Plenary Lecture 3

Equity in Mathematics: What Does It Mean? What Might It Look Like?

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ABSTRACT In this plenary lecture I draw on the findings and subsequent analysis of a large 5-year project that was conducted in some of the most disadvantaged contexts in the Australian educational landscape — remote and very remote Indigenous communities. The intent of the project was to develop an understanding of the successful practices adopted in these schools that were creating success for Indigenous learners. It was a strength-based project and intentionally moved from deficit models to one that sought to document what was working in these schools. It was not interventionist but rather drew on the knowledge of those working in the field, those who experienced the contexts, the learners, the communities and sought ways to build success. It was grounded, and ethnographic in its design. This plenary, and paper, shared the outcomes of the study. The implications of the learnings from this research have application to other equity contexts

This plenary lecture was based on the findings from the "Success in Remote Indigenous Communities" project[2]. The project sought to investigate, document and celebrate the numeracy successes of schools working in remote and very remote Indigenous communities. These communities are seen as the most disadvantaged communities in the Australian educational landscape. The project focused on the practices of those schools. Using an ethnographic case study approach, project was not evaluative since a fundamental premise of such an approach is to document what, and how, practices are contributing to the success of Indigenous learners in these contexts. The project adopted a strength-based approach, so underpinning the ethos of the project was a celebration of the work being undertaken in selected remote schools. Such successes would documented and shared with others. A website, hosted by Stem Educational Research Centre at the University of Canberra, acted as repository for the case studies and could be freely accessed by any educator or other persons interested in learning of the success of these schools. It was intended that such case studies could support others working in similarly challenging contexts and provide practical ideas to support their work A final, summative report was developed to augment the case studies so that an overarching sense of the schools, the participants and the practices could be developed. This Plenary Lecture is a synopsis of that project.

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1. Equity in Mathematics Education

Foundational to this Plenary Lecture is the notion of equity as it applies to mathematics education. Many terms are used in this domain and many are rooted in particular paradigms and ideologies. When discussing equity, the domain from which I operate is critical sociology. This domain of thinking shapes the actions and patterns of thought of the researcher such that there is an assumption that in some ways schools are set up to reproduce social inequalities and the task of educators and researchers is to challenge the reproductionist agenda to bring about change. It is structuralist in its orientation so that practices that are adopted in mathematics education often reproduce social inequalities, often at a very subconscious level.

Often in mathematics education we see researchers and systems adopt practices of the past with the intent that they will bring about positive outcomes for learners. An example of such an approach is the adoption of Direct Instruction (DI) (Kinder and Carnine, 1991) in remote Indigenous contexts in Northern Australia. This is a model of pedagogy formed in the 1960s in the USA to work with disadvantaged learners. Since the 1960s there have been significant advances in research and pedagogy as to what constitutes quality learning and pedagogy yet the education systems in Australia have adopted an antiquated model of pedagogy for implementation in remote Indigenous schools. Some critical educators have been quite scathing of the rollout (and costs) of DI in remote Indigenous schools (Guenther and Osborne, 2020) while other conservative educators advocate the success of the program (Pearson, 2020). The difference between the two perspectives was the data upon which they drew to mount their cases. What is clear is that the expense of implementing DI (in excess of $20 million) in these communities has been very high while the outcomes have been limited and their sustainability has been questioned (Luke, 2014).

From an equity perspective, there is a need to do things differently as the practices of the past have reified social, cultural and linguistic differences so that such differences have been normalised and seen as part of the natural order, thus preserving the status quo. From a critical equity perspective, those who have been marginalised in their access and success in mathematics need to be treated differently so as to reduce the gap in outcomes. Treating learners the same as other learners will only help to reify social and educational differences. That is, not only in terms of mathematics scores, but also in terms of attitudes towards mathematics, continuation in the study of mathematics, application of mathematics into contexts beyond schools.

2. Method

The project was funded to undertake 32 case studies but for a number of reasons, the final project involved 39 schools. Some of the case studies, however, were not published. This was due to a range of issues including the lack of triangulation between the views of the leadership teams and the practices described or observed of the teachers, or lack of coherence in the data sets or the timelines not being met for approvals for inclusion of the case studies.

Schools were initially selected on their performance on National Assessment Plan for Literacy and Numeracy (NAPLAN). This is a national testing scheme for Years 3,5,7 and 9 across Australian schools in literacy and numeracy. Trends in school data for numeracy were used for the initial selection of schools so schools could be seen to be performing above similar schools; increasing in their performance over time suggesting that improvements were being made at the school; or through recommendation by the systems as schools that were performing well but this was not reflected on the test scores. At the outset, it is acknowledged that national testing scores are not a fair representation of success but they were the only 'objective' measure of success in numeracy. Hence, personal recommendation by systems of particular schools was a way to circumvent the narrow definition of success in NAPLAN results. Schools were required to justify their success on other measures including but not limited to other testing schemes or other measures.

The case studies were ethnographic in form and were developed through site visits to each school. Data were collected via interviews with members of the leadership team, teachers and local workers at the school; observations of classrooms; profiling of lessons, and collection of school artefacts. Collectively these were used to develop individual case studies for each site. A positive, strength-based report was generated in consultation with the school, and once approved by the leadership teams at the schools, were uploaded to a website for sharing (and celebrating) the successes of the schools. The Remote Numeracy website was hosted at the University of Canberra3 .

A meta-analysis across the schools was undertaken at the completion of data collection and coding. Trends across the data were undertaken through the application of a software package — NVivo — into which all interviews were coded and analysed using grounded theory. This enabled the identification of key trends across the data set. Two further analyses were conducted using Leximancer and a separate NVivo of the published case studies, to confirm the trends reported here were valid. Across the three analyses there was a very strong confirmation of the themes/coding. A further statistical analysis was undertaken of the classroom observations. This analysis was undertaken by a statistical expert outside the project to ensure validity of the claims being made.4 The data from the classroom observations is not included in this paper.

Schools Permissions were gained from State Government and Catholic sectors in Queensland, Western Australia (WA), New South Wales (NSW) and South Australia (SA). The Northern Territory (NT) Department of Education and Training (DET) denied access to government schools. There was only one Northern Territory Catholic school that met the criteria for inclusion but elected not to participate in the study. One NT Independent school approved access for the study. This is not to say that there is an absence of good practice in NT, as quite clearly there is some outstanding practice. Rather, it is a factor of the regulatory requirements to access schools through permission from the DET.

[3] https://serc.edu.au/remote-numeracy/

[4] The views expressed in this report are those of the author and not the funding authority

The distribution of schools across the states varied and were contingent upon success as defined previously. There was no attempt to seek inclusion of schools in terms of ensuring what would be typically described as a representative sample of the schools. The schools were included solely on their performance so I was incongruous to pursue a selection of schools that proportionately represented the diversity of schools in this field. However, the sample of schools did represent the diversity of schools, states and systems as a collective.

Tab. 1 Distribution of school — published case studies

	Government	Catholic	Independent	**Total**
WA	11	3	7	**21**
QLD	4			**4**
SA	4			**4**
NSW	5			**5**
NT			1	**1**
Total	**24**	**3**	**8**	**35**

The schools include the range of schools that could be expected across Australia — including primary, secondary, schools to year 10, schools to Year 12, Vocational Education and Training (VET) schools, and boarding schools. There was considerably diversity in the structure of the schools. The schools also range in size from 'one-teacher' through to schools with 50 teaching staff. Some of the schools are located in the community, while others (such as boarding) are outside the immediate community. Some schools serve the community in which they are located, while others draw students from surrounding communities. Some schools are single campus, while others are multi-campus. Some schools are boarding schools including a senior vocational college, while most are day schools. One case study is based on a system-level approach so spans many schools within that system. The project's method has endeavoured to capture the diversity of schools operating across Australia. Two schools were visited and data collected, but at the completion of the site visit there was no coherent story to be written, so no case study was developed. A further two schools were completed towards the end of the project but the principals relocated and hence the stories could not be confirmed/approved. In total, four sites were visited without case studies being published from those sites. Accordingly, of the 39 sites visited, 35 case studies were published.

3. Analysis

Two levels of analysis were undertaken in this study. At the first level was the ethnographic case study approach. Each school has had a case study produced. These draw on the key themes of the school following the site visits. The case studies were negotiated with the school so that the stories presented in the case study were validated by the school and were seen to be a fair representation of the school. The case studies were published on the project website. The second level of analysis was undertaken

and will be ongoing given the enormity and breadth of the data. All interview data were entered into a qualitative database (NVivo) and coded using a grounded theory approach. This enabled trends across the data sets to be identified. The data presented in this plenary provided a summary of the key findings of the project.

A quantitative analysis was undertaken on the pedagogical profiling of the lessons and the complete dataset in NVivo which is not part of this plenary. A further macro analysis of the data sets was undertaken with Leximancer and a NVivo analysis of the case studies. These analyses were used to verify the macro trends in the data sets and to triangulate the subjective coding used in NVivo with the mechanistic (objective) coding made through Leximancer. There was strong congruence in the three systems of coding.

4. Key Findings

Unsurprisingly, there is no unifying approach across the states, or schools. However, there are some features that appear in many cases that are noteworthy. While there are examples of practices that would appear to be diametrically opposed such as problem based/investigative group work with the highly structured worksheets of 'direct instruction', there is a unifying philosophy behind the teachers' intent with the adoption of these practices. First is that they sought to identify the entry level of the students (through assessment for learning practices) and then to develop targeted strategies to meet the needs of the individual students (differentiation). Much can be said of the practices observed in schools, and these are contained in the case study reports. As the project data set was very large, some model was needed to make sense of the data across the project.

4.1. Masking Sense of Surprises in the Data

Initially the project was developed with the intent that there would be reporting on teacher practices, however as the project unfolded, there were times when teacher practice was not the key practice of the schools. Many issues beyond the practices of the teachers became critical in rethinking the initial assumptions that underpinned the project. IN the next two sections, I will share two examples (that were among many) that resulted in rethinking the macro analysis of the project.

4.1.1. Attendance

Attendance is a key issue in education, and more so in remote Indigenous education where attendance rates are notoriously problematic for teachers and systems. There are often good reasons for non-attendance from the perspectives of the families and learners.

> *Principal: I am not sure why you are here. We have not focused on maths at all so I don't know how we can help you.*

At this school, there had been a very strong focus on student welfare. Absentism was high. The principal had created a position of student welfare officer whose role was to follow up with students and why they did not come to school. Issues such as no food in the home, or no shoes for the learners so they could not come to school were often found to be the cause for non-attendance. The school then developed strategies — such a breakfast club, free lunches, a clothes stores — so that the issues being confronted by the families and learners were addressed and students could come to school without shame. Increases in attendance converted to increases in performance.

4.1.2. Attitudes Towards Schools

> *Principal: When we arrived at the school, the students (and families) would stand on the other side of the school fence and taunt us. There was clearly a strong divide between the school and community so we had to do something to redress this issue.*

At this school, the whole of school worked on developing a culture at the school where the learners were valued and welcomed to the school. Over time, more children and families started coming to school, feeling that they were valued and important. Teachers and administration staff would welcome children when they came through the gate and farewelled them when they left. Any child who had problems during the day, were especially encouraged to return the following day. The school staff conducted event outside the school gates and in the broader community, bringing the school into the community. Again, attendance translated to success.

These two examples were among many where schools had not primarily focused on teaching mathematics, but had used other strategies to bring about changes that impacted indirectly on performance in mathematics. To this end, the project needed to develop a model that accounted for these learnings.

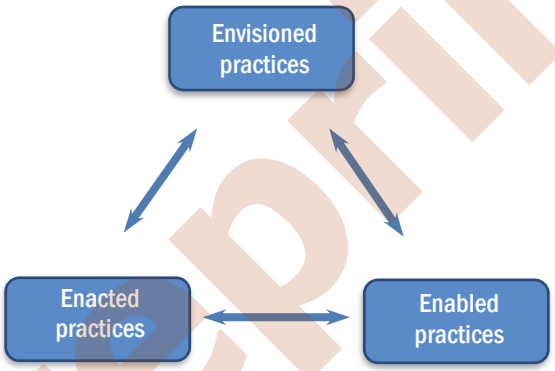
4.2. Identifying Norms

Rather than focusing on describing practices per se, the project has identified the norms that appear to underpin the practices. To make sense of the multiple levels of practice observed across the study, three levels were developed — envisioned, enabled and enacted. Schools need to have a strong and well-articulated vision. They then put practices in place to enable the vision to be enacted by the staff at the school. Different schools had different emphases in their case studies. Each of these levels of analysis and examples are provided in this report. While this is represented in a nested manner, it is the case that each of the levels of practices interact with the other, thus suggesting a much more dynamic model.

5. The Three Levels of Practice

As a result of the macro analysis and to make sense of the ‘surprises’ in the data, a three level model was developed. The levels are not meant to be hierarchical but rather cyclical and dynamic with each informing the other.

- ***Envisioned Practice*** — this level referred to those practices that created a vision for the school and how the leadership team worked with the school and wider communities to share and enact the vision of the school
- ***Enabled Practices*** — these were an intermediary practice that worked between the enactment of the vision and the work at the level of classroom. Two standout practices at this level were the inclusion of a numeracy (middle) leader who would support the work of the teachers to ensure that they were able to enact the vision of the school. The second type of practice was the employment (and upskilling) of local Indigenous people who could work with teachers in the area of numeracy but also around issues of culture and language as they impacted on learning.
- ***Enacted Practices*** — these were the actions of the teachers and support staff in the classroom level.



5.1. Envisioned Practices

Many of the schools in the study were very clear about the culture of the school that they sought to develop (or had developed and sought to maintain and sustain beyond the principal's time at the school). Features of these included:

- Articulating and leading the rollout of a school-wide approach to the desired culture and vision for the school.
- A supportive leadership team to work with staff to enable the effective management of the school culture — both in terms of the culture of the school, and the mathematics learning culture.
- Working relationships with community to share the visions of both the community and the school.
- Being prepared to evolve a positive culture over an extended period of time, and to ensure that the culture is embedded so that it endures changes in staff. Change needs to be slow if it is to be effective. Communities and families are often change-weary.

They were wary of new leaders coming in to make their personal mark for personal gain, rather than for the gains of students and community.

- Sharing vision and working with staff and community was an important factor for success.
- Middle leadership was a strong theme emerging from the school data — this level of leadership mediates the vision of the school and supports teachers to enact the vision of the school. Being able to see the value of middle leadership was a vision in many of the schools.

5.2. Enabled Practices

To ensure staff and students meet the goals of the school and thrive in the classrooms, schools employed a wide range of practices to enable teachers and support staff to enact the vision of the schools. These practices sought to implement the vision of the school and to ensure that teachers were given quality opportunities to develop as teachers while aligning with the values and approaches of the school. Some enabling practices observed included:

- Employment of quality local (Indigenous) staff to work alongside teachers. Investment of time and resources were evident. Local people took a strong role in the classroom and were an invaluable resource within the school. In some schools, their title was a co-teacher to signify their status within the class and wider community. Quality learning opportunities were provided to upskill the local people so that they felt strong and comfortable in these roles.
- Quality professional learning for teachers — most of the schools were staffed by graduate teachers who were often in their first remote position. Considerable support was made available to induct these teachers into remote education, and to provide ongoing support in their development as teachers of numeracy/mathematics.
- Numeracy Coaches were employed at some of the schools. These individual roles varied depending on the context and needs of the teachers, particularly in relation to funding the role. The role included sharing the vision of the school and supporting teachers to enact the vision of the leadership team. It also included providing in-class support for teachers, from planning lessons to providing feedback (middle leadership). Many terms were used to describe this role depending on the school.

5.3. Enacted Practices

At the level of the classroom, there was an extensive range of quality practices that were articulated and observed. While this was the original intent of the project, it was clear that for this role to be successful, the other levels of practice also needed to be considered. Enacted practices included:

- Being explicit about the intent of learning, how lessons were organised and what was expected of the students. There was no "hidden" agenda of lessons. Students knew teacher expectations.
- Differentiating learning to enable identification of students' learning needs through assessment for learning practices and then to build quality learning experiences that met and extended the needs of each learner.
- Recognising language as a key variable in learning, providing appropriate scaffolding in language (both home and SAE) to build bridges between the home and school, and provide entry into school mathematics.
- High expectations — of both students and staff — across social and mathematical norms. Students were provided with age-appropriate learning outcomes (e.g. algebra for secondary students) and then quality teaching practices to scaffold learners to achieve those learning intents. There was no space for deficit approaches to pedagogy and learning.
- Focus on mathematics — mathematics was a priority for learning. The mathematics that was being taught was age-appropriate so that students were being exposed to levels of mathematics that could be expected in regional settings. It became the task of the teachers to provide appropriate scaffolding for students to enable them to reach these levels of learning. High mathematical expectations were reinforced.
- Culturally responsive pedagogy was evident. Many strategies were developed to cater for culture of the students. Most obvious were strategies used to build language (of mathematics and the home language as well) and to have strategies that were cognisant of issues of "shame" within the classroom (Robyn. Jorgensen (Zevenbergen), 2019). There has only been one class to date that incorporated the more overt aspects of culture (e.g. art) but other teachers had sought to draw on the everyday activities that the students undertake (e.g. fishing, trips to town).
- Creating a sense of numeracy for life. Most communities had limited numeracy practices synonymous with urban living. Teachers have developed many strategies to create opportunities for students to see the purpose of mathematics/numeracy in their lives.
- Pacing of lessons, or parts of lessons, was often quick so as to engage learners, and prepare them emotionally as well as mathematically for the mathematics lessons. Using a quick pace engaged the learners. Humour was often part of the lesson as well, again to engage learners in a non-threatening manner.

6. Norms within the Levels of Practice

While categorising practices into these three levels provided a way of clustering the practices, a further analysis of the data produced a theorisation of these practices around the notion of norms what were aligned with the three levels. These norms provide an overarching model that describes the principles that underpin each of the

levels of practice. The model gives coherence to a collection of practices at each level. Having norms to underpin and guide practice provides principles for success.

In Tab. 2 below, I have intentionally reversed the order of the levels to reinforce the non-hierarchical model of these practices. The norms provide principles to underpin the practices at each of the levels of practice.

Tab. 2 Summary of the norms identified from the project

Enacted Mathematical Norms	**Enabled Mathematical Norms**	**Envisioned Mathematical Norms**
• All students can learn mathematics — to high levels • Embedding mathematics is critical for understanding — embedding in the brain as well as embedding in contexts • Mathematics is as much about language as it is mathematical concepts • Transparency in learning and teaching mathematics enables students to access the "secret knowledge" of school mathematics • Mathematics lessons should engage learners at their levels of understanding, and then extend learning into new levels	• Teacher quality is essential for quality learning • Recruitment, development, retention of staff • Teacher support is integral to developing quality mathematical environments • A key person for mathematical support across the school enables quality teaching and environments — numeracy coach • Indigenous people are a key resource in teaching and the classroom	• Leadership is critical for developing a positive mathematics culture, supporting teachers and supporting community • Establishing a whole school approach to teaching mathematics ensures consistency and transparency — for students, teachers, and community

There is considerable literature in mathematics education on the notion of norms as they pertain to the mathematics classroom. Most notably the work of Yackel and colleagues (2000) draws on the notion of sociomathematical norms that relate to the normative understandings of the mathematical realities in classrooms. While these norms relate to the mathematical activities that are undertaken in a classroom, they are different from the mathematical content. The sociomathematical norms in a classroom provide the framework for the interactions through which mathematical meanings can be negotiated by the learners and teachers. Norms act as a means for mediating learning. Many terms are used to describe the practices that come to constitute norms in the classroom, including discourses, discursive practices, practices, and/or culture. For this project, the term "norms" has been chosen as it is well established in the mainstream mathematics education literature and dates back to the very early work of Cobb and colleagues (Yackel and Cobb, 1996) which still endures in the current context (Campbell and Yeo, 2021; Hofmann and Ruthven, 2018).

Norms can be seen as principles that underpin the practices. They provide the implicit and explicit guidelines through which the practices will evolve, and reflect what is valued within the classroom, school and/or community. They shift thinking

from deficit models to strength-based models of practice. Under each of the norms, there are many sub principles and practices that need to be developed in order to embed and enact that particular norm. For example, if a school were to opt for a program that spanned across the whole school, as it was recognised that this would not only help students and community to see a common approach across the school, but there was also a need for a commitment from the staff to develop strategies that would enable this to happen. This would include staff development so that they would be familiar with the program. There may need to be consideration as to how best enable staff to undertake that staff development given that the schools are often unable to release teachers during teaching time due to the issues around isolation and inability to access to teacher relief. Considerations would also need to be made of how to ensure that the program is sustainable in the immediate context, but also how it may continue after the current staff leave the school. As such, each norm reflects various strategies (or practices) that have been shared through this research project.

7. Conclusion

While this study was conducted in some of the most disadvantaged communities in Australia, the findings have wider application. In concluding, I would like to make two key points. The first is with regard to the three levels of practice and the norms associated with those levels. The three levels of practice that arose from the study suggest that as a community, mathematics education research needs to consider the interaction of these levels. It may not be sufficient to have an interventionist program where it is not sustained by other levels of practice. While a program aimed at improving mathematics teaching and/or learning may have merit, it becomes necessary to consider the other levels of practice if success is to be enduring and long term. It became clear throughout the conduct of this research that each of the individual levels may impact on mathematics learning in and of itself, but a richer, more holistic way of working in the research domain may be at the intersections and inclusion of these levels. As argued elsewhere (Jorgensen (Zevenbergen) and Lowrie, 2015), there has been little achieved in the systemic redressing of inequities in outcomes in mathematics education. Perhaps, we have been barking up the wrong tree and may need to consider expanding research projects to include multiple levels of practice if real and deep change is to be affected.

The second point that I would like to conclude with is the focus of this study and its expansion into other equity target areas. While this study was focused on, arguably, the most disadvantaged learners in the Australian educational landscape, it is possible that the learnings from this study can be applied to other equity target areas. The levels of practices and the norms within those three levels may offer insights to support other equity target areas. This study should not be considered as relevant to only remote and very remote Indigenous learners.

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