Structured Failing: Reshaping a Mathematical Future for Marginalised Learners

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In this paper I draw on a particular case that encapsulates some of the most extreme elements of educational disadvantage – poverty, remote location, English as a foreign language, cultural diversity and Aboriginality – to provide a lens for understanding the complexity of coming to learn school mathematics. In so doing, I illustrate the need for a greater understanding of the intersection of various factors that limit the opportunities for success in school mathematics. The objective of this paper to provide an understanding of the complexity of teaching in remote contexts that will challenge current practice and move to a more holistic model for conceptualising research, practice and policy in mathematics education that may enable greater access to mathematics and schooling for some of the most disadvantaged students in Australian schools.

Learners from particular backgrounds have a greater chance of failing school mathematics than their peers from mainstream, middle-class backgrounds. A popular mythology is that this is due to some innate ability and one that has considerable acceptance in school mathematics. This standpoint preserves the hegemony of school mathematics and perpetuates its status, while reifying the structured failing of too many students. In this presentation I will propose a model for analysing the structured failing of students who come from particular social, cultural, regional and language backgrounds. Increasingly, policy makers, educationalists, researchers and the wider public recognise that there is something inherent in mathematics education (and schooling) that works against the success of some students. The solution cannot be found in looking from a mathematical lens but must be much broader if increased access to mathematics education is to be a reality of the future.

In this paper, I draw on my past twelve months in the field where I have been working in one of the most disadvantaged contexts in Australia. The experience has shown me how limited a researcher‘s perspective can be when we undertake ‗fly in fly out‘ research. The complexities of teaching and learning in these contexts are elusive when approaching research in this way. In structuring this paper, I provide a scenario from the classroom in which a young Anangu student was working on some activities around equivalence in fractions. Drawing on this scenario, I then discuss the multitude of factors that facilitate or hinder mathematical learning. From this I conclude that learning mathematics must be considered in the context of learning so as to build a much stronger theory of learning mathematics, particularly for learners who live in worlds different from mainstream education. Finally, I discuss the implications of these earlier considerations on teacher education.

In writing the paper, I draw on the theoretical constructs of Bourdieu (1977; 1990) – game, habitus, field - but deliberately do not extend these. Such extension is beyond the scope of this paper. Familiarity with the constructs has been assumed. My key intention is to unpack the complex milieu in which marginalised students are working and trying to make sense of school mathematics, often with limited success.

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Equivalent Fractions: An Exemplary Case

The classroom is in a junior secondary in a remote Aboriginal community. As is culturally-appropriate in this context, young men and women are taught separately with a teacher of the same gender. On this day, the female teacher is working with the only female student. There is some revision around fractions using a commercially produced resource that has pizzas divided into halves, quarters, eighths and sixteenths. Another set of pizzas is divided into thirds, sixths and twelfths. The teacher is working with the student, Anastasia[5] and asking the usual questions that require her to articulate how many pieces in the different pies. The sequence was originally on the halves and then extended to other denominations.

T[6]: How many halves are there in the pizza?
Pause
S: two
T: That's right. So how many quarters are there in that pizza?
S: Two
T: mmm so how many quarters in that pizza?
T: points to the pizza with quarters
S: (Smiles) Four
T: Good, so you do know this stuff. That's really good

This type of interaction continued through different quantities of fractions. What became increasingly apparent throughout the interactions was that as the teacher posed a new question on a given fraction (such as half or quarter), the student would reply using the previous answer. After about 6 of these questions, the student appeared to understand the game behind the questions being posed.

The teacher then moved into equivalent fractions. A similar process occurred with this game question. The moves in the interaction saw the teacher a series of questions as to how many smaller parts _made up' a part of a whole. Initially Anastasia relied on the questioning strategy in the first question sequence as to how many made up the whole. It appeared that she took her cue for the questions from the initial stem in the question. This is shown in following extract:

T: So how many quarters make a half
S: four
T: Have a think about it again… how many quarters make a half – one of these (points to half a pizza).
S: two
T: Great, that is good. You are very clever. I knew you'd learnt this before. So how many eighths in a quarter?
S: Eight
[teacher repeats process to draw attention to the part of the part process]

After a few examples, the teacher then draws on two strategies to highlight equivalence. Both are used concurrently. The teacher writes on paper the 4 to 8 relationship of how many eighths in a quarter trying to illustrate the doubling/halving process so that the –two-ness' can be shown with figures. Many questions and much talking is focused on the numerical relationships. Anastasia, however, relies heavily on visual cues, often taking the smaller units to make the larger unit - e.g. two eighths to show how it is visually the same as one quarter. However, at no time does she place the pieces on top of each other, and each time she manipulates the objects it is an immediate

[5] This is a pseudonym for the student.
[6] T is used to indicate T and S is used for Student

recognition – that is, she immediately would take 2 eighths or 3 sixths to create the equivalent.

In the final part of this section of the activity, Anastasia made a whole pizza using pieces scattered around the table. These were varied in sizes (quarters, eighths, and sixths. She took pieces and worked them to make a whole. The final piece, a quarter, was not taken by trial and error but with perceived automaticity in recognition of the size. It appeared from this interaction that the student relied heavily on visual recognition for identification of size and equivalence. There was little reliance on the use of numbers.

In the next section of the activity, the teacher moved to the use of computers and a fraction game where the student would have a nominated piece (such as ¾) and had to place on a number line that had denominators in twelfths. The initial strategy was to hang the monkey on the hook that had the same numerator (i.e. 3/12). This did not work of course. The teacher then used a range of strategies that relied on a cross multiplying strategy to find the equivalence. This created great confusion as in one game the multiplier was 4 when the piece to be hung on the line was in thirds (2/3) and the next piece was ¾ so needed a multiplier of 3. Anastasia appeared confused with this irregularity in multipliers. At some points she would rely on drawing lines in clusters to show that there were four groups of three so that ¾ could be seen to have nine twelfths.

What is poignant in these observations was the non-reliance on number to understand fractions. Anastasia's work was heavily drawing on visual thinking. It appeared that she struggled to understand the use of numbers and the ways in which numbers could be multiplied. Her strategies were very reliant on being able to create visual representations. As in the pizza work, her capacity to respond to teacher questions, once she accessed the game the teacher was using with her questions, was very much in the visual.

Of further note is that the language background of many remote Aboriginal students is very heavily in their home language. In this case, the student was a Pitjantjatjara speaker whose main contact with Standard Australian English was through school and if she interacted with non-Aboriginal people in community, or if she went to a regional centre. For many remote students, Australian English is a foreign language. This makes questioning students about metacognition an almost impossible task without the use of an interpreter. Even then, the home language of the student often does not have the language structure to enable appropriate responses to be developed due to the mathematical concepts not being a (natural) part of that culture and hence language.

In the following sections, I seek to analyse the interaction with Anastasia to highlight the problematic engagement with mathematics in particular, and schooling in general for remote Aboriginal learners. In doing so, my goal is to draw out the need for new education and research paradigms that may seek to explore the complexity of assimilationist education. This proposition may be construed negatively but I contest this. By its very nature, Western education should be considered to be assimilationist. It represents particular worldviews that are incongruent with many Aboriginal cultures. Coming to learn school mathematics requires a conscience effort to take on board the knowledge structures of Western thinking and rationalism

Closing the Gap: A National Initiative

The Federal Government espouses a commitment to ~~"c~~losing the gap" between the first nation people of Australia with the rest of the nation with priorities in the areas of health, housing and education. Undeniably the statistics for first nation people represent a national disgrace in terms of provision and outcomes. The Rudd government is putting significant

amounts of money into a range of initiatives to address the gap between First Nation people and the rest of the nation.

However, in considering the Rudd initiative, consideration must be made of the differences among First Nation People. The AAMT initiative –Make it Count" recognises these differences and has strategically focused on working with First Nation people in regional centres rather than remote. Similarly, Pearson cites research where it was found that First Nation people who marry outside their culture and live in urban areas are more likely to have children who will engage with schooling and become successful in their studies and transitions to work. For a plethora of reasons, this is far more difficult to achieve in remote communities.

While there are many aspects of the –Closing the Gap" initiative that can be criticised, the intent of the Government is heavily focused on addressing the inequalities in outcomes between First Nation People of Australia and mainstream Australians. This gap is significantly increased when remote living is considered. In education, this is most evident in the NAPLAN testing where remote Aboriginal students are consistently underperforming nationally. A recent announcement by the Federal government (Patty & Harrison, 2010) was their intention to reform preservice teacher education so that teachers would be better prepared to work in remote locations to develop better programs and be able to cope with remote living. Aboriginal activist Noel Pearson has influenced government significantly with Aboriginal and Torres Strait Islander advice. He is a strong advocate for quality teachers being sent to remote sites as he sees this as a strong factor in bringing about quality education to remote students. However, what is seen as –quality" in one context may not directly transfer to the new context. Transposing urban ways of living and schooling into remote settings may meet with opposition and failings as many of the assumptions underpinning urban education may be quite different from remote contexts.

Worldviews : The Clash of Cultures and Ways of Working and Being

The difference in worldviews between Western education and remote Aboriginal cultures is widely recognised as a considerable issue in First Nation education but how this has been built into education reforms is at best a very mixed bag. For example, in the Northern Territory (NT) bi-lingual education was abolished in late 2009 as it was seen not to have met with success while in the Kimberley region, bi-lingual education in the early years is seen as a key to educational reform. Having children come to school strong in their home language but weak in Standard Australian English has resulted in an early years bilingual program in the Kimberley (with considerable resourcing) when it was being ceased some few hundred kilometres away in the NT after being operational for a number of decades in the neighbouring state.

Aboriginal students in many remote areas are still very strong in their home cultures and languages. This is most evident in the desert regions of Australia – the APY lands in South Australia, most of the Northern Territory and the far north of Western Australia. Aside from language issues, many of the cultural norms create dissonances between expectations of the learners with formal schooling. These barriers are quite profound and contribute significantly to the poor attendance in these regions. These need to be an integral part of coming to understand the impediments to learning that are beyond the bounds of mathematics education yet contribute significantly to them.

In terms of mathematics education, the immersion in a numerate and literate culture as represented in school knowledge is not part of the habitus of most communities in remote areas. The exposure to written text and number is almost non-existent in communities and

the home. Taken-for-granted aspects of mainstream Australian culture are not evident in remote communities or families – often birthdates are not known or seen to be important; students' names can change many times (both first name and family names); street names and numbers are not present in communities; most families do not have a home phone or computer (or written texts). These absences represent significant challenges to creating bridges between the home and school.

The culture among Anangu people is very strong. For many young people this means that they undertake particular cultural activities that mark the transition into adulthood. In becoming adults, the young person is able to choose whether or not to come to school. This transition into adulthood can occur as young as twelve years of age, thus limiting the time in school significantly.

Life in remote areas has created a very different way of being and living in the world. Long and medium term planning is absent so the premises upon which must of Western education is built, particular mathematics, are missing from the habitus of the learning. Number is not an important aspect of desert life, particularly big numbers. A recent case of an Anangu family wanting to buy a car from a resident saw the Anangu family come to the buyer indicating they had the cash. The car was for sale for $7000 but the family had $700 and were very disappointed that they could not take the car. This confusion with big numbers is a common occurrence. The level of trust required by non-numerate people to live in a numerate world can only be considered phenomenal but also very disempowering.

If we return the original case at the opening of this paper, the impact of the worldview becomes foregrounded. In this case, Anastasia did not use number in her solution of problems. Her initial visual strategy allowed potential for success and helped with some aspects of the computer game. However, the need to move forward with the concept of part number will be contingent on the possibilities to use number sense. However, this is likely to be severely limited due to her restricted sense of number – both whole number and part number.

The linear logic that is integral to a significant portion of teaching school mathematics is not part of the Anangu habitus. In solving the fraction problems using visual strategies offered different potential for solutions but this strategy limits the extension of that knowledge. This was very evident when Anastasia tried to work out the equivalent fractions needed in the computer game. Visual strategies were far less successful in this type of problem. The logic needed focused on relationships between number families (such as half, quarter, sixths and twelfths). Seeing relationships and then applying a logic to these to find and calculate equivalence was not evident in the strategies observed.

Furthermore, Anangu culture focuses in the "here and now" and does not adequately include a futures perspective. This is evident in much of the 'planning' undertaken in Anangu events. For example, in one community, there is a "Yellow Bus" (an American-type school bus) that is used to take members of the community to events such as funerals or football/sporting events. The travellers are expected to cover the costs of fuel. When the bus leaves, it is filled by the amount of money people have contributed which inadvertently means the bus frequently runs out of fuel on long trips (and every trip is a long trip in remote Australia!). The events are so frequent that the local shire managers have requested that travellers will need to put up the fuel money prior to departure from community. There are numerous tales that highlight this aspect of Anangu "planning". The capacity to plan is a key part of the Western rationality and relates strongly to financial literacy. However, many of the financial literacy packages available to schools are premised on a Western notion of forward planning and budgeting which is not part of the Anangu habitus. Thus, to

be able to participate in such learnings, a reconstitution of the Anangu habitus is necessary if there is to be success.

A common observation of students is their reliance on a range of strategies that are different from those common to mathematics teaching and learning. The systems of reasoning are not those of Western education so remain invisible to teachers and hence cannot be drawn upon to transition students into Western mathematics. Hypothetically, what this disjunction between the two ways of knowing and doing may be the root of the failure observed in the NAPLAN data that appears in late primary school. It is here that differences in performance appear to grow. While it may be a function of attendance, the failure to attend school could be, in part, associated with the failure to walk in both worlds and experience success.

Language Barriers

The language of instruction and mathematics offer particular barriers to learning. In Pitjantjatjara there are only a few prepositions in comparison to the 60+ in English. Coming to see equivalence requires a language of number, fractions and prepositions (for transposing fractions) as well as the language games that are used in the teaching episodes. As I have argued in many papers, the language games that are played in mathematics classrooms represent a particular cultural form and access to mathematical understandings is contingent upon ‗cracking the code" of school mathematics.

What can be seen in the interactions between Anastasia and the teacher is a typical pedagogic interaction where the teacher poses questions to scaffold learning. However, what can also be seen is Anastasia trying to make sense of the pedagogic interaction. In the first set of interactions, the game is for her to be able to articulate how many items in the whole. I suggest that in the first interaction where the teacher poses the question of halves and she replies two, this answer is then offered again for quarters (i.e. two). While this is incorrect, I contend that this interaction is similar to the others where Anastasia is trying to interpret the game that is being played as much as trying to work out the mathematical ideas that are embedded in the interactions. This guessing the game, which I draw from the work of Bourdieu (1977; 1990), is one that is common among students for whom the game is not part of their familial habitus.

In the second set of interactions, there is a shift in the game. Here the teacher is no longer talking about the whole but focuses on parts of the whole so the student has to try to make sense of this shift. What can be seen is that Anastasia is trying to guess the game by drawing on the key words used by the teacher. In this case, it appears that her responses draw on the words of quarters and eighths and these are the cue words to which the student responds. Over the subsequent interactions, the student anticipates the game and understands that the questions are now relating to the parts and parts relationships.

What is not shown in the earlier transcripts is how the teacher also writes the fractions on a piece of paper using numerical representations. These, however, are not used by the student who relies on her visual strategies. The interactions around the numerical representations did not appear to make sense to the student who would look at the teacher as she wrote but then return to the manipulation of the pizza fractions.

Student Attendance: The Greatest Barrier to Learning

In using the case of Anastasia, it is not my intention to draw attention to one particular student. Rather, the examples drawn from the one example have been used to highlight the

struggles faced by students and teachers in remote communities as they try to teach school mathematics. The issues to which I have drawn attention are embedded in the clash of cultures between that of school/mathematics and that which First Nation learners bring to school. There are many areas that need to be addressed if there is to be a closing of the gap in Indigenous performance and outcomes in education. However, I would contend that perhaps the biggest hurdle to success is attendance. The poor attendance, and subsequent engagement when attending, is the lynchpin to success.

The attendance issue is endemic and needs to be addressed seriously if First Nation students are to succeed in Western schooling, and mathematics. Funding regimes are premised on the notion that for success in schooling, students must attend 80% of the time. Schools are measured against this. However, the slipperiness in attendance records denies actual attendance and, moreover, engagement. In many remote communities, formal learning is not part of the habitus of First Nation people so the concept of schooling is not integral to their worldviews. This impacts significantly on students but also teachers. The high turnover of staff in remote areas is a reflection of the harsh conditions of remote life of which the job satisfaction levels are limited by the engagement of students. As one teacher commented, "I did not train for four years to have no students in my class" as she nearly broke down with the frustration of poor attendance, student walk outs and the perception of school being a 'drop in' centre.

Planning quality learning experience with irregular attendance is a considerable challenge for remote teachers. Not knowing who will come to school on a given day (or part of the day) means that planning for learning is a complex task as the diversity in any one class is immense.

NAPLAN and National Curriculum: Inclusion or Exclusion?

The above arguments are drawn together with the culmination of NAPLAN testing. Without being critical of the testing scheme as a whole, I intend to draw attention to the inappropriateness of these tests for remote First Nation students. The capacity to answer the questions in Year 7 and Year 9 tests is severely limited. The tests are administered by age yet by the time students are in Year 9 many would have been lucky to have attended the equivalent number of days as a primary school student in Year 5. The chronological age of the students is a poor indicator of time in school and hence the tests are targeting the dominant group in Australian society, those who have attended school for most of their lives. This is clearly not the case for most remote students.

The diversity within a classroom may present one set of challenges to teachers, but a tension with this diversity is the students' desire to be the same as their peers. This meant that the recent tests identified particular students to sit the tests. The fact that they are set apart from their peers is problematic. A more appropriate approach would be for all students who attend to sit the test so that the isolation is not obvious.

> Regardless of their capacity to sit the test or read the booklet, the students all like to be the same. They all like to do the same thing. Having some sit the test and others not sit is more likely to result in all the students walking out. A better solution is for all of them to sit it.

Furthermore, teachers expressed frustration with the test. The levels were well above what was possible. The Year 9 test was above the capacity of the students, as well as the relevance of many of the questions and reading materials. For example one reading item consisted of three related items about gorillas and the impact of mining in the region that resulted in land clearing, which in turn, drove gorillas out of their environment making

them easier for poachers to catch and kill. The experiences of remote First Nation students are very tied to their country and the immediate areas around that country.

> The tests are not set up for our students. They are meant to fail them. It is a waste of their time, our time and government money. Once they realise the tests are on, they don‘t come back the next day.

This last point should not be lost. The students are proactive in voting with their feet and do not return to experiences that they do not enjoy. NAPLAN was not something that they found useful or enjoyable. No student sat more than one test.

National Curriculum

The capacity to deliver a national curriculum in remote areas is perhaps one of the biggest challenges to First Nation education. For the reasons cited in the preceding sections of this paper, I would contend that the priority for remote education is to enable First Nation students the right to be literate and numerate in the first instance and then to consider priorities in curriculum.

Past practices in remote education has often been focused on attendance and entertainment. Creating environments that allow students to draw on their culture (e.g. music, dance, art, football) or interest areas to ensure that they attend school may have put other learning areas (such as literacy and numeracy) at risk. The considerable catch-up required due to poor attendance means that priority areas must be integral to First Nation education. Already NAPLAN data suggest that literacy and numeracy are at worryingly low levels and that the gap widens with the time in school. Having priority areas of learning for remote First Nation people must be a serious area for discussion.

The challenges faced by teachers in remote areas are already enormous. Placing further demands on them when they are barely able to meet basic levels of literacy and numeracy engenders greater burnout and dissatisfaction. This is not a moot point. One of the key factors in success is stability of the teaching staff yet teacher turnover in remote education is very high.

Implications for Teacher Education: Preparing to Teach Mathematics

If the Rudd government is serious about the challenges of creating success for remote First Nation students, then closer scrutiny of the complexity of teaching and living in remote Australia must be a prime consideration. If the Rudd government wants to take a proactive stance in the preparation of teachers to work in remote communities, then particular notice needs to be taken of the whole context. Before I discuss implications for teacher education, a powerful point must be made. It is not the sole responsibility of teachers to ensure that First Nation students are successful in school or mathematics. There are many factors that contribute to success. Perhaps, the most important factor is attendance. This is a whole of community responsibility. Teachers can only do so much to encourage students to come to school. In many communities teachers have to drive around the communities prior to school to collect and bring students to the school. Some teachers have to conduct community meetings and work with communities to develop strategies for coming to school (such as ―no school, no pool" policies, or closing the community store if the numbers in school are low; or developing incentive plans to reward attendance). Attendance is a community issue where all parties must work collectively to ensure attendance at school. Without attendance, regardless of how good a teacher may be, there is little chance to achieve success.

As I have attempted to show in this paper, researching mathematics education in remote contexts must capture the multitude of factors that impinge on learning and teaching. While it is easy for us as community of mathematics educators to focus on our discipline, it cannot be considered in isolation of the contexts of learning. Failure to recognise these factors isolates us from the reality of the classroom, the schools, the communities and the field of education. As such, the impact of our research possibilities is limited. Quick fix solutions will not address the entrenched failure that is enmeshed with the context of learning.

Of most significant importance is the prime need for students to attend school on a regular basis but also when in school that there is engagement with learning. While cultural issues of shame feature strongly in teachers‘ minds when trying to extend learning and not wanting to embarrass learners, or for learners to walk out rather than engage, strategies need to be developed that shift the habitus of the learner from that of the home culture to that of the school culture. Explicit teaching of these skills and dispositions is increasingly important if there is to be some change in outcomes.

Teaching the game of schooling and interactions is also important. Bourdieu‘s work on games shows how the game of schooling is not taught explicitly but acquired through engagement with the game. One way of learning how learning happens in First Nation culture is for teachers to try to learn something new from the students (such as card games or other gambling games). There is little explicit teaching but rather modelling or apprenticeship type approaches. Coming into the school context represents a very different teaching approach that is clouded with other factors (such as language and mathematical concepts and ways of thinking and working) that are not part of the familial habitus. If First Nation students are not engaging with the schooling, then it is increasingly difficult to engage with the game of learning.

Tenacity is a disposition that is needed for teaching in remote communities. Not only in relation to the hardships (and joys) of living remote, teachers must also learn to develop resilience to the on-going task of engaging students who do not see education as part of their life or world. There is often a feeling of groundhog day where the impact of teaching is minimal One teacher commented that he felt that working with remote students felt like

> You work all day with them and you think that they have it. Then at night, something miraculous happens. Something comes into the community and sucks everything out of their head. Then they come to school the next day and you have to start all over again.

Most of the models of planning taught in pre-service teacher education fail to prepare teachers for the conditions they will encounter in remote communities. The ―revolving door” phenomenon in remote classrooms means that students, particularly adolescents, may drop in and out over the day, week or month. This means that the usual planning processes adopted by teachers fails to account for this type of teaching. More flexible models that cater for diversity in the learners as well as their knowledge systems are essential for these contexts.

What I have sought to do in this paper is to provide some insights into the failure of First Nation students in school mathematics. Rather than see such failure as due to innate ability of the learner or the failure of teachers to provide adequate teaching, I have argued that failure is complex and new ways of thinking about education provision must be addressed. Mathematics education, if it is to redress structured failings must take a much more holistic approach to educational research and practice that encompasses the multitude of factors that work for success.

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