

‘Reading and writing the world’ with mathematics in a Middle Eastern context

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Abstract

Very little work has been published on teaching for social justice in the Middle East. This paper demonstrates how a group of Arab women’s *reading and writing* of their world was facilitated by using a social justice pedagogy based on Gutstein’s (2006) model. The study involved 20 Middle Eastern women (ages ranging from 16-36). The findings suggest that the students have developed significant abilities to use mathematics as a tool to read and write their world. In addition, the findings show that, like their counterparts elsewhere in the world, these young women are also interested in social justice issues. This is particularly significant because of current ongoing social developments in the Middle East.

Introduction

As Tanko & Atweh (2012b) argue, in many school curricula around the world mathematics is privileged for its perceived importance both for society and the individual student. The social importance of quality mathematical knowledge is often justified due to its role in technology and science, which is seen as essential for the economic development of a society and its standard of living; and at the personal level of the student, mathematics is seen as opening the doors to many careers and courses of further study. Mathematics is also increasingly seen more broadly as a key element of modern citizenship, helping people understand their world better, and enabling them to seek their legitimate share of the benefits in their society while contributing to its positive development. Using Freire’s terminology, Gutstein (2006) argues that developing mathematical knowledge not only helps students to ‘read the world’, i.e., understand it, but should lay the foundation for their capacity to ‘write the world’, i.e., change it.

In an earlier paper (Tanko, 2014), I illuminated some of the challenges associated with teaching mathematics for social justice in this context. The focus of this paper is to explore further how a group of Arab women’s *reading and writing* of their world was facilitated in the United Arab Emirates (UAE) by using a social justice pedagogy based on Gutstein’s model. Gutstein’s framework of teaching mathematics for social justice identifies two sets of goals for learners and teachers: *mathematics goals* (academic success in the traditional sense and a changed orientation to mathematics) and *social justice goals* (to develop awareness of and agency in mathematics in everyday life, as well as positive cultural and social identities). These goals are elaborated further in the section below on literature.

There are three justifications why social justice teaching is relevant to the context of this study: the question of identity; recent developments in democracy in the country; and the role of women in society. In recent years, as the prosperity of the UAE has increased, the ratio of immigrants to ‘native’ Emiratis has risen sharply. This has caused concern – particularly over the possible impact on the country’s security, as well as on its social and cultural values. Such concern was expressed by the UAE’s late President, His Excellency Sheikh Zayed Bin Sultan Al Nahyan. In his Annual Speech to the Nation in 2003:

The most important of these and the one that holds most danger for the future of our country and its national identity, is the imbalance in the demographic structure of the UAE. This is a matter of major concern to us, and that is why we would like to take this occasion to emphasise the necessity of ensuring tighter supervision of this issue, and of implementing effectively the rules, regulations and decisions introduced or taken on how to correct this imbalance. We continue to believe that this imbalance represents a dangerous situation that threatens the stability of our society, and of that of the generations to come. (UAE Interact, 2003)

Maintaining one's cultural identity, i.e. developing positive cultural and social identities, is one of the core values of teaching for social justice. Therefore, teaching for social justice has the potential to provide opportunities for young Emiratis to develop their national identity while simultaneously preparing them to be functional and effective participants in an increasingly globalised world.

In addition, democracy is sweeping across the Arab world at an indescribable pace. In the UAE, a small but increasingly active number of young Emiratis are beginning to discuss, often on social media like Twitter and Facebook, how their country's development can be sustainably and fairly promoted in the future. The teaching of mathematics for social justice implemented in this study would provide opportunities for the learners to acquire the skills, knowledge and sense of agency necessary for effective understanding of important political issues and discussion of these within a modern society. It is my belief that teaching mathematics for social justice has the potential to contribute to the preparation of UAE's young adults for the political developments that will have an increasing effect in the country.

Of particular significance is that this research takes place in a college for women. Assad (2008) reported that in the World Economic Forum's (WEF) Global Gender Gap Index (GGGI) 2007, the UAE was ranked 105 out of 128 countries: "the UAE has a highly competitive economy but ranks poorly in terms of gender equality" (p. 1). Culturally, some women do not consider that a woman has any significant role to play in the society beyond being a housewife, and this kind of thinking is challenging to change. One of the first steps towards achieving change is to provide the people with an education which provides opportunities for empowerment. Providing such opportunities is one of the main goals of teaching for social justice; therefore, teaching for social justice can play an important role in shaping the future direction of the UAE.

Teaching mathematics for social justice is relatively new in many parts of the world, including the UAE. This exploration of practice was prompted partly by the observation that a noticeable gap exists in the literature on teaching mathematics for social justice in this part of the world. The objective of the project was to investigate opportunities for empowerment, and specifically the ability of students to read and write their world with mathematics, as a result of the adoption of social justice teaching within the Diploma Foundation (DF) years of the Higher Colleges of Technology (HCT).

Research context

In general, the language of instruction in government owned primary and secondary schools in the UAE is Arabic. All these schools are single sex: boys attending boys' schools and girls going to girls' schools. Parallel with the UAE state school system are the private fee-paying schools attended by the majority of expatriate children; in these, the language of instruction is mainly English, and the curriculum reflects the national origin of each institution's founders. Some Emirati children attend these schools, too, especially if their parents are planning to send them abroad (for example to Australia, the UK or US) for their university education. The UAE government has continued to invest huge amounts of money in the education of its citizens at all levels. However, it is fair to say that, like many other countries in the

world, it is struggling to make sense of its place in the 21st century, and to develop an appropriate education system (Issa, 2010; Ridge, 2009; Hatherley-Greene, 2012).

At school, many Emirati students are taught using a methodology that places great importance on memorization, learning designed to pass examinations, and a strategy that places the teacher, not the students, at the center of learning (World Bank, 2009; Nereim, 2012). In addition, there seems to be a mismatch between expectations at school and at college. These situations have resulted in many Emirati students “entering colleges and higher education with a strong sense of dread and an expectation of failure” (Hatherley-Greene, 2012; Ridge & Farah, 2012).

In March and early April in their final school year, all Emirati high school students in the UAE take the Common Educational Proficiency Assessment (CEPA). The results of this assessment determine the destination of students’ post-secondary education. Those who are perceived as high achieving students, i.e., those with a CEPA score of 180 or over (approximately 10% of the total candidates) will normally gain admission into universities in the UAE (UAE Yearbook, 2010), while the middle and lower ability ones tend to seek admission into other institutions including the HCT – a national system of colleges of which ‘College A’, where this study took place, is a part. It is pertinent to mention here that the CEPA scores of the participants in this research range from 85 to 115, with an overall average of 97; many of them could not complete simple arithmetic, like, $14.5 \div 5$ in one minute, without a calculator.

During the period in which this research was conducted, more than 50% of the student population at College A came from rural areas outside the city. The college provided a bus service at a subsidised rate to students who required the service. Some students were dropped off and picked up from the college by their parents, or by the family driver, and some drove themselves to college. Those who drove themselves were mostly working students, studying full-time as well as holding down a full time job, with their working hours adjusted by agreement with their employer. The students who caught the bus not only had to travel for more than an hour to get to college every morning, they also had to catch the bus as early as 05:30 because the bus driver needed time to pick up other students from other locations.

I chose to research the teaching of percentages, graphs and time calculations because of my previous experience teaching these topics using the traditional teaching approach. I was also motivated by my observations of DF students at College A, which led me to believe that these students continued to find these topics particularly challenging.

Literature review and theoretical background

The social justice approach adopted here is based on the work of Gutstein and his colleagues (Gutstein, 2001, 2006; Gutstein & Peterson, 2005) in a Chicago school in the United States of America (USA), who argue that engaging students in mathematics within a social justice context increases students’ interest in mathematics and also helps them learn important mathematics.

Teaching mathematics for social justice

Very little work, mostly unpublished, has ever been done in the Middle East on teaching for social justice. As an exception to this, see Tanko (2012, 2014), Tanko & Atweh (2012a, 2012b)). These studies are probably the only published work of their kind here in the UAE and the wider Middle East. Therefore, this paper is significant because it contributes in small measure to research into teaching for social justice in this part of the world.

Globally, a number of researchers have documented how their students read and write the world with mathematics. For example, Gutstein (2001; 2003) documented how middle school students utilised their understanding of the concept of 'area' to argue that the world map projection used in their school (typically, Mercator's) was misleading and distorted, because it enlarged Europe and Greenland but shrunk the African continent (2001, p. 18). He also documented how his students utilised mathematics to discover that the cost of one B-2 Bomber could pay for the full, 4-year scholarship for the whole graduating class for 79 years. Turner (2003) described how urban middle school students utilised mathematics as a tool to understand the crowdedness at their school in comparison to others in the district. Tracey (2007) documented how students in a Maths Club used mathematics as a tool to argue against a plan to close their school, by considering the costs of bussing them to the new school and the subsequent overcrowding and adverse learning conditions that may result at the receiving school.

Gutstein (2003; 2006; 2007) offers a particular framework of teaching mathematics for social justice that integrates issues of equity and the role of mathematical knowledge, as well as an emphasis on agency. As mentioned earlier, Gutstein's framework has both mathematics goals and social justice goals. The *mathematics goals* are: to 'read' the mathematical world; to succeed academically in the traditional sense; and to change, for good, one's orientation to mathematics. The *social justice goals* are: to 'read' the world with mathematics; to 'write' the world with mathematics; and to develop positive cultural and social identities.

Mathematics goals

Read the mathematical world: Mathematics is so influential in today's world, that a limited understanding of it can hinder the more complete grasp of important social and political issues. In other words, if a person has trouble entering and 'reading' the world of mathematics, s/he may struggle with using mathematical information and reasoning to 'read' the wider social world. Gutstein (2006, p.29) argues that "reading the mathematical world is equivalent to developing mathematical power".

Succeed academically in the traditional sense: This is achieved when the learner passes the prescribed examination which would enable him or her to gain admission into his or her desired course. It was important that my students' participation in social justice projects should not put them at a disadvantage, compared to their peers in other sections, in terms of their readiness for the end of course Key Common Assessment (KCA) examination.

Change orientation to mathematics: Changed orientation occurs when one sees mathematics as a powerful and relevant tool for understanding complicated, real-world phenomena rather than as a series of disconnected, rote rules to be memorized and regurgitated (Center for the Mathematics Education of Latinos (CEMELA) website, June, 2010). This is demonstrated when the learner who initially dislikes mathematics for whatever reasons, begins to now enjoy the subject and says so.

Social justice goals

Reading the world with mathematics: To read the world with mathematics means

to use mathematics to examine various phenomena both in one's immediate life and in the broader social world and to identify relationships and make connections between them. (Gutstein, 2003, p. 45)

In other words, people read the world with mathematics when they use mathematics to improve their understanding of the day-to-day events with which they are involved. For instance, if a person uses mathematics as a tool to understand how banks make their profit or what information they hide from customers or who is left out, and so on, then s/he has read the world using mathematics. Gutstein

(2006) acknowledged that in the absence of concrete direction and guidance, one does not easily become a 'reader' of the world using mathematics.

Writing the world with mathematics: If after using mathematics as a tool to read the world one follows this by taking action aimed at improving the situation, then one has also 'written' the world with mathematics. Action could be taken by meeting face to face with authorities to discuss findings and make recommendations, by simply writing a letter and making recommendations, or by taking civil action, or by a combination of strategies.

Gutstein (2006) stated that he views writing the world with mathematics as a developmental process, of beginning to see oneself as capable of making change; and he referred to writing the world for youth as "developing a sense of social agency" (p. 27). He added that from his observations, learning to write the world with mathematics was as complicated, if not more so, than learning to read the world – because it entails taking action, or at least seeing oneself as making a difference through actions: this is a step further than just understanding a situation.

Develop positive and social identity: positive cultural identity is demonstrated, as reported when the learner succeeds in an academic sense while still maintaining his or her cultural integrity (Ladson-Billing, cited in Gutstein, 2006). Students develop cultural competencies that enable them to maintain their cultural integrity while succeeding academically. Students' home culture, language, and community are rich sources of knowledge, understanding, and actions that can be effectively utilised in learning to read the world.

A review of literature relevant to this study has highlighted the need for more research into the teaching of mathematics for social justice, especially at college level. In particular, research on teaching for social justice is almost nonexistent in the Middle East. Therefore, this study is significant because it may help to define how students in the UAE respond to teaching mathematics for social justice. In turn, this will hopefully confirm some or all of the findings that researchers from other parts of the world have revealed with regard to teaching mathematics for social justice. The discussion above has also shown the need to tap into students' existing knowledge of everyday life in order to better understand how they think about, and learn, mathematics. Such knowledge will provide a wealth of valuable insights that can be helpful in designing a sensible curriculum – one with real life connections to the learners' world.

Methodology

This study involved a group of 20 female participants between the age of 16 and 36 years in the DF Mathematics course at College A. The objective of the research was to trial an approach to enhance the teaching of a course that relates mathematics to the real lives of the students, whilst addressing some social justice issues within the DF years of the HCT. During this research, I was responsible for teaching mathematics to three DF sections but I purposely chose one of the three sections, not because of their ability in mathematics but because, relative to others within the student body, the majority of the students in the chosen class had a reasonable command and understanding of both written and spoken English. Therefore, they were more likely to be able to express themselves both in written and spoken English during interviews. According to Creswell (2005), purposeful qualitative sampling permits the selection of participants or sites that can help the researcher(s) to best understand a particular phenomenon.

All the names used in this paper are pseudonyms.

Procedures

At the time of this research, the academic year at HCT starts in August and consists of two semesters (that is, August to December and January to June). Students were taught eight modules during each academic year, usually four modules in the first semester and four in the second semester. The Modules targeted in this research, namely, percentages, time calculations and graphs, were taught in the second semester.

The projects were conducted in four stages (for further details see Tanko (2012)):

Stage 1 (two weeks): Students brainstormed issues that were of concern to them, or to their community, and narrowed down to one topic that they then investigated.

Stage 2 (one week): The questionnaire developed by the students and used for the Career Aspirations project was typed and piloted; the data collection sheet for the Time of Travel project was designed; and the students working on the Car Parking project went out into the field to measure the dimensions of car parks.

Stage 3 (one week): All the groups tabulated their data and did the necessary calculations, then decided on an appropriate way to present their results.

Stage 4 (two weeks): Recorded focus group interviews were conducted and students interviewed the College Director. In this period students also prepared and delivered a presentation of their findings to the whole class.

Data sources

Triangulation (Stake, 2003) was achieved through multiple sources of data including (1) student presentations, (2) participants' reflective questionnaires, (3) student focus groups, and (4) the use of my own reflective journals. Another important aspect of the triangulation method, for observation and interpretation of data, is to involve those interviewed in reviewing the transcribed interview data. To minimize interview bias, as identified by Robson (2002), all the interviews were recorded, transcribed and given back to the participants to read and agree or disagree. In this way I was able to verify and authenticate the information collected at the interviews as reliable and accurate representation of what was said by the interviewee. Grounded theory approach was used to analyse the data, specifically the approach set by Strauss & Corbin (1998) and Charmaz (2008). Next I provide descriptions of the data sources and their significance.

Students' presentations

Four groups of students each had 20 minutes to present their project to the whole class, and 10 minutes was allowed for questioning. Students' presentations were recorded on audio tape (not on video because it involved students who were refused permission by their parents to take part in interviews). In addition, I took notes during the class presentations on the way the student presenters used mathematical language to explain their finding(s); the degree of confidence and ownership of work demonstrated by the presenters; the way presenters related their findings in the project with social issues; issues raised or questions asked by the other students in the class (engagement); and the level of interest demonstrated by other students in the findings presented. At the end of each presentation, the group leaders handed in a copy of their Powerpoint presentations to me, and this data was also analysed.

Participants' reflective questionnaires

After completing the project, students were invited to complete a short reflective questionnaire consisting of open-ended questions about their experiences in the unit of work and their learning from it. The use of students' reflective questionnaires was particularly important because those who were denied participation in interviews now had their chance to express their views. All 20 students in the class completed the questionnaire, which included four open-ended questions, such as "What do you like or not like about the mathematics projects you have completed this semester?". In order to make sure I got the whole 'story', I asked them to tell me about things that they found useful, or otherwise, in the projects and gave them the choice of writing in their mother tongue (Arabic), if they so wished.

Focus group interviews

I formed three focus groups, consisting of students who did not mind their conversations being recorded. It is pertinent to mention that initially, all the students agreed to take part in interviews but some parents declined the invitation for their daughters to be recorded on video or tape, even though the students indicated that they wanted to take part. This was a significant setback for me because three of these students were among the most able in the class. However, the parents were happy for their daughters to take part in the projects as a whole class activity but not in the interviews.

Three group interviews were conducted. I had an initial informal meeting with the students during which I sought information about their views of mathematics and their interest in it as well as past experiences in its study. Then I conducted relatively structured interviews with the groups three weeks into the start of the project, in order to address any challenges faced by the students. In the fourth week into the projects, I repeated the relatively structured interviews. During interviews I asked the groups questions such as: "Tell me about your experiences of learning mathematics during your school days" and "What do you expect to achieve in this project?" The early interviews were not recorded but I made notes of what was discussed. The final interviews with all the focus groups, as well as the interview conducted by the Car Parking group with the College Director, were recorded. The final interview prompts with the focus groups were open ended, for example, "Explain to me what you did in your project." Each interview with the focus groups lasted for at least 50 minutes.

My own reflective journal

Throughout the research, I maintained a journal in which I recorded my observations about my planning and the students' reactions ('a-ha! experiences') in the classroom. Every day, throughout the student projects, I spared time after college work to reflect back on my lessons with the participants and expand on my journal entries. This journal was particularly useful during those interviews that were not recorded and also during whole class discussions. In my journal, I noted students' enthusiasm in lessons in which they were working on the projects; enjoyment of what they were doing; learning mathematics and difficulties encountered; collaboration between students; teamwork; and, of course, views expressed by students who could not be recorded on tape. I also used this journal to record observations made during interviews and class presentations which could not be recorded; for example, body language and eye contact. I also utilized the journal to make notes on conversations which took place during math club sessions with some of the participants.

All the recorded interviews in this research were recorded by the participants themselves, using their mobile phones and/or laptops. One of them then copied it for me onto my USB drive for transcription. This was deliberate, on my part, because I wanted to ensure they had copies of all the recordings to enable them cross check the transcribed scripts that were made available to them. I used direct quotations from the participants to support some of my data analysis throughout this paper.

Data analysis methods

Data analysis involves organising what the researcher has seen, heard and read so that he or she can make sense of what was learned. I started this process right from the outset of this research work. In qualitative research such as this, researchers use different approaches to analyse data. In this research, I used the Grounded Theory approach to analyse the data because it possesses the power of allowing data to 'speak for itself'. Processes suggested by Strauss & Corbin, 1998 and Charmaz (2008) involved coding the data by interesting features/topics and then reorganizing the data by codes into data clusters for further analysis and description (see Tanko, 2012).

During the data analysis process, the first thing I did was to identify the primary domain or themes related to my research objectives; for example; engagement and enjoying mathematics, which recur in the interviews, group presentations and class discourse. Table 1 and Table 2 below respectively show some of the themes, definitions, sub-themes; and universal themes generated.

Table 1: Themes, definitions and data examples.

Theme	Definition	Example data extract
Mathematics profile and positive change	Expression of liking for mathematics from the initial position of a math phobia participant.	I understand math better and I want to do math all the time. I go to class early after break no late again. I don't want any break for double period I stay in class. (Afra, reflective questionnaire)
Fun and enjoying mathematics	When participant makes a statement demonstrating happiness with the task in hand.	We are doing math with no fear like before in school. Is all fun and nice to do. This project is special for me because is different, is about car parking and I drive my car to college. (Aisha, reflective questionnaire)
Reading the world with mathematics	Using mathematics to better understand both local and global issues.	I like this project because we use math to understand the problem with transport to college. (Muneera, reflective questionnaire)
Writing the world with mathematics	Using mathematics as a tool to seek improvement of an unjust situation.	There is the need for more awareness campaign here at our college on the important role that private sector plays in the UAE economy. (Career Aspiration group, letter to Career Coordinator)
Problem solving	Demonstrates the ability to think "out of the box" - critical thinking ability. High order thinking.	Is cheaper for me to travel by private transport but I like the college bus because I make new friends on bus, this is very important in life. (Sheikha, presentation)

The preliminary themes above which have similarity were grouped into universal themes:

Table 2: Universal themes.

Universal Themes	Sub-themes (see Table 1)
Social justice	Reading the world with mathematics Writing the world with mathematics
Mathematics	Mathematics profile and positive change Problem solving
Attitude to work	Fun and enjoying mathematics

For further details on how credibility and validity in data collection and interpretation of results were achieved, see Tanko (2014).

Discussion

As stated earlier, the objective of this research was to investigate the ability of students to read and write their world with mathematics as a result of the adoption of social justice teaching within the Diploma Foundation (DF) years of the Higher Colleges of Technology (HCT).

Qualitative research usually results in a huge amount of data: therefore, it was important that I maintained the data in an organised manner and analysed and incorporated it in a timely fashion (Denzin & Lincoln, 2003). The data in this research were collected from multiple sources: student presentations; participants' reflective questionnaires; focus groups, and the use of reflective journal maintained by the researcher.

To make better sense of the data that I collected for this research, the analysis was done based on the appropriate research aims.

Reading the world with mathematics

Mathematics can be used as a tool to examine various phenomena both in one's immediate life and in the broader social world, and to identify relationships and make connections between them. In other words, borrowing the terminology from Gutstein (2006), it is possible to *read the world with mathematics*. Data collected in this project shows that the participants have developed significant ability to use mathematics as a tool to better understand their world, as demonstrated in the examples below.

The Car Parking project group thought the parking allocation between teachers and students at the college was unfair. During their project, the group was provided with the number of students who were registered to park at the college premises as 300. However, the students disputed the number. A good example is when Ayesha questioned the number of students who drive to college as 300 by saying "I know students who drive to the college but they are not registered to park in the car park" (Car Parking interview with the college Director).

Students went out 'in the field' with a measuring tape and measured the dimensions of both the students' and teachers' parking areas and utilised mathematics as a tool to work out the number of cars that can be parked on each (see Appendix 1), and based on their result they reached a conclusion, that:

We initially thought that the parking space allocation at [our college] was not fairly done. We are happy to report to you [college Director] that, contrary to our initial perception, the parking space allocation at [college] is reasonably fair. However, there will be the need to provide more parking when the number of students registered to drive and park at the college premises increases.

The Time of Travel group investigated whether or not the transport (bus) provided by the college was good value for money. To arrive at their answer, they had to calculate the total number of hours they spent on the bus travelling to and from college. They were provided with information on the cost of a 2-hour travel time using a public bus. Based on the result of their calculations they reached conclusions; for example, Figure 1 below shows Shaikha's work. Shaikha said traveling by public transport would be cheaper for her but she still preferred the college bus because she would be with her friends and it was safer. One very interesting aspect of Shaikha's work is that it reminds us of one of the limitations of mathematics, which is, that mathematics alone does not always provide the right solutions to authentic problems – this is why interpretation based on awareness of the individual's needs is so important.

Time	Cost
120 minutes	Dh 15
533 minutes	N
$120n = 15 \times 533$ $n = \frac{15 \times 533}{120} = Dh66.63 \text{ per week}$	

My semester is about 20 weeks, so I multiply the answer by 20,

$66.63 \times 20 = Dh1332.60$, one semester.

It is cheap for me to travel by public transport, only Dh1332.60 in one semester. But, I pay Dh1900 to travel in the bus. I still take the college bus because it is better than public because I travel with my friends and is safer and I don't worry when I am late to college because we are many.

Figure 1: Shaikha's travel cost calculation.

The Career Aspiration group investigated career aspirations amongst DF students. They designed a questionnaire (see Appendix 2) with which they collected primary data. Their investigation found that many DF students knew very little about the private sector as the largest employer in the UAE and hence its potential as a career choice for them. They also discovered that DF students didn't like attending Career Fairs, usually organised by the College to educate students, because as students they were only interested in part-time jobs and the fairs usually featured full-time jobs with no information on part-time employment. Again, as demonstrated in Tanko & Atweh (2012a) these students have used mathematics to understand their worlds.

Writing the world with mathematics

As Gutstein (2006) argued, in the absence of concrete direction and guidance, one does not easily become a 'reader and writer' of the world using mathematics. Students need scaffolding from the teacher not only to learn and perform well in the mathematics stipulated in the curriculum, but also to develop a sense of agency to use it for change. As a teacher in class, I was conscious of the significance

of the data obtained in the three projects as source of potential action towards certain improvement of the learning environment for the students. However, I was also well aware of the traditional expectations that students, and in particular female students, were passive and subservient to educational authorities and arguably to men. There were certain risks to pursue the topic that students have investigated towards action to be taken. However, I felt that such risks were possibly worth taking, particularly since the topics raised were not likely to be seen as too controversial or too confrontational in that particular context.

With each of the project groups I raised the question “How would you make your result known?” This question was often met with silence and deep thinking in the groups. The Car Park project, was the quickest to come up with some possibilities. Ayesha said that they would make their result known by telling “the college”. I asked, “Who is the college?” Ayesha said she would meet with the college Director and tell him about their findings. I then asked, “Tell me how you would meet with the Director?” One student suggested that they could send him e-mail to request a meeting. With some editorial assistance from me, the group sent the following email:

Dear Dr. X,

Our group with the support of [our teacher] was engaged in a Mathematic Project on our campus. The project was about Car Parking Spaces at [college]. We have discovered some interesting things that we would like to inform you about, with the hope that our result will have effective help in the future planning of [our college]. We would be grateful if you could spare some time for us to come and present our result.

Regards.

As a result of the above email, the students were granted audience by the College Director (see Appendix 1).. The other two groups were not as forthcoming in nominating specific people at the administration who might be interested in their results. Additional scaffolding was needed for the Travel Project group to think about contacting the college’s Transport Coordinator and for the Career Aspiration project to think about contacting the Careers Coordinator. Arguably, these two coordinators may have been less familiar to the students as their day-to-day interaction with the students was limited. With some assistance, these two project groups wrote to the respective coordinators requesting meetings with them. However, only the first group was successful in arranging a face-to-face meeting with the Director, whereas the other groups put their results in emails to the two coordinators.

During the meeting with the college Director, the students presented their findings and made recommendations for change. The students questioned the credibility of the information given to them by the Student Service department (i.e., 300 as the number of students who park at the college). The team leader said:

The number from the Student Service is not right, because many girls that we know they park [inside the college] but they didn’t register at the student service. So is more than that [300] for sure.

In addition, the participants mentioned that they were concerned with the safety of their fellow students because the students’ car parking gate was narrow. They presented that the gate was not safe for 2 cars to pass through simultaneously, as was the case at the time of their project. Also, the same gate is used as both entrance and exit, plus the college buses use the same gate. Below is an extract of the conversation which occurred during the interview.

Director: Okay. So, what are your recommendations to the college?

Student: We want more student parking area and something have to be done with that gate!

Director: Oh,..., so your recommendation is to have two gates, an in and an out?

Student: Yes!

Director: Okay, so one of the concerns that people are going to have is with the guards. If we open up a new gate, we gonna have to have a new guard here. Because, you don't want people just coming in here, and you don't want people to just park their cars and they come into campus this way, because then there is no checking.

Student: Yes!

[...]

Director: Alright! What I will do is I will get together with our Facilities [maintenance department] people and security and talk to them about this idea. Because your concerns and the concerns is that - is just more than the inconvenience! Right? ... You are saying it's more than inconvenience to have to wait, there is a safety issue. Do you agree?

Student: Yes

Director: It shows you how important math can be...

The students not only highlighted the problem with car parking space but also pointed to a potential safety issue. Exit and entrance to the car park are by the same gate, which means there is a high chance of accidents happening. Both of these issues are significant because we are not sure any of these students has ever thought of asking the college to provide more parking area for them, or questioned the credibility of information given by an authority (in this case the Student Services department). I believe they didn't even know they were free to offer suggestions on issues relating to their life on campus. However, through their project they have realised that they could and they have indeed relished the opportunity to ask for change.

Similarly, the Travel project participants took action by sending a letter (see Appendix 3) to the Student Services Coordinator at the time. In the letter they made recommendations on ways to improve the bus services at the college. Lastly, the Career Aspiration project students took action by writing a letter (see Appendix 4), to WC Career Coordinator explaining their findings and making recommendations.

The results of these meetings and correspondences were very pleasing, and perhaps a little surprising to both students and myself. The following year witnessed three changes in the school: firstly, more spaces were allocated for student parking; secondly, the college starting time was changed from 7:30 am to 8:30 am thus allowing students travelling from surrounding localities a more leisurely travel to the college in the morning; and lastly, the Careers Fair included more information about part-time work as well as careers in the private sector.

Mathematics Club, of which I was the coordinator during this research, became another meeting place for students to discuss their projects. Usually, DF students have an hour break, per day, in their time table; and during the period of the research, participants kept coming to the Mathematics Club, during their lunch time, to continue working on their projects. On one occasion I asked Haleema why they were using their lunchtime for the project instead of enjoying the time with their fellow students around the campus. Haleema replied:

This project has meaning to us. We want to solve the problem with the bus in college. I don't stop working on the project, even in my home. Other girls also work in the house.

It seems that Haleema and other students were working on the project even at home because they wanted to change what they believed to be unjust (the bus service). This is an indication of my students' attempting to write the world with mathematics.

During all focus group interviews I asked students to tell me about their experiences of learning mathematics during their school days. Many students spoke of lack of opportunities to express opposite viewpoint in class, and the possibility of getting into trouble with the authorities when such views were

offered. Consequently, many students expressed the fear of retribution from the college authorities. For example, one student (Hafsa) said “I hope this project will not be trouble for us sir.” I reassured them that the college had given me permission to carry out the research; therefore, there would be no trouble for anyone. She asked the same question again during another interview; and when I asked, “Can you explain to me your fears?”, she replied: “Is because this is new to all of us, we never did this before”. Another student (Muneera) added:

In school only the teacher think for student. Nobody can say anything different from the teacher point [of view].

The fear expressed by these students suggests to me that they had not been used to or given the opportunity to express their personal views on important issues during their school days. In addition, in response to one of the questions on the reflective questionnaire (*What do you like or not like about the mathematics projects you have completed this semester?*), various students wrote:

I like the project class because this is first time I relax in math class. In school only teacher talk and we listen, no say or argue [debate] like in this project. (Bedour)

I like because now I can talk [express] my view in class doing math. No chance in school to learn about this things. Is like politics now before I am afraid the teacher angry with me and I get trouble. (Nada)

This project teach me about asking for my right no fear like before. My teacher [in school] never try this way to teach us, may be afraid also. (Zainab)

From the participants’ comments it became obvious to me that prior to their projects, these students had not been used to taking action; therefore, the action taken by them was, indeed, exceptional and a breakthrough in their journeys towards becoming agents for change. I believe the project undertaken by these students and the action taken by them was significant in influencing their college administrators to make the changes mentioned above. Therefore, I contend that after ‘reading their world’ with mathematics the participants have also ‘written the world’ with mathematics.

Conclusion

Implications

One of the important implications of this study is related to the practice of teaching mathematics in this context. The findings from this study draw attention to an urgent need for a meaningful mathematics curriculum at the Higher Colleges of Technology – one with real life connections to the learner’s world. Such a curriculum could support students’ understanding of mathematics because it would allow them to draw upon their familiar experiences in making sense of the mathematics.

Another important implication of this study is related to the theory and research on social justice teaching. A very important aspect of this research is that the participants are young Middle Eastern Muslim women. Traditionally they are not as visible in public life as young men; but the findings in this research show that, like their counterparts in the Western world, these young women are also interested in social justice issues. This is particularly significant given the current ongoing social developments in the Middle East; extending the research to this new context of women in traditional societies shows that a focus on social justice is possible and beneficial.

Finally, this research has made a contribution to the field of teaching for social justice as well as mathematics education. It is the first study to investigate the influence of teaching mathematics for social justice in a Middle Eastern country to college students (adult learners) in normal classroom

settings. A research gap in investigating the ability of students to read and write the world with mathematics as a result of social justice teaching in the UAE was also bridged through this research.

Limitations

This research has some limitations. One is that the time spent on the research was not long enough for the kind of trust necessary for teaching for social justice to flourish. This is even more so for me being a male teacher teaching females for whom, I was probably the first male to exchange words with them in a formal classroom setting. If I had taught this class for the whole academic year, it would have allowed me more time to establish a solid foundation for better trust between the participants and myself.

Another limitation of this research is that because I come from a different cultural background to the students', it may not be possible to fully understand many of the challenges these students might have encountered throughout their journey with me in this research.

Recommendation

In terms of recommendation for future research, the findings in this research could serve as a springboard for future research in the Middle East. In particular, it would be valuable to attempt a longitudinal study, tracking a group under a social justice learning paradigm vs. a control group with a similar educational/social profile, through several years of College, through various levels of study, in order to ascertain long-term benefits of the pedagogy. This is important because it is needed to show that teaching for social justice does not disadvantage students academically; instead it provides them with opportunities to be better prepared for their future educational journeys.

A final comment

I humbly believe my research has uncovered certain things. First, although there is still a lot more to be done in terms of exploring the effectiveness of Gutstein's framework for teaching mathematics for social justice in the Middle East, data analysis from this study suggests that his framework is relevant and applicable in the UAE. By utilizing Gutstein's framework in this context, students have developed a significant ability to use mathematics as a tool to *read* and *write* their world. Secondly, the findings show that these young women are also interested in social justice issues. Finally, restricted in scope though this research has been, it contributes to the limited literature available on the teaching of mathematics for social justice.

Reflecting on my journey in this research, it was both interesting and salutary for me to be made aware, through frequent discussion with the students, just how limiting social and cultural constraints can be for students. However, for these young women, the Social Justice Pedagogy employed within their classroom gave them unprecedented insight into their learning process. For the first time they took responsibility for learning outcomes rather than have them dictated by their teacher mentor or, equally common, by reference to the answer section at the back of a textbook! By applying mathematics to their everyday lives, it suddenly became relevant to them, and they realised the potential which it could have for re-examining often long-established norms and communicating new ideas in a locally appropriate way.

References

Assad, C. (2008). *Gender equality in the United Arab Emirates: a driver for increased competitiveness?* Dubai School of Government. Policy Brief No. 5

- Center for the Mathematics Education of Latinos. (2010). *CEMELA*.
<http://math.arizona.edu/~cemela/english/>
- Charmaz, K. (2008). Grounded theory in the 21st Century. In N. K. Denzin & Y.S. Lincoln (Eds.), *Strategies of qualitative inquiry* (3rd ed.). Thousand Oaks, CA: Sage Publications.
- Creswell, J.W. (2005). *Educational research: planning, conducting, and evaluating quantitative and qualitative research* (2nd ed.). Upper Saddle River, NJ: Pearson Education.
- Denzin, N. K & Lincoln, Y. S (Eds), (2003) *Strategies of qualitative inquiry* (2nd Ed., pp. 133-164). Thousand Oaks, CA: Sage.
- Gutstein, E. (2001). Math, maps, and misrepresentation. *Rethinking Schools: An Urban Educational Journal*, 15(3), 6-7
- Gutstein, E. (2003). Teaching and learning mathematics for social justice in an urban, Latino school; *Journal for Research in Mathematics Education*, Vol. 34, No. 1, 37-73.
<http://dx.doi.org/10.2307/30034699>
- Gutstein, E. (2006). *Reading and writing the world with mathematics: toward a pedagogy for social justice*. New York, NY: Routledge.
- Gutstein, E. (2007). "And that's just how it starts": Teaching mathematics and developing student agency. *Teachers College Record*, 109(2), 420-448.
- Gutstein, E., & Peterson, B. (2005). *Rethinking mathematics: Teaching social justice by the numbers*. Milwaukee, WI: Rethinking Schools.
- Hatherley-Green, P. J. (2012). *Cultural border crossings: Improving transitions from high school to higher education*. (Doctoral dissertation). Curtin University of Technology, Perth, Australia.
- Issa, W. (2010). Juvenile crimes on the rise Dubai police say. *The National*.
<http://www.thenational.ae/news/uae-news/juvenile-crime-on-the-rise-dubai-police-say>
- Nereim, V. (2012). School violence: the truth behind a tragedy. *The National*.
<http://www.thenational.ae/news/uae-news/education/school-violence-the-truth-behind-a-tragedy>
- Ridge, N. (2009). *The hidden gender gap in education in the UAE*. Policy Brief No. 12. Dubai School of Government, UAE.
- Ridge, N., & Farah, S. (2012). *The 30%: who are the males in higher education in the UAE*. Policy Paper No. 3. Al Qasimi Foundation for Policy Research.
<http://www.alqasimifoundation.com/en/Publications/Publication/WhoAreTheMalesinHigherEducationin-theUAE.aspx>
- Robson, C. (2002). *Real world research: a source for social scientists and practitioners* (2nd ed.). Oxford: Blackwell.
- Stake, R. E. (2003). Case studies. In N. K. Denzin & Y. S. Lincoln (Eds), *Strategies of qualitative inquiry* (2nd Ed., pp. 133-164). Thousand Oaks, CA: Sage.
- Strauss, A., & Corbin, J. (1998). *Basics of qualitative research* (2 ed). Thousand Oaks: Sage.
- Tanko, M.G. (2012). *Teaching practical numeracy through social justice pedagogy: case study of Abu Dhabi Women's College*. PhD Thesis, Curtin University, Perth, Australia.

- Tanko, M.G. (2014). Challenges associated with teaching mathematics for social justice. *Learning and Teaching in Higher Education: Gulf Perspectives*, 11(1). <http://lthe.zu.ac.ae>
- Tanko, M.G & Atweh, B. (2012a). Developing Mathematical Knowledge through Social Justice Pedagogy with Young Adult Arab Women. In J. Dindyal, L.P, L.P, Cheng & S.F, Ng (Eds). *Mathematics education: Expanding horizon*, (Proceedings of the 35th annual conference of the Mathematics Education Research Group of Australia, eBook, pp 720-717). Singapore MERGA, Inc.
- Tanko, M.G & Atweh, B. (2012b). Mathematics Student and/or Social Activist? Young Arab Women and Social Justice Pedagogy. Proceedings of the 7th annual conference on Science, Mathematics and Technology Education held in Muscat, Oman. 4th – 7th November.
- Tracey, K. (2007). *The impact of human resources capital on ethnic minority Middle School Students, engagement in a mathematics community of practice and their mathematics identity*. PhD Thesis, University of North Carolina at Greensboro, USA
- Turner, E. E. (2003). *Critical mathematical agency: urban middle school students engage in significant mathematics to understand, critique, and act upon their world*. Unpublished Doctoral Dissertation.
- UAE Interact (2003). *Sheikh Zayed highlights UAE achievements in a remarkable speech on National Day*. http://www.uaeinteract.com/docs/Sheikh_Zayed_highlights_UAE_achievements_in_a_remarkable_speech_on_National_Day/10174.htm
- UAE Yearbook (2010). <http://www.uaeyearbook.com/Yearbooks/2010/ENG/>
- World Bank MENA ECD Report. (2009). <http://siteresources.worldbank.org/INTMNASUMMNSHD/Resources/IssuePaper5.12.09FINAL.pdf>

Appendix 1

Work presented by the Car Parking Group

Now we show you our calculations:

- We divided the student parking area into rectangles and triangles as in the diagram.

$$\text{Area of triangle} = \frac{1}{2} \text{base} \times \text{perpendicular height}$$

$$\text{Area 1} = \frac{1}{2} \times 5 \times 15 = 37.5 \text{m}^2$$

$$\text{Area 2} = \frac{1}{2} \times 5.15 \times 15 = 23.6 \text{m}^2$$

So, the total area is approximately $750 + 500 + 300 + 37.5 + 23.6 = 1611$ square meters

1. We measured the lengths of an average car as 4.7 meter by 1.6 meter

So, the area is $4.7 \times 1.6 = 7.52$ square meters

2. It means, for the students' car park, we have approximately $1611 \div 7.52 = 214.23 = 214$ car parking spaces. We have rounded down our answer here so that we don't have more cars than space available.

3. And, since there are 2150 students at WC, it means we will have the ratio as

$$214: 2150 = 1:10$$

This means there is only one parking space to every 10 students.

This is clearly not fair!

4. For the teachers, there are 3 car parking areas and we calculated the total area as 3440 square meters. And, there is 212 staff at WC.

Therefore, there are approximately $3440 \div 7.52 = 457$ car parking spaces. We have rounded down like before.

This means:

$$457: 212$$

2: 1, this answer is rounded down.

This means there are 2 parking spaces for every staff at the college.

Looking at the above results one will easily say the parking space allocation at WC is not fairly done. Then, we remembered that not all students drive car to college, some come by bus. Therefore, we asked for more information and we were told that approximately 300 students are registered to drive and park at the college premises.

Below are our calculations with the new information:

Teachers:

5. *Nothing changed.*

Students:

6. *Car: population*

214: 300

1: 2, we rounded up here to make sure we don't have cars without place to park.

This means, there is one car parking space for every two students at WC.

Car Parking group's letter to College Director:

The Director

Dear Sir,

CAR PARKING PROJECT

For few weeks now, with the help of Mr. Y, we were engaged in a project that we thought will help to further improve the quality of life of students and staff here at WC.

Many of us (students who drive to college) have concerns with the space provide for us to park our cars, so when Mr. Y introduced us to "Social Justice Mathematics", we immediately thought the car parking project would be a great one to pursue.

Below are our findings:

1. We found the ratio of parking space to population as follows;

Staff member: parking space

1:2

This means, there are two parking spaces to every staff at WC.

Student: parking space

2:1

This means, there is one parking space to every two students at WC

2. Student car parking entrance and exist are the same.

Suggestions and Conclusions:

1. We initially thought that the parking space allocation at WC was not fairly done. We are happy to report to you that, contrary to our initial perception, the parking space allocation at WC is reasonably fair. However, there will be the need to provide more parking when the number of students registered to drive and park at the college premises increases.
2. For safety reasons, we would like to suggest that, the entrance and the exits be separate or at least be made wider.
3. Through this project we have discovered the hidden powers of mathematics to resolve potential conflict. What we initially thought was unjust turned out to be just. We would like to recommend that more of this type of project be encouraged at our campus, and may be across the whole HCT colleges in the future.

Thank you very much.

Appendix 2

Career Aspiration group questionnaire

Please answer the following questions.

1) Have you ever thought of what you want to do after college education?

- I always think about it sometimes I think about it I never thought about it

2) Have you ever discussed career opportunities with anyone?

- with my parents with my teacher with my friends

3) Tick which career you think is suitable for a woman, man or both?

Career	Women	Men	Both
Nursing	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Teaching	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Engineering	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Doctor	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Military	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Pilot	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

4) How would you describe your understanding of the UAE Government Emiratization programme?

- Excellent Very good Very little Poor

5) Would you like more information about the Emiratization policy?

- Yes may be I know enough

6) Which of the following agencies would you like to work for?

- Government Private Sector None

7) Did you know that the private sectors in UAE are obliged to have Emiratis as part of their work force?

- I knew I didn't know

8) Do you believe men and women are equal at work place?

- They are equal there are not equal

9) Who would you rather have as your boss at work place?

- a man a women I don't mind

10) Do you live in Abu Dhabi?

- Yes No

11) Who is a civil servant amongst your parents

- my father my mother father and mother none

12) Who would you prefer to have as your teacher?

a male a female I don't mind

13) Select your age range from below

17 – 19 20 – 24 more than 24 years

Appendix 3

Travel group's letter to Transport Coordinator

The Coordinator

Bus Services

Dear Ms. T

TIME OF TRAVEL PROJECT

During our study of the topic of percentages we were engaged in a project titled "Time of Travel". The aim of the project was to use mathematics as a tool to investigate the advantages and disadvantages of using the college bus and also to make recommendations for improvement.

These are our findings:

1. All the students who use the college bus said they are grateful to the college for providing them with this option, and also to you for coordinating this very important aspect of our college experience.
2. For some students it is cheaper to travel to college using public transport. However, all students agreed that because college bus picks them from the front of their home it is safer, therefore better, as this gives the parents rest of mind.
3. Most of the drivers drive too fast and they are found of using their mobile phones while driving.
4. Pick up time is too early for some students. Breakfast is very important for the human body system to function well, but is almost impossible to have time to eat breakfast before coming to college. And for those with family is difficult to see their children before leaving home for college.
5. The bus is sometimes too noisy (students playing loud music), and dirty because students eat and drop things on the floor.

Recommendations:

1. Speed control/monitoring devise should be install on all the buses.
2. Bus Company should install hand free mobile phone facilities on their buses for the drivers to use.
3. College start time should be at least 9:30 am for all the morning students.
4. College should appoint student leader for each bus to report any misbehavior on the bus and any use of mobile phone by the drivers.
5. College should ask all students using the bus to sign a contract of good behavior.

Conclusion:

The bus services provided by WC is very good value for money and we (students) are very grateful to the management of the college for this. However, we would like to see the problems identified in this project taken seriously in the planning for next academic year.

Thank you.

Appendix 4

Career Aspiration group's letter to Career Coordinator:

The Coordinator
Career Services

Dear Ms. H,

CAREER ASPIRATION PROJECT

Recently, we completed our study on the topic of percentages using a project called “Career Aspirations at WC”. The aim of the project was to use mathematics as a tool to investigate the level of career awareness amongst Diploma Foundation students’, and also to draw their attention to useful information on the opportunities available here at WC and UAE in general.

These are our findings:

1. All the students agreed that the career department here at WC is doing great job in providing them with information regarding career opportunities.
2. Many students have reasonable understanding of the UAE government policy on Emiratization program; however, there are many issues that they would like clarification on.
3. Most students knew very little about the opportunities available in the Private sectors. Some thought private sector only employs foreign workers.
4. WC students are more interested in part-time jobs. They would be interested in full time jobs only in the later stages of their studies at WC.
5. Majority of DF students don't like to attend the career fairs.
6. Many students are interested in careers in Engineering.

Recommendations:

1. College should invite guest speakers from the Emiratization department to give talk and answer questions about their programs.
2. There is the need for more awareness campaign here at WC on the important role the private sector plays in the UAE economy.
3. College should invite more role models to speak about their life experience and how they succeeded. Most DF students say they will be more willing to attend and listen to career talk if a role model was present.
4. Private sectors attending career fairs at WC should focus a bit more on part-time jobs for the summer.
5. College should make available more engineering courses to WC students.

Conclusion:

The Career Services department here at WC is providing excellent services to students. However, we would like to suggest that the challenges identified and the recommendations given above are given seriously thoughts in the planning for the next academic year's career programs in this college.

Thank you,