret these graphical representations so that they can access successfully the literacy (and/or the literacies) demands of the test items. Teachers also need to show students the many different ways in which the graphics can be used to represent opposed position language, such as are used in calendars or temperature gauges.

Implications for pedagogic practice

A number of pedagogical strategies were recommended to the teachers and some were identified as being more culturally appropriate. Recommendations included:

- Read the questions aloud
- Instruct students to highlight keywords
- Teach students how to adopt a process of elimination with multiple-choice questions
- Engage Indigenous students in more interactive, 'hands-on' activities
- Encourage students to attempt every question or activity
- Encourage students to deconstruct the question or item
- Discuss the process or strategy used in completing questions
- Be creative in the use of textbooks by opening up discussion about certain questions
- Give more open-ended questions for problem solving
- Encourage peer learning
- Use whole class or small group activities
- Encourage individual problem solving.

The following inclusive practices were advocated:

- Commence with an activity where all children experience success
- Develop sequential steps to build on number facts introduced and to gain confidence in answering questions and solving problems

- Implement strategies by use of posters of different question stems and have students indicate when a particular question stem has been used
- Incorporate into daily and weekly teaching activities practices such as the use of the discourse of testing, and the deconstruction of test items to develop student familiarity with the language of testing and the types of test questions or mini-investigations
- Use of number games to be completed for homework so that parents or caregivers can engage and encourage the enjoyment of mathematics learning both at home and at school.

Teachers' implementation

The telephone interviews of the teachers sought to investigate:

- The extent to which the teachers had implemented these activities and strategies into their classroom practice
- Their views on how effective the strategies had been in assisting students' learning of the maths concepts that the tests and tasks are designed to assess.

All eight teachers interviewed were very positive about the number strategies and activities and 25–50 per cent indicated that they had used particular strategies/ activities. Given the focus on culture-fair assessment, the teachers were also asked the extent to which the professional development sessions had raised their awareness either in terms of culture-fair assessment or culture-responsive pedagogy. At this stage of the project more ethnographic and qualitative data needs to be collected to identify any changes to pedagogic practice and any development of culture-fair assessment.

It is also difficult to make a fair assessment of the value of the software program –at one school the software had just been loaded onto the computers and in the other two schools the software had been loaded onto the teachers' laptops but not onto the classroom computers. Consequently only four of the teachers were positive about the potential for the use of this program in their classrooms. The teachers indicated that they had not had much opportunity to either learn the software themselves or to use it with their classes.

Conclusion

These are early days for this project; however the anticipated outcomes from the assessment and pedagogic approaches under development will advance knowledge to include more 'culture-fair' assessment practices. There is much data to be collected and to be more theoretically analysed. The view of equity that underpins this assessment project is more of a socio-cultural issue than a technical matter. Equity involves much more than a consideration of the specific design of the tests or tasks. As can be seen from the initial data collection and analysis, whether all students have access to learning is fundamental; equally important considerations are how the curriculum is defined and taught and how achievement is interpreted. The opportunity to participate in learning (access issues) and the opportunity to demonstrate learning (validity and fairness in assessment) are deemed fundamental factors in developing culture-fair assessment (Klenowski, 2009).

The differential performance of students from different cultures may not be due to bias in the choice of test content or design alone, but may be attributable to real differences in performance because of these students' differing access to learning, different social and cultural contexts, or real differences in their attainment in the topic under consideration due to their experiences and socio-cultural background. As is apparent from the professional development program organised for this design experiment, the content and mode of the NAPLAN assessment tests are outside these students' experiences and they limit their engagement with the tests as the students position themselves as not knowledgeable in this particular assessment context.

The intention of culture-fair assessment is to design assessments so that no particular culture has an advantage over another. The purpose of culture-fair assessment is to eliminate the privileging of particular groups over others. It is however difficult to claim that assessments can be completely culturally unbiased. To achieve culture-fair assessment there is a need to address issues in language, cultural content, developmental sequence, framing, content and interpretation, and reporting. The sampling of the content for assessment, for instance, needs to offer opportunities for all of the different groups of students who will be taking the test. Assessment interpretations of students' performance need to be contextualised so that what is, or is not, being valued is made explicit as well as the constructs being assessed and the criteria for assessment. To achieve culture-fair assessment the values and perspectives of assessment designers need to be made more public. Further, to understand how culture-fair assessment practice is developed and attained requires this careful study of how the learning experience is modified by teachers for particular students to achieve engagement, participation and improvement in learning. This is now the focus of this project.

References

Berlack, H. (2001). Race and the achievement gap, *Rethinking Schools Online, 15* (4). Retrieved October 31, 2008, from http://www.rethinkingschools.org/archive/15_04/Race154.shtml

de Vries, E. (2009). PowerPoint presentation, Cloncurry, Queensland.

Diezmann, C., Lowrie, T., Sugars, L., & Logan, T. (2009). The visual side to numeracy: Students' sensemaking with graphics. *Australian Primary Mathematics Classroom, 14* (1), 16–20.

Kelly, A. E. (2003). The role of design in research. *Educational Researcher, 32*(1), 3–4.

Klenowski, V. (2009). Australian Indigenous students: Addressing equity issues in assessment. *Teaching Education, 20,* (1), 77–93.

Lokan, Jan. & Ford, Phoebe. & Greenwood, Lisa. & Australian Council for Educational Research. 1997 *Maths & science on the line : Australian middle primary students' performance in the Third International Mathematics and Science Study / Jan Lokan, Phoebe Ford, Lisa Greenwood* ACER, Camberwell, Vic. :

McGaw, B. (2007, August 1). Resourced for a world of difference. *The Australian,* p. 25.

Murphy, P., Hall, K., McCormick, R., & Drury, R. (2008). Curriculum, learning and society: *Investigating practice. Study guide, Masters in Education*. Maidenhall, UK: Open University.

Sullivan, P., Tobias, S., & McDonough, A. (2006). Perhaps the decision of some students not to engage in learning mathematics in school is deliberate. *Education Studies in Mathematics, 62*(1), 81–99.

Warren, E., & de Vries, E. (2007) Australian Indigenous students: The role of oral language and representations in the negotiation of mathematical understanding. In J. Watson & K. Beswick (Eds.), *Proceedings of the 30th annual conference of the Mathematics Educational Research Group of Australia.* Australia: MERGA Inc.