Teaching Mathematics with a Social Justice Focus

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PROJECT PARTNERS

32 primary/junior teacher candidates from the Inner City cohort, 2009–10

Toronto District School Board associate teachers affiliated with OISE's Inner City cohort

ABSTRACT

This research project documented the experiences of teacher candidates as they designed and team-taught mathematics lessons with a social justice focus. The purpose of this project was to provide opportunities for teacher candidates to explore social justice issues in the context of teaching mathematical concepts. The research included 32 primary/junior teacher candidates from OISE's Inner City cohort. Participants also included associate teachers from Inner City cohort partner schools in the Toronto District School Board. Research data comprised artifacts associated with the course assignment (lesson plans, reflective writing, video recordings) and interview transcripts. Data analysis focused on the project's impact on teacher candidates' development of instructional strategies and pedagogical choices in teaching mathematics with a social justice focus. Teacher candidates reported feeling more confident in teaching mathematics and described increased levels of engagement in mathematics among students who were traditionally unengaged during mathematics lessons.

"Through collaborative curriculum writing, observation of teaching by their peers, and shared reflection on the curriculum implementation, teacher candidates saw their own work improve."

PROJECT CONTEXT AND FOCUS

Mathematics can be seen as a *gatekeeper* subject that provides a "passport" to gain entry into practices that enjoy a different status in the wider society (De Abreau & Cline, 2007). Mathematical proficiency, then, is an equity issue, and equitable access to mathematics learning is critical for all students, especially those marginalized by the school system. However, mathematics is a curriculum area in which many teacher candidates feel unprepared to teach. Teachers have to do a kind of mathematical work that involves what Deborah Ball refers to as "an uncanny kind of unpacking of mathematics that is not needed or even desirable in settings other than teaching. Many of the everyday tasks of teaching are distinctive to this special work" (Ball, Thames, & Phelps, 2008, p. 400). Preparing teacher candidates to teach mathematics in inner-city contexts is therefore a complex task.

Mathematics teacher educators engage with the challenges of developing teacher candidates' pedagogical as well as mathematical content knowledge. The aim of this research project was to strengthen teacher candidates' confidence in planning and delivering inclusive and accessible mathematics lessons, to enable them to form a critical approach to knowledge, and to overcome models of deficit thinking. In this way, the research aimed to inform the development of OISE's mathematics education curriculum; the goal was to increase understanding of teacher candidates' journeys of learning to teach mathematics with a social justice focus. At the same time, the underlying purpose of the project was to inspire teachers to change the content of the curriculum as a means to provide access to mathematical concepts and skills for elementary school students who are typically underserved by the educational system.

The following questions guided the project:

- What pedagogical choices do teacher candidates make and what instructional strategies do they use to develop mathematics curriculum with a social justice focus?
- What are the experiences of teacher candidates as they engage with the elements of a social justice mathematics assignment in their practicum settings?

STAGES OF THE PROJECT

This cohort of teacher candidates had a special emphasis on inner-city schools, issues of social justice, equity, anti-oppression, and poverty. Central to the mathematics course, and also the context for this research project, was an assignment called "Exploring Issues of Social Justice through Mathematics."[1] The project built on a Japanese Lesson Study approach to develop a social justice mathematics framework that incorporated principles of culturally relevant pedagogy and critical education.

In the first stage of the research, the course instructor modelled lesson design, demonstration lessons, and interactive simulations, which helped teacher candidates begin to think about how to change the content of the curriculum as a way to provide multiple entry points into mathematics for elementary school students. While designing a mathematics lesson plan is a fairly standard teacher education process, this assignment used a Japanese Lesson Study[2] approach to focus not only on specific mathematical concepts to teach but also on a social justice issue.

[1] Course and assignment designed by Caswell.

[2] Japanese Lesson Study is a professional development process used to examine and improve the practice of mathematics teaching. The focus is on student thinking and preconceptions related to specific mathematics concepts. Teachers work collaboratively to design activities and lessons that reveal student thinking and give students access to these concepts. Lessons are implemented in the classroom with other teachers present to make observations, which are then discussed professionally during a debrief session. The purpose of these "research lessons" (Lewis, 2009) is to gain a deeper understanding of how students learn and thus how teachers can teach mathematics more effectively.

Data from an initial questionnaire about attitudes toward teaching mathematics showed that over half the teacher candidates reported a negative relationship with mathematics and felt uncomfortable about teaching the subject.

In the second stage of the project, groups of three to five teacher candidates, who were placed in Toronto District School Board Inner City cohort schools for their teaching practica, consulted and collaborated with colleagues and their associate teachers. Their aim was to develop lessons that (a) took into account the identities, lives, and knowledge of the students in their practicum classrooms (Gonzalez, Moll, & Amanti, 2005); (b) focused on the co-construction of mathematical knowledge through inquiry; and (c) used mathematical concepts and skills to raise students' awareness of power dynamics in society and to engage students in social justice work (Gutstein, 2006).

In the third stage, teacher candidates team-taught the lessons in their practicum classrooms. Each lesson implementation was video recorded. In the fourth stage, teacher candidates asked their associate teachers for feedback. Embedded in the assignment was the opportunity and expectation for teacher candidates to make careful observations of student thinking and to examine student work as evidence for learning. They produced structured written reflections on the process and outcome of their lessons and commented on (a) the collaborative process of lesson preparation, (b) their response to the cultural and academic needs of their students, and (c) how they balanced the mathematical content and social justice issue.

Finally, teacher candidates prepared formal presentations, which were then shared during their regularly scheduled mathematics class at OISE. Further, teacher candidates were invited to present their work to an audience of over 30 associate teachers, as well as principals and instructional leaders as part of the Culturally Relevant and Responsive Pedagogy Seminar Series hosted by the Centre of Urban Schooling at OISE.

DATA COLLECTION AND ANALYSIS

The participants in this research were 32 primary/junior teacher candidates in the Inner City cohort, a program that is committed to addressing the needs and challenges of inner-city students, schools and families. Of these 32, ten were selected for interviews based on a representative sample of classroom levels in which the lesson was taught and a representation of a range of diversity. Five associate teachers from partner schools in the Toronto District School Board were also interviewed. The research data included artifacts associated with the course assignment (lesson plans, reflective writing, video recordings) as well as transcripts of formal interviews conducted with 10 teacher candidates and five associate teachers. Data analysis focused on the teacher candidates' instructional strategies and pedagogical choices that they identified as helping to create access to mathematics for the students in their practicum settings. Three key strategies were identified.

Use of real-life mathematics problems linked to issues of inequity

One aim of the mathematics lesson was to make the concept of inequity based on power relationships an explicit part of the curriculum.[3] A teacher candidate linked her observations of increased student engagement with the social justice mathematics lesson to her theories about motivation. She noticed that when there was a reason for the students to learn mathematics, as opposed to "you just need to know it," they seemed more curious and interested: "If there is actually something behind it, it's more engaging."

Another teacher candidate made the curriculum relevant by "taking it outside the textbook." She said, "it doesn't have to be just about numbers [and] equations, and I think bringing real life into it makes it easier for the children to understand. You can bring in things that

[3]This is one of Cochran-Smith's (2004) six principles of teaching for social justice.

are relevant for them, to have them make more sense of it." Teacher candidates made curriculum decisions to use mathematics to understand social studies topics. For example, during a study of the electoral process in a Grade 5 classroom, teacher candidates introduced students to the Ontario Budget to examine issues around provincial spending and to read, represent, compare, and order large numbers (a key expectation for number sense and numeration in the mathematics curriculum for that grade level). In another example, students compared spending on recreation to money needed for education, food, clean drinking water, etc. Teacher candidates recognized that real-life curriculum gave students opportunities to express learning in a variety of ways, including artistic means such as creating a rap, a dance, a poster, or a role-playing scenario. One teacher candidate said, "Even students who were not usually engaged with math were very engaged, and also I think [this is] because there was a bit of an artistic design element."

Connect mathematics to students' lived experiences

Teacher candidates included pedagogical choices that built the curriculum on the lived experiences and knowledge of their students (e.g., knowledge based on a variety of worldviews). For example, teacher candidates built on Grade 3 students' knowledge of their community to design a mathematics lesson where students created three-dimensional geometric figures to contribute ideas for the city's plan to revitalize their community. In another example, the mathematics lesson[4] integrated geometry (e.g., use of the coordinate system), measurement (area), and beginning algebra to examine land claim issues that students were familiar with from their home countries. Teacher candidates recognized that when "students had space to reflect their worldviews" they brought in "important aspects of community and culture."

Use inquiry-based learning models and emphasize social learning

The teacher candidates wanted to move away from using only teacher-centred pedagogies that they had experienced in their own schooling. They were interested in developing principles of inquiry-based knowledge construction from a social justice perspective (Cochran-Smith, 2004). Excited by the social learning they observed among their students, one teacher candidate reported, "Everybody really wanted to share and … all the kids were very comfortable, and then they sort of fed off each others' ideas."

According to one teacher candidate, pedagogical choices can be acts of social justice. She suggested that social justice means "really knowing your students and knowing what they are interested in, where they're coming from so you can build on their experiences." To her, this emphasis was different from having the sole focus on meeting curriculum expectations. Teacher candidates began to see the power of student-driven curriculum development: "What was important to the students … it was their ideas, their concerns ... it was their voices being heard in the project, as opposed to ours." Table 1 provides examples of mathematics learning in relation to social justice learning.

"The results of the research project show that the social justice mathematics assignment became a catalyst for building teacher candidates' confidence in teaching."

[4] This lesson was adapted from *Maththatmatters* by David Stocker (2006, 2008), CCPA Education Project.

Table 1. Exploring Issues of Social Justice Through Mathematics

Social Justice Focus	Mathematics Curriculum Expectations
Examining inequitable distribution of world resources (through simulations)	• Number sense and numeration • Grade 5: Solve problems involving the multiplication and division of multi-digit whole numbers, and involving the addition and subtraction of decimal numbers to hundredths, using a variety of strategies • Grade 3: Subtraction with regrouping; graphing world resources
Designing a safe and equitable playground: "Mapping recess"	• Measurement, geometry, and spatial sense • Identify different types of quadrilaterals • Record and represent measurements of length in a variety of ways • Estimate, measure, and record the distance around objects, using non-standard units (Grade 2)
Food equity: Where does our food come from? (based on *A Handful of Seeds* by M. Hughes)	• Data management
Water consumption and conservation Fair trade: Where does our clothing come from?	• Data management and measurement • Measuring and recording capacity and volume • Data management: graphing and mapping
Provincial spending	• Build a model to represent a number pattern presented in a table of values • Read, interpret, and draw conclusions from primary data and from secondary data presented in charts, tables, and graphs
Cultural contributions to mathematics	• Geometry and symmetry in Islamic art, for example
Global trading simulation	• Number sense and numeration • Mathematical processes: problem solving, reasoning, reflecting, connecting, and communicating
Environmental issues: Ecological footprint, recycling	• Performing calculations, graphing results
Maps of the world: Changing perspectives	• Geometry and spatial awareness
Community revitalization	• Three-dimensional geometry
Micro-credit and community development (based on *A Basket of Bangles: How a business begins* by Ginger Howard, the story of Muhammad Yunus and the Grameen Bank)	• Examine currency from a variety of countries • Grade 5: Read and write money amounts to $1000 • Calculate interest rates on loans, payment schedules, experiment with business models

IMPACT OF THE SOCIAL JUSTICE MATHEMATICS ASSIGNMENT

As a result of this project teacher candidates experienced seven important impacts of the mathematics assignment. These included increasing students' mathematical proficiency through student engagement and developing high expectations. As well, they developed confidence in their mathematics teaching, which increased teacher efficacy and awareness of a new vision of mathematics learning by engaging in a social justice curriculum and collaborative professional inquiry.

Student engagement

Teacher candidates reflected and theorized on students' increased levels of motivation and engagement in the mathematics lessons. Discussed less, but evident, was the idea that promoting diversity (i.e., multiple representations and perspectives) is an act of social justice. A teacher candidate described her perception of students' investment in the lesson when she noticed that "all the students were on task, they were all fully engaged, even the AT [associate teacher] commented on that, and the groupings worked out well, so that every student was participating." Teacher candidates discussed how providing multiple entry points into the lesson increased student engagement.

> They really liked it, they were very engaged, they were really excited. We gave them the two-minute warning and they [said], "No, we want more time."

Teacher candidates named many instructional strategies and pedagogical choices as reasons for increased engagement: play-based learning, inquiry-based learning, integrating multiple curriculum areas, learning outside the classroom (in the playground, outside the school, and in school hallways), and making mathematics relevant.

High quality work

Teacher candidates remarked on the extra time it took to work collaboratively to create lessons, but they also recognized that the multiple perspectives brought to the activity increased the quality of the lessons they prepared. Through collaborative curriculum writing, observation of teaching by their peers, and shared reflection on the curriculum implementation, teacher candidates saw their own work improve.

Confidence in teaching mathematics

Data from the initial questionnaire showed that over half the teacher candidates reported a negative relationship with mathematics and felt uncomfortable about teaching it. The results of the research project show that the social justice mathematics assignment became a catalyst for building teacher candidates' confidence in teaching mathematics. Even a teacher candidate who said she was already comfortable with teaching mathematics reported,

> I was not very comfortable to start off … what am I going to get them to do in Grade 1 that's going to revolve around equity? But by doing this lesson, by sharing our ideas, and by working like four heads together, I saw how you can … step out of that box…. It was successful. So right away, that being your first experience, you are tempted to try it again and again.

Efficacy and agency

Teacher candidates often cited that the social justice mathematics assignment was a turning point in developing their teaching identity. Many claimed it was the first time they "really felt like a teacher." Several reasons underlay their claims to greater efficacy: (a) having a new relationship with curriculum expectations, (b) working outside the associate teacher's math program, and (c) finding a "crack in the curriculum to do social justice work."

Although they linked independence with greater teacher efficacy, the teacher candidates recognized the important role of the associate teacher. They consistently reported that associate teachers were "open," "supportive," "attentive," and their consulting role was key to the success of their mathematics teaching. One teacher candidate reported, "It was very helpful when the associate teacher just gave me all ownership and helped with the setting of the desks and stuff and gave me ideas, and said, 'If you need resources, here are the resources,' but basically gave us full reign of it." Another teacher candidate reported that the associate teacher supported the group by "giving us the time to do it…. It made a big difference because we were able to explore the students' ideas. Teacher candidates also appreciated when the associate teacher "stepped back to give us the room to experiment with the lesson."

New vision of mathematics learning

Teacher candidates had opportunities to revise their vision about learning mathematics, even what counts as mathematics learning. One teacher candidate opened a discussion with the comment, "Are we really learning math? It is so engrained in my psyche that learning math is doing worksheets. It's hard to let go!" Another described the importance of thinking about "math as a tool for other learning, rather than the object of learning."

Curriculum implementation challenges

Teacher candidates became aware of both the rewards and challenges of putting into practice a mathematics curriculum oriented towards social justice. They recognized tensions that arose because of the pressure of preparing students for standardized testing. They felt this tension, for example, when an associate teacher commented, "These ideas are great and incredible, but sometimes you just need to get through the curriculum, and you need to teach certain things." Some teacher candidates strategized around these tensions by recognizing the limits of "doing something separate just to get my math assignment done." Instead, they tried to make their social justice math assignment relevant to important mathematical concepts that students were working on in class, such as regrouping in subtraction. Other strategies included taking into account students' cultural backgrounds, countries of origin, and the resources produced in each country. One group of teacher candidates placed in primary classrooms engaged children in "buying and selling, negotiating, finding ways to calculate, and problem-solving with different sets of base-10s, and holding a sharing circle to discuss results" during an activity to simulate world wealth and distribution of resources.

Associate teachers' professional learning

The equity-oriented mathematics lessons sparked the interest of associate teachers in developing alternative pedagogies and incorporating issues of social justice into their teaching. An associate teacher reflected,

> It's an incredibly valuable experience, because you're doing all that reflection upon your own teaching, and you're also watching them teach, and when you're watching somebody else teach you're doing a lot of reflecting, and you're thinking oh, they do that really great—maybe I could. You know you're learning, too…. It's great PD [professional development], it's awesome.

IMPLICATIONS

This study had an impact on the instruction of mathematics on three different levels. First, the study aimed to examine whether the experience of collaboratively planning and delivering lessons with a social justice focus helped teacher candidates overcome their apprehensions around teaching mathematics. Second, in alignment with the focus of the Inner City cohort, the study aimed to make mathematics accessible and engaging for students typically marginalized by the educational system. Finally, the study sought to assess the impact of the role of associate teachers in the implementation of the lessons and their perceptions of integrating social justice into regular classroom instruction. This research project raises questions about the role of a university's initial teacher education assignment in creating a professional learning model based on shared inquiry. As well, the research raises the question of how to create opportunities for associate teachers and teacher candidates to participate further in inquiry around mathematics teaching with a social justice focus.

Another question concerns the fact that there was little discussion of student learning, which points to the need for more explicit teaching of the skills required to collect evidence of student learning. The teacher candidates planned lessons that were exciting for students, but whether students gained a deeper understanding of the mathematics content remains untested.

NEXT STEPS

This project has added to the complex task of preparing teacher candidates to teach in inner-city schools. This research has prompted the development of professional learning communities that will continue to provide opportunities for teacher candidates and associate teachers to collaborate on inquiry projects that build teacher content knowledge in mathematics. As well, the project has contributed lesson plans to an online database that can be accessed through OISE's Centre for Urban Schooling (CUS) website: **http://cus.oise.utoronto.ca/Resources/NEW_Teacher_Resources.html**. The project has also initiated the opportunity for teacher candidates to present their social justice mathematics lessons annually at OISE's Educating for Peace and Social Justice Conference and the Educational Activism Conference. Fundamentally, an ongoing result of the project will be increased access to mathematics for students typically underserved by the educational system.

ACKNOWLEDGEMENTS

For their enthusiasm and support of this project, we thank the students and teachers of the Toronto District School Board, the Centre for Urban Schooling, and the teacher candidates of the Inner City cohort in the Initial Teacher Education program at OISE.

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