

Challenges Related to Teaching Mathematics Using Social Justice Pedagogies: A Secondary School Experience

Richard Voss.

MPhil (Curtin University).

PO box 1240, Portland, 3305, Victoria, Australia

Dr. Tony Rickards.

Science and Mathematics Education Center

Curtin University, Kent Street, Bentley, 6102, Western Australia

Abstract

This study involves an Australian Western Victorian District High School year nine mixed ability mathematics class learning mathematics using social justice pedagogy. The learning intent of the unit required students to compare their own lifestyles against different families from around the world and use mathematics as a tool to investigate inequality. Although the study's findings showed that there were associations between student learning and engagement when using this initiative, there were also many individual and unique challenges encountered during the study. These challenges included integrating the study into an already overloaded school curriculum and many different educational stakeholders. Data analysis suggested that teachers who use social justice pedagogies within their classroom practices need to be flexible, highly adaptive and have a strong commitment to achieve the best learning outcomes for the students.

Keywords: Social justice mathematics, student engagement, inequality, society, mathematics, challenges.

1. Introduction.

This paper both analyses and evaluates the researcher's experience with teaching social justice mathematics (SJM) to a year nine Western Victorian District High School mixed ability mathematics class. Tanko (2014) describes that social justice mathematics can be defined in many different ways depending on individual world views. For instance, Osler (2007) provides one definition of social justice mathematics that involves "understanding issues of social, political, and economic (in)justice through a mathematical framework" (p.3). Gutstein (2006) suggests another framework that has been successfully trialled for teaching social justice mathematics that builds upon the students' culture, beliefs and life experiences. Gutstein (2006) further asserts that the aim of the social justice pedagogy approach is to engage students in the use of mathematics to think about and act upon world problems. To achieve this aim, students need to be able to read and write the world in mathematics. This study uses Gutsteins framework for teaching mathematics for social justice to create an open ended problem and promote students to use mathematics as a tool to address, debate and to propose possible solutions to issues involving social justice.

The literature reveals that there are an increasing number of teachers, researchers and educators promoting the use of social justice pedagogies for teaching mathematics in different countries from around the world, however, Tanko (2014) argues that in some countries there has been little work done or empirical evidence gathered to support this initiative. In Australia there has been a limited amount of research documented by a small group of researchers who include Atweh (2009), Atweh & Clarkson, (2001) and Zevenbergen (2000).

Research shows that teachers who teach mathematics for social justice face many challenges from school administration and other educational stakeholders. According to Osler (2007) today's mathematics curriculum is both mandated and burdened with high stake standardized tests. This mandate places an increasing amount of pressure on mathematics teachers to teach towards specific exams that use pre-determined textbooks chosen by educational policymakers. For instance, in the state of Victoria, Australia all students in years three, five, seven and nine who are being taught in government schools are required to annually participate in the Federal Governments National Assessment Program on Literacy and Numeracy (NAPLAN). These standardized tests allow educational policymakers to taking a snapshot of student numeracy levels, language convention skills and the ability to read and write. Furthermore, students face further high stake testing in years eleven and twelve as part of the Victorian Certificate of Education (Victorian Curriculum and Assessment Authority, 2013). Osler (2007) writes that as a result of mandated curriculums "Teachers find it difficult to try anything non-traditional in their classrooms for fear of reprisal from their administration and concern that their students won't pass high-stakes tests" (p.5).

A second challenge faced by teachers using social justice pedagogies is to balance the time required to write and implement the units of work with other teaching and departmental commitments (Altman & Mann, 2014). Brown (2013) and Cochran-Smith (2004) both warn teachers that when creating and teaching units involving social justice pedagogies it can become an overwhelming and complex task. For instance, Lopez (2001)

describes that teaching mathematics for social justice requires teachers to work outside of their comfort zones and in curricular areas that they may not be familiar with. Cochran-Smith (2004) hold the view that since each learning task is authentic and is based around real world issues, the tasks take more time to plan, prepare and execute than standard lessons. Jacobsen and Mistele (2010) also write that when preparing and executing social justice lessons plans it is important to create the correct balance between the mathematical component and the social justice component of the topic being taught.

In the context of this research project, the above challenges played a significant role in negotiating the study with the high schools administration and shaping the study's design accordingly. The challenges faced also played a factor in the lesson content being taught and how unit it would be delivered and assessed.

2. Context of the Research

The Western Victorian District High School involved in the study is approximately four hundred kilometres from the capital city of Melbourne in the state of Victoria, Australia. At the last census, the town had a population of 9601 residents, with forty-nine per cent being male and fifty-one per cent being female (Australian Bureau of Statistics, 2011).

Socioeconomically in 2012, the town rated below the average living wage of \$606.40 per week when compared to individuals who work in Melbourne, Victoria, Australia. Employees who work in the town earn a median individual income of \$472 per week and a median household income of \$898 per week (Fair Work Australia, 2012).

The town's educational facilities consist of four primary schools, one private secondary college, a technical and further education (TAFE) campus and one public government school. The government school participating in this study employs sixty staff and has around 750 students. At the government school there were a total of 114 students undertaking year nine Mathematics. It was negotiated with the high schools administration to use a sample size of forty-five participants from the student population to undertake the study.

The choice to teaching financial mathematics, that included reading graphs and converting fractions to decimals to percentages, was made in consultation with the researcher, the college's administration and the high schools mathematics department. The colleges' administration ensured that the financial mathematics unit outcomes from the study aligned with those from other year nine traditional mathematics classes being taught. The researchers/teacher also had a particular interest in the integration of practical mathematics focusing on society to assist students who struggle with basic numeracy skills in the classroom.

3. Methodology

The study was made up of twenty nine male and sixteen female participants aged between thirteen and fifteen years of age. The class had a wide range of mixed abilities, interests and backgrounds. The class also contained four integration students who had learning disabilities, and an integration aide to assist them with learning tasks. The participants were selected using a convenient sampling technique. The Western Victorian District High School assigned the first author as a teacher researcher to teach mathematics to a specific group of year nine students for the year. Triangulation (Creswell, 2012) was achieved by cross-referencing multiple sources of data obtained from (1) a focus group sessions (2) a folio of students work (3) a summative mathematics test conducted at the end of the unit (4) pre and post unit concept maps (5) a student survey and, (6) observations recorded in the researchers' reflective journal. To analyse the data the researcher used a grounded theory approach as described by Denzin and Lincoln (2011) that incorporated a qualitative based action research methodology. The study excluded traditional mathematics classes taught by other teachers as the participants could not be observed directly by the researcher and therefore risked contaminating the study's findings.

4. Experiment.

In order to introduce the students to the idea social justice Mathematics, the researcher chose a sample topic, 'sweatshop wages', as outlined by Gutstein (2006). The topic focused on factory workers from third world countries who were employed for sixty cents a day. This highlighted to students some of the social justice issues that involve wages, housing, poverty and human rights. In negotiating and discussing the research procedures with participants, one of the students said, "How can you live on sixty cents a day?" The researcher answered, "Well... could you use Mathematics to create a budget to see if it is possible to live on this wage and to find out how these people survive?" A second student quietly commented, "Gee... sixty cents a day, nah... it can't be done... even a bag of chips costs a dollar at the canteen." The first student asked, "Well... how do these people survive then?" After some time discussing the topic, a third student asked, "So Mr Voss, you mean we can choose any problem that we like and try and use maths to solve it?" The researcher said, "in a nutshell yes, but you have to work in groups and negotiate a topic with me as the teacher." Furthermore, "Your participation in the study is totally voluntary and if you choose not to take part, you can still complete the investigations with your classmates and will not be penalised, nor will I include your responses in the report."

To brainstorm possible topics for investigation, the researcher wrote several pre-determined social justice topics based on ones used by Gutstein (2006). These were used as possible examples on the white board and allowed the students to use their laptops to access the radicalmaths.org website to obtain further suggestions.

For twenty minutes the workgroups considered many different topics. These included world poverty, child labour, corporate & banking profits, and compulsory school uniforms versus casual clothes. After much deliberation and negotiation with the students, as a class they chose to study the global food and mathematics topic.

The students dedicated three hours every week (including time researching as part of the homework program) working on the global food and Mathematics unit within their respective work groups, each of which contained between four and six students. Each work group was required to investigate and produce a portfolio of work explaining their understanding of the issues that involve world hunger and poverty and how Mathematics can be used to understand various problems.

Students were required to analyse a series of photographs presented by Lowe (2012) as shown in figure 1 and compare different people from other countries with Australia. Secondly, students were asked to use the Internet to determine the cost of the groceries in their homes and calculate the average cost within the workgroup. Thirdly, students were directed to use the Australian Bureau of Statistics resource to determine the percentage of income spent by average families on food, and compare it against the other countries in the photograph. Finally, they were asked to choose a strategy from a range of options that were on offer that could assist third world countries to minimise global hunger. These included supporting online forums, organising a guest speaker from an appropriate charity and taking part in World Vision's forty-hour famine.

Figure 1. *Sample of Lowes (2012) photographs used in the global food and mathematics unit.*



Ecuador: The Ayme family of Tingo
Food expenditure for one week: US\$31.55
Family recipe: Potato soup with cabbage

To collect and analyse the data, the project was conducted in four stages as described in MacIsaacs' (1995) research model.

Stage one (1 week): The first stage of the project consisted of a survey followed by a focus group session. The survey went for thirty minutes and consisted of a concept map and a broad range of questions to help students express their attitudes to learning Mathematics, their past learning experiences, and their interests and motivations.

Stage two (2 weeks): The second stage of project required students to gathered preliminary data for their portfolio. For instance, students had to collect a range of supermarket shopping dockets to determine the average class cost of groceries purchased.

Stage 3 (3 weeks): The third stage was informed by the second stage, and required students to take the initial data obtained and carry out a range of mathematical investigations.

Stage 4 (2 weeks): The fourth stage integrated mathematical modeling into social justice issues. Students were required to describe the Mathematics required to support their workgroup's investigations.

Stage 5 (1 week): The fifth stage involved compiling, presenting and reflecting on all previous investigations collected as part of the student's folio of work. Students were required to submit their portfolio for assessment, undertake a Mathematics test and participate in the final focus group.

5. Result Analysis.

The data from this study supports the assertion that there are associations between student learning, student engagement and higher order thinking. The outcomes linked to practical classroom practice that teachers can use

as a result of this study include:

1. Using real life scenarios based around the students' interests involving social justice to improve student motivation, engagement and academic achievement rather than learning Mathematics by using textbooks.
2. Using social justice pedagogies to promote student discussions that allowed the students to develop a sense of connectedness with the unit and a sense of social responsibility.
3. Using social justice pedagogies to promote student discussions that promoted higher order thinking.

Challenges encountered when teaching social justice pedagogies.

When teaching Mathematics for social justice, although there were recorded successes, there was also a range of challenges encountered throughout the unit. The challenges encountered included: (1) negotiating the study with school stakeholders, (2) undertaking the study and covering the curriculum, (3) and the extra time requirements to prepare teaching resources for class.

Negotiating the study with school stakeholders.

When attempting to negotiate the study with the Western Victorian District High School management there was considerable conflict between the research study, the curriculum demands that existed in the school and the teaching and assessment policies that were in place. For instance, the high school's curriculum structure did not promote the use of interdisciplinary learning in a classroom environment between subjects. The high schools policies dictated that English should be taught in English, Math in Mathematics and social studies in social studies to ensure that the subjects curricular content aligned and remained siloed exclusively within its own VELS domain. Meeting minutes obtained from the school also revealed that the teachers from different departments never met together to share ideas or to investigate the possibility of integrating student projects across different subject areas.

Observations recorded in the researchers' reflective journal highlight an initial meeting that took place between the researcher, an assistant principal and the head of the social studies faculty to discuss the research proposal. The head of the social studies faculty voiced some concern that the global food and mathematics unit would best be taught in his subject area. He suggested that if the study was prepared to write up the unit lesson plans, assessment tasks and project sheets to align with the high school's curriculum model, he would be prepared to teach the lesson and provide a weekly verbal feedback. After reviewing the projects aims, deliverables, constraints and also considering the above comments, the researcher agreed to leave the department with a copy of the unit lesson plans for future use. However, it was felt that it was important that the researcher taught the lesson and observed the participants involved in the study. This participant observation strategy was designed to increase authenticity of the data, but also the immersive nature of the process allowed a richer data set to be collected. It was the researcher's strong belief that by allowing other teachers to participate in the study without sufficient knowledge of the study or research experience would increase the risk of contaminating the study's findings.

A second comment noted from the same meeting with the management of the school involved the assistant principal who said "I have concerns that if the study is approved, all students will not be able to cover the same curriculum or undertake the same assessment tasks". The researcher assured her that the students would cover the same curriculum content and assessment tasks but in a different context". After much deliberation and in order to adhere to the colleges' teaching and assessment policies, the researcher agreed to develop a range of mathematical scaffolding exercises and common assessment tasks that were re-written with a social justice focus. This was a good outcome and demonstrated the flexible delivery and negotiation that was required and applied for success of the study.

Undertaking the study and covering the curriculum.

When developing the global food and mathematics unit the teacher had some flexibility in how the lesson content would be taught. However, due to the high school's curriculum and the limited time available, some concessions had to be made. One concession included only spending a set amount of time each week undertaking the project. The mathematics department allocated a one period (ninety minutes) per week to be used towards the study and the remaining four periods per week for teaching core mathematics.

Data analysis shows that during the initial stages of the study students struggled to link the lesson content from one week to the next due to a break in consistency. When speaking to each of the table groups during these initial sessions, many of the students commented that they felt slightly lost and were unsure where the unit was heading. As a result the researcher tried to re-negotiate the study with the assistant principal who refused. The assistant principal commented that students were required to focus on NAPLAN tests and an end of semester examination. As a result the unit was taught in breadth rather than depth giving the students an appreciation into learning mathematics through social justice pedagogies. Osler (2007), Altman and Mann (2014) both support this observation as they describe that beginning teachers involved in social justice Mathematics often found resistance from peers due to an 'overloaded curriculum' and were forced to negotiate and make concessions in order to teach this pedagogy.

The extra time requirements to prepare teaching resources for class.

A third challenge encountered when teaching using social justice pedagogies is the extra time required to prepare teaching resources for class. Observations from the teachers chronicle and the researchers' journal both highlighted that during each class there can be four 'mini' investigations taking place at any one time. When speaking to the teacher whom I team-taught the class with she commented that "the amount of preparation and correction time that you are putting into making this class work is three times the normal. If we (the mathematics department) were to use this method we wouldn't have time to do anything else." The teachers chronicle supported these comments as it showed that the researcher had allocated a considerable amount of time into preparing, teaching and assessing work for this unit.

5. Conclusions.

Teaching mathematics for social justice is an innovative pedagogy that allows students to connect the lessons learnt at school with their own real world and authentic life experiences. The pedagogy is supported by Australia's new AusVELS curricular model that supports interdisciplinary learning as it creates links between the mathematics discipline and the social sciences. Future studies may choose to investigate the links here to a greater degree than this study has, and could perhaps investigate the findings with a wider state wide sample perhaps.

In order to promote social justice pedagogies in schools, administrators and teachers must be prepared to review their professional practices and be flexible with planning and delivery in the classroom. School administrators must be prepared to consider moving from a system bound by examinations and high stake testing to a different model that promotes inclusive learning for all students. Upholding the values of society and providing authentic and engaging global socially interactive perspectives is vital to encouraging students to think globally and act locally.

References.

- Altman, M. & Mann, L. (2014). Equity in Mathematics education: Analysis of research and connections to practice. Equity within the classroom conference. Ann Arbor, MI.
- Australian Bureau of Statistics, (2011). Socioeconomic Indexes for Areas webpage. Retrieved 13/11/2012 from <http://www.abs.gov.au>
- Atweh, W. (2009). What is this thing called social justice and what does it have to do with us in the context of globalisation? *Critical Issues in Mathematics Education*, ed. Paul Ernest, Brian Greer, Bharath Sriraman, 111-124. Charlotte, NC, USA: Information Age Publishing.
- Atweh, B. & Clarkson, P. (2001). Internationalization and globalization of mathematics education: Towards an agenda for research/action. In B. Atweh, H. Forgasz, & B. Nebres (Eds.), *Sociocultural research on mathematics education: An international perspective* (pp. 77-94). New York: Erlbaum.
- Brown, K. (2013, March). Modeling with Mathematics using real world applications. California Mathematics project. Curtis centre conference. Retrieved 16/2/2014 from http://www.curtiscenter.math.ucla.edu/curtis_conf_2013/Brown.pdf.
- Cochran-Smith, M. (2004). *Walking the road: Race, diversity, and social justice in teacher education*. New York: Teachers College Press.
- Creswell, J. W. (2012). *Educational research: Planning, conducting, and evaluating quantitative and qualitative research* (4th ed.). Boston: Pearson.
- Denzin, N. K., & Lincoln, Y. S. (2011). *The SAGE Handbook of qualitative research* (4th ed.). Los Angeles: Sage Publications.
- Fair Work Australia (2012). Retrieved from www.fwa.gov.au
- Gutstein, E. (2006). *Reading and writing the world with Mathematics: Toward a pedagogy for social justice*. New York, NY: Routledge.
- Jacobsen, L. J., & Mistele, M. J. (2010). Please don't do "connect the dots": Mathematics lessons with social issues. *Science Education and Civic Engagement*, 2(2), 5-11.
- Lopez, A. (2011). Student engagement and culturally relevant pedagogy. *Inquiry into Practice: Reaching Every Student Through Inclusive Curriculum*. Retrieved 16/11/2013 from http://www.oise.utoronto.ca/oise/UserFiles/File/ITE_PUB_2011_COMPLETE_LR1.pdf
- Lowe, I. (2012). *Global food and Mathematics*. Retrieved 1/3/2013 from www.mav.com
- MacIsaac, D. (1995). *An Introduction to Action Research*. Retrieved 13/7/2013 from <http://www.phy.nau.edu/~danmac/actionrsch.html>
- Osler, J. (2007). *A guide for integrating issues of social and economic justice into the Mathematics curriculum*. Retrieved 12/3/13 Retrieved from www.riniart.org
- Tanko, M.G. (2014). Challenges associated with teaching mathematics for social justice: Middle Eastern perspectives. *Learning and Teaching in Higher Education: Gulf Perspectives*, 11(1). Retrieved from

<http://lthe.zu.ac.ae>

- Victorian Curriculum and Assessment Authority. (2013). National assessment program - literacy and numeracy testing (NAPLAN). Retrieved from <http://www.vcaa.vic.edu.au/pages/prep10/naplan/index.aspx>
- Zevenbergen, R. (2000). "Cracking the code" of mathematics classrooms: School success as a function of linguistic, social and cultural background. In J. Boaler (Ed.) *Multiple Perspectives on Mathematics Teaching and Learning* (pp. 201-223). Westport, CT: Ablex Publishing.