

Science and Mathematics Education Centre

**Teaching Practical Numeracy Through Social Justice Pedagogy:
Case Study of Abu Dhabi Women's College**

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Declaration

This thesis contains no material which has been accepted for the award of any other degree or diploma in any university. To the best of my knowledge and belief, this thesis contains no material previously published by any person except where due acknowledgement has been made.

Signature: 

Date: 21st March 2012

ABSTRACT

The study presented in this thesis investigates the impact of using Social Justice Pedagogy in teaching Practical Numeracy to Diploma Foundation Students, in Abu Dhabi Women's College (ADWC), of the Higher Colleges of Technology, in the United Arab Emirates (UAE). Gutstein's (Gutstein, 2003, 2006a, 2007) framework for teaching mathematics for Social Justice was utilised. His framework had both social justice goals and mathematics goals. Productive Pedagogical principle (Mills, et al., 2009) was utilised as a framework to reflect on teaching practices in this study.

In order to achieve credibility and validity in data collection and interpretation of results, triangulation method was utilised in accordance with (Cooper 2001), and grounded theory for analysis, in accordance with Strauss and Corbin (1998), and Charmaz (2008).

There were twenty participants in this research. Their ages ranged from sixteen to thirty-six years and all of them were among the body of students whom I taught (class DF203). Three students' projects were completed in this research work, namely Time of Travel (TT), Career Aspirations (CA) and Car Parking (CP). The topics were chosen based on individual participant's interest after brain-storming sessions in my class and all dealt with one or more issues that have social justice implications. The TT project group investigated ways in which the transport, provided by the college, could be improved – they utilised mathematics as a tool to understand the challenges they face and made recommendations to the college Transport Coordinator on how to change and / or improve this very important aspect of their college life. The action taken by the TT project group contributed to a change in college start times from 7:30 am to 8:30 am for the students at Abu Dhabi Women's College (ADWC). The CP project group thought the parking allocation at ADWC was unfair (teachers have more space per head than students). Therefore, they used mathematics as a tool to investigate the car parking space allocation at ADWC. It was also as a result of the actions taken by the CP project group that students' car parking space was significantly increased at ADWC. The CA project group used mathematics

as a tool to investigate and inform the College Career Coordinator on how informed, or otherwise, the students in the Diploma Foundations (DF) at ADWC were, with regard to the career opportunities available to them. Similarly, as a result of the action taken by the CA group, Career Fairs at ADWC now feature information on part-time jobs and not only on full-time jobs as was the case before this project.

For my students the Social Justice Pedagogy employed within their classroom gave them unprecedented insight into their learning processes. For the first time they took responsibility for learning outcomes rather than have them dictated by their teacher mentor or, equally common, their reference to the answer section at the back of a text book! By applying mathematics to their everyday lives it suddenly became relevant to them and they realised the potential which it could have for changing often long-established norms. Equally, it was both interesting and salutary for me, the researcher, to be made aware, through frequent discussion with the students, just how limiting the social and cultural constraints are within the society of which the students are a part (McIntosh, 14th November, 1990). It is reasonable to assert that, limited in scope though the research has been; it has, nonetheless, supported the assertions of those who had hitherto engaged in the same field and it has also added to the limited literature available on the teaching of Mathematics for Social Justice.

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I still recall one morning, when my late father and mother, may Allah continue to bless them, amen, called me to daddy's seating room. I thought I had done something wrong. Dad looked at me in my eye and said, Goma wherever you find yourself, please remember one thing *never bite the finger that feeds you*. Even though I did not understand what he meant, I nodded and said 'yes father, I never will'. However, as I commenced my educational journeys, I soon realized that, along their paths, there exists so many such fingers that daddy referred to in his philosophical speech to me.

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CHAPTER ONE

INTRODUCTION

This study is about using Social Justice Pedagogy to teach Practical Numeracy to Diploma Foundation students, in Abu Dhabi Women's College (ADWC), of the Higher Colleges of Technology, in the United Arab Emirates (UAE). In this thesis Social Justice Pedagogy refers to a way of teaching mathematics which, at the same time helps learners to understand their world better and also enables them to seek their legitimate share of the benefits in their society while contributing to its positive development. In particular, it includes issues of equal opportunities for jobs and income, civic participation, and information and support related to one's personal life.

The Practical Numeracy course prepares young Emiratis at their Higher Colleges of Technology (HCT) for their Diploma Courses. In this sense, one may define Practical Numeracy (PN) as an aggregate of mathematical skills necessary to cope with the rigors of the higher levels of diploma programs. The PN course offered within the Diploma Foundation departments across all seventeen HCT colleges in the UAE falls within the category of developmental education as described by Boylan, Bonham, and White (1999). Developmental education is a service provided to students who are not prepared for the academic demands of higher education (Breneman & Haarlow, 1998).

The research work in this thesis is rooted in an educational paradigm which defines *equity* to mean that all learners will not only have equal access to all educational resources but they will also have very good educational outcomes (social, cultural and political) to advance in their society and the global world and become agents of change in them. A culturally relevant instruction, coupled with teaching for social justice, can motivate marginalised students to learn mathematics (Leonard, Brooks-Johnson & Q. Berry III, 2010). However, as Gutierrez (as cited in Varley-Gutierrez, 2009)

argued: equity should include issues of power and student identity, not just access and outcome. She said,

When an understanding of equity is limited to access (to teachers, rigorous curriculum and high expectations) and outcomes (such as test scores and course or career selection), issues of power and student identity are often overlooked in understanding the multiple factors (for example, political, economic and historical) that influence learning setting and individuals in that setting. (p. 35)

1.1 Why Social Justice?

There are three justifications why Social Justice Pedagogy 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 UAE has increased, the ratio of immigrants to “native” Emiratis has risen sharply. Currently, the population of UAE is approximately 8.19 million, out of which 20% are nationals and 80% foreigners - a ratio 1:4 (Abu Dhabi Statistical Yearbook, 2009). This has, rightly, caused concern - particularly over the possible impact on the country’s security and social and cultural values. Such concern was also expressed by His Excellency the late Sheikh Zayed Bin Sultan Al Nahyan. In his Annual Speech to the Nation in 2003, he said,

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)

The quote above shows that while the UAE rulers are welcoming of foreigners; they are also committed to maintaining the cultural identity of their people. 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, in a fast growing economy, like that of the United Arab Emirates, teaching, using Social Justice Pedagogy, is necessary conditioning for developing national identity, while simultaneously preparing its young adults to be functional and effective participants in an increasingly globalised world

In the same speech, His Excellency the late Sheikh Zayed Bin Sultan Al Nahyan, reiterated the importance of the positive role that both the young men and women of UAE need to play in the future development of the country. He stated, clearly, that UAE's education curriculum needs to continue to undergo modernisation in order to serve the best interest of its peoples. He added,

Although we have already achieved a considerable amount in terms of the training and preparation of our young people, both men and women, there remains a great need to continue to focus on this training and to intensify it. We believe that getting the country's young people involved in working for its future is a task to which we should devote all of our efforts, so that it may be achieved in the best possible way. This requires that we should continue to modernise our educational curriculum, so that it may deal effectively with the recent advances in science and technology and the new opportunities that they make available. (UAE Interact, Dec 2003, italics added for emphasis)

An effective and modern curriculum for the 21st century is one that has "rich" connectivity to the lived lives of the learners. The research reported in my thesis is aimed at making the learning of Practical Numeracy meaningful while addressing some social justice issues. The Sheikh's call is in line with the kind of teaching approach proposed in this research work i.e. teaching for social justice.

In addition, democracy is sweeping across the Arab world at an indescribable pace. In the United Arab Emirates, a small but increasingly active number of young Emiratis are beginning to question, often on social media like Twitter and Facebook, the cost of their parents' "genteel quiescence" (Solomon, 2011). The change that usually comes with democracy is too "bitter a pill" to swallow for some of the leaders around the world, especially in the developing nations. (Myanmar/Burma and Zimbabwe spring immediately to mind as but two examples among many.) That said, however, it is fair to also mention that the United Arab Emirates is one of the few countries in the Middle East region which, to some degree, has demonstrated a willingness to embrace the change associated with democracy. For example, in 2006, twenty of the forty members of its Federal National Council (UAE's advisory Council) were elected by an Electoral College. This was the first time such elections were held. This was followed by the launching of the "Government's Strategy" in 2007. The launch was described by the Vice President and Prime Minister of UAE, H.H Sheikh Mohammed bin Rashid al Maktoum, as follows,

This (launch) sets the foundations for a new era of public administration. The changing times and the nature of the challenges prompt us to think in a different way and to adopt international best practices in the area of public administration. This strategy unifies efforts within a strategic framework with clear objectives, based on detailed studies (and)...clearly identifies and integrates federal and local efforts. (UAE Interact, 2011, italics added for emphasis)

The election in 2006 was a breakthrough in the reform process designed by the UAE leaders to enhance public participation in the UAE political system. This was a small step, but contextually significant.

The change envisioned and undertaken by the UAE leadership represents an indigenous initiative reflecting the need to transform the country's traditional political heritage – based on consensus, the primacy of the consultative process and gradual social change – into a more modern system that takes into account the rapid socio-economic

advances made since the establishment of the federation. (UAE Interact, 2011)

May 2011, saw the first ever UAE University political forum held in Dubai. During the forum a young Emirati woman stood in front of her fellow students and shouted “sometimes change doesn’t come from being polite and restrained sometimes you have to get your hands dirty” (Solomon, 2011, p.1). Solomon added that one UAE analyst, Christopher Davidson, said,

The on-line campaign questioning how oil wealth is spent could be effective in spurring ordinary Emiratis to action. However, they need to educate the population with the truth, with how the oil wealth is spent, how the budget is divided between the different emirates and most importantly what chunk of the annual oil surplus goes directly to the royal family members. (*Italics added for emphasis, p. 2*)

Gutstein (2006a) argued that if one has a limited understanding of mathematics, his or her ability to understand important political issues would be hindered. Consider the world-wide confusion over the Global Financial Crisis, or the struggle to have population’s comprehend the scientific, economic, political and societal-impact details and significance of Anthropogenic Climate Change, and the resultant policy response debate arising out of the scientific consensus. The teaching of mathematics for social justice implemented in my research would provide opportunities for the learners to acquire the skills, knowledge and sense of agency necessary for effective understanding of important political issues. It is my belief that teaching mathematics for social justice has the potential of contributing to the preparation of UAE’s young adults for the political change that is sweeping across their country with gathering momentum.

Although the constitution of the United Arab Emirates upholds the principles of equity, it does not specifically address gender issues. Women are sometimes restricted to their traditional roles of wives and mothers. However, it is pertinent to mention here that the rulers of UAE, especially, the late Sheikh Zayed Bin Sultan Al Nahyan, have acknowledged the positive role

that women play in the extraordinary development of the UAE. In his Annual Speech to the Nation in 2003, he said,

We are pleased to mention, with pride, that which our women have achieved in terms of strengthening the economic and social role that they play in society, in both the public and the private sectors. We reaffirm our commitment to provide all necessary support for our women, such that will ensure that their role in society can be further strengthened, and so that the scope of their participation in the comprehensive development of our country can be widened. (UAE Interact, Dec, 2003).

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). Although UAE's ranking is better than the other Gulf Corporation Council (GCC) countries, it would be an understatement to say there is still a lot of work to be done in order to achieve equity between men and women. Culturally, some women have accepted their lower positioning in the society - this kind of thinking is challenging to change. However, one of the first steps towards achieving change is to provide the people with what I call *relevant education* - an education which provides opportunities for empowerment. Providing such opportunities is one of the main goals for teaching for social justice. Therefore, the teaching approach proposed in this research work i.e. teaching for social justice, is important for shaping the future direction of the UAE.

Social Justice Pedagogy employs the "problem-posing" approach in which students pose problems that matter to them; attempt to understand these problems; have input into them; and eventually change their community and the broader world. It is in total contrast to the "banking education" approach whereby knowledge is "deposited" into the heads of students by their teacher. As Freire was quoted in Frankenstein (2006), "Our task is not to

teach students to think – they can already think – but to exchange our ways of thinking with each other and look together for better ways of approaching the decodification of an object” (p. 28).

1.1.1 *Gutstein’s Framework for Teaching Mathematics for Social Justice*

In this research, I will utilise Gutstein’s (2003, 2006a, 2007) framework for teaching mathematics for social justice. His framework has both *mathematics goals* and *social justice goals*. In order to realise the *mathematics goals* one must learn to read the mathematical world; succeed academically in the traditional sense; and change his or her orientation to mathematics (Gutstein, 2006a).

Read the mathematical word: Mathematics is pervasively influential in today’s world, so much so, that a limited understanding can hinder the more complete grasp of important political issues. In other words, if one has trouble reading the mathematical word, she or he may struggle with reading the world with mathematics (Gutstein 2006a).

Succeeding academically in the traditional sense: This is achieved when the learner passes a mandated examination which would enable him or her to gain admission into his or her desired course or chosen career. While this will not be a major component in the design of this study, nevertheless, it is necessary to be aware of any possible decline in achievement of the participating students at the final traditional assessment that they undertake in the subject.

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

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.

Read the world with mathematics: Reading the world with mathematics entails using 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). For instance, if one 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 he or she has read the world using mathematics. Similarly, if one utilises mathematics as a tool to expose social injustice, then he or she has also read the world using mathematics.

Write 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". Gutstein (2006a) stated that he views writing the world with mathematics as a "developmental process of beginning to see oneself capable of making change, and he referred to writing the world for youth as developing a sense of social agency" (p. 27).

Develop positive cultural and social identities: This requires the students to be "strongly rooted in their home languages, cultures, and communities, [while] at the same time, be able to appropriate what they need in order to survive and thrive in the dominant culture" (Gutstein, 2006a, p. 147). Positive cultural identity is demonstrated, as reported by Ladson-Billing (1995b) when the learner succeeds in an academic sense while still maintaining his or her cultural integrity.

Social justice and Productive Pedagogy have a strong academically recognised link; hence the two may be used simultaneously. In this research, the principle of Productive Pedagogy is used as a means to reflect on my practices.

1.1.2 Social Justice and Productive Pedagogy

In 2001, the Queensland State Government initiated the Productive Pedagogy Project. The project built upon a very large body of extensive research into the production of socially equitable student learning outcomes

initially developed by the Queensland School Reform Longitudinal Study (QSRLS) team in 1999 (QSRLS, 1999; Ladwig, Luke and Lingard).

Productive Pedagogy is a “comprehensive summation” of familiar classroom techniques in one workable model that focuses on high quality student learning and improved outcomes (Van Helda, 2002). Van Helda, said,

In essence, Productive Pedagogy takes existing techniques and learning concepts, and groups them into this simple model. Productive Pedagogy almost seems too basic to have any real effect. However, it is the measurement and evaluation of these factors, combined with the increased awareness of teachers of the most effective techniques that contributes to the program's success. (n.d.)

The design in this research is based on Social Justice Pedagogy; however, Productive Pedagogy will be used to reflect on the researcher’s practices (Mills, Goos, Keddies, Honan, Pendergast, et al., 2009). In this research, to cover the material in the ADWC Diploma Foundations Mathematics Course Outline, I will make the most of the recognised link between social justice and Productive Pedagogy, by utilising the data collected by the participants to develop “Mathematical Enriched Worksheets”, and use the principles of Productive Pedagogy (Hayes, Mills, Christie & Lingard, 2006) approaches in reflecting on the students’ activities.

1.1.3 Social Justice and Qualitative Literacy (QL)

The justifications as to why qualitative literacy is relevant to the context of this study are its emphasis on: mathematics in context; cultural appreciation; and logical thinking (Qualitative Literacy Team, 2001). Many researchers have argued that there is a strong connection between Social Justice Pedagogy and Qualitative Literacy. For instance, Wiest, Higgins and Frost (2007) assert that there is a connection between Social Justice Pedagogy and Qualitative Literacy. They defined QL as “an inclination and ability to make reasoned decisions using general world knowledge and fundamental mathematics in authentic, everyday circumstances” (p. 48). They argued that with QL,

ordinary citizens are given the power to understand their society better and hence function effectively within it:

Developing a qualitatively literate citizenry is not only important for creating a more effectively functioning society but also is a matter of social justice in that it places numeric understanding in the hands of “ordinary” citizens, preparing them to function, for example, as informed voters and consumers. Without qualitative understanding in this Information Age, laypersons may be relatively powerless compared with a small number of individuals with specialized knowledge. (p. 47)

Similarly, Schoenfeld (as cited in Wiest, Higgins & Frost, 2007) defines QL as: “The predilection and ability to make use of various modes of mathematical thought and knowledge to make sense of situations we encounter as we make our way through the world” (p. 51). On the other hand, quantitative literacy was defined by Alsina (as cited in the International Life Skills Survey (ILSS), 2000) as:

An individual’s capacity to identify and understand the role that mathematics plays in the world, to make well-founded mathematical judgments and to engage in mathematics in ways that meet the needs of that individual’s current and future life as a constructive, concerned and reflective citizen. (p. 1)

In 2001, Steen identified the characteristics of QL to include: confidence with mathematics; cultural appreciation; logical thinking; making decisions; applying mathematics in context; number sense; practical skills; and interpreting data.

1.1.4 Social Justice, Mathematical Beliefs and Understanding

In order to successfully attain any of the teaching mathematics for social justice goals, it is necessary that one believes in his or her ability to understand and do mathematics. Therefore, mathematics beliefs and understanding are relevant to the context of this research. Bandura (1986)

argued that in all areas of life, the behavior of human beings is impacted by their beliefs. One's experience of learning mathematics during school days can have a long lasting effect on the way one subsequently thinks of the subject. Positive experience can lead to the holding of positive self-belief, while negative experience can lead them to developing negative self-belief about their ability in mathematics.

This research has provided me with the opportunity to gain an insight into my students' views about their learning of mathematics during school days. My many discussions with the participants in this research suggest that, their experience in learning mathematics during their school days has led them to develop negative self-belief about their ability in mathematics. Some beliefs are explicit while others are tacit (Schraw & Olafson, 2002). One kind of belief is epistemological beliefs – which comprise an individual's beliefs about the nature of knowledge and knowing. In general, mathematical beliefs are categorised into: beliefs about mathematics; beliefs about mathematics teaching; beliefs about self; and beliefs about the social context (McLeod, 1992). My experience of teaching DF students suggest to me that many of them have developed “non-availing beliefs” (Muis, 2004) about the subject. These non-availing beliefs of students are both “deeply antimathematical in fundamental ways” (Schoenfeld, 1985, p. 13) and contrary to the conception of mathematics and mathematics learning advocated by the National Council of Teachers of Mathematics (NCTM) principles and standards (2000), which emphasizes relational understanding rather than memorization. Teaching for social justice has the potential to act as a catalyst to achieving positive self-belief. It is not uncommon for private tutors and operators of after-school mathematics centres (like Kumon) to report that students come to them from age 6 upwards with shattered self-belief and certainty that they are incapable of comprehending mathematics. Often, this is based on the fact that their teachers, parents and/or peers have convinced them that they are “stupid” and incompetent.

The power of teachers to influence outcomes through expectations has long been postulated, going right back to the original, controversial so-called “Pygmalion in the Classroom” study (Rosenthal & Jacobsen, 1968). Certainly,

teacher's *negative* expectations can have profound, lasting, deleterious impacts. In Western societies in the last century, educators have seen a shift in cultural expectations, reflected in the classroom, along the gender divide. Certainly there is much anecdotal evidence that, in terms of overall performance, females were not *expected* to be competent in mathematics and the sciences until relatively recently, where now they often outnumber and outperform boys in advanced mathematics classes in co-ed school settings.

It is notable also, that teachers have a tendency to replicate within the classroom the social structure and "caste system" of the social strata from which individual students come (Rist, 1970), thus "locking in" performance expectations associated with social class stereotypes.

As educators of mathematics, I believe that we have a moral duty to teach our students using a relational approach and connect the learning to their worlds. Doing this would enable them to achieve deeper understanding and, consequently, be empowered to create their own mathematical meaning, enjoy learning and applying mathematics in their lives both in and out of school and enhance their self-belief about learning mathematics. My sentiment was succinctly stated by Boaler (1998) when she said, "Many mathematics educators are increasingly concerned that many students are able to learn mathematics for 9 years or more but are then completely unable to use this mathematics in situations outside the classroom context" (p. 1).

Various mathematics educators, for example, Boaler (1998, 2000b, 2002a), Cobb, Stephan, McClain and, Gravemeijer (2001) and Schoenfeld (1985) concluded that students' lack of understanding is as a result of the way mathematics was being taught to them, and the consequence is that students cannot use school-learned mathematics rules and procedures. The teaching approach adopted in my research work facilitated the participants' journey towards acquiring the skills necessary to enable them to use mathematics in situations both within and outside the classroom context.

During my many discussions with the participants in this research, many of them told me that during their school days mathematics was never connected

to their lived lives. In other words mathematics was taught to them as isolated facts, skills and procedures. This suggests to me that, perhaps, this may be one of the reasons why they have not developed the ability to transfer and apply the key ideas in related situations. Consequently, they perceived mathematics as not connected to social reality in any substantive way - they have been robbed of an important tool to help them fully participate in society (Peterson, 2005). Analysing, as well as synthesising mathematical findings, is alien to them. This is consistent with cognitive theory that predicts lack of retention unless “rich” links within cognitive structure are developed (Bransford et al., 1999; Gagné & White, 1978). Teaching for social justice can act as a vehicle to achieving better relational understanding.

1.2 Significance of the Study

The majority of the learners, in the context of the investigation, exhibit weak Common Educational Proficiency Assessment (CEPA) scores and are, therefore, perceived as mathematically weak. Hence, it is an understatement to say that the majority of our DF students arrive at HCT not liking mathematics for one reason or another. From my own experience, the common reason given by students is that the majority cannot see, or have never been given, a reasonable chance to see how mathematics could be a catalyst to better living conditions for them. Therefore, one of the main reasons for undertaking this research was to reassure the learner by making the learning of mathematics relevant and useful, and providing opportunities for them to acquire the skills, knowledge and sense of agency necessary for effective understanding of important political issues in their communities and the world.

The majority of our DF students enjoy task based projects and this fact is reflected in all the previous results sheets that I have seen over the past 3 years. I also have firsthand experience of this as one of the teachers at the Diploma Foundation level in the HCT. Therefore, a further outcome of the proposed research may be that it may flag to HCT administrators, at ADWC,

the benefits of using Social Justice Pedagogy in the teaching of Practical Numeracy at the Diploma Foundation level.

Teaching mathematics through Social Justice Pedagogy is “relatively” new in many parts of the world. For example, this research is probably the first of its kind here in the UAE and the broader Middle East, as a whole. Therefore, another significance of this research is that it may help to define how students in the Middle East respond to teaching which uses Social Justice Pedagogy. In turn, this will hopefully confirm some or all of the benefits and challenges that researchers from other parts of the world have discovered with regard to teaching mathematics for social justice.

To the best of my knowledge, much of the research work to date, in which Gutstein’s framework for teaching mathematics for social justice was used, was based on middle and high school students (see Gutstein, 2000, 2001; Varley et al., 2007; Tuner et al., 2009). Therefore, my research work is significant because it focuses on college students (adult learners). The research results may help to support or refute the assertions of those who have hitherto engaged in the same field in other parts of the world. Consequently, it will also add to the limited literature available on the teaching of mathematics for social justice.

1.3 Research Aims

The purpose of this research is to trial a pedagogical approach which enhances the teaching of a Practical Numeracy course within the Diploma Foundation (DF) years of the Higher Colleges of Technology. The medium selected was to seek to relate mathematics to the real life of the students whilst, at the same time, addressing some social justice issues.

The research aims in this thesis were to investigate the results among students after adoption of a social justice approach to teaching, in particular the effects upon:

1. students’ learning in mathematics;
2. students’ engagement;

3. students' ability to develop agency and
4. successes and challenges encountered in using this approach to teaching in this particular context.

1.4 Constraints of the Study

Although dealing with important issues, my research has been constrained in its scope as follows:

1. *College Policy on course allocation*: One recommendation by Gutstein and Peterson (2005), on getting started on teaching for social justice was “get to know your students and their communities well and listen closely to the issues they bring up” (p. 4). At the time of this research, it was a policy in the Diploma Foundation Department that no teacher should teach a particular class for 2 consecutive semesters. This meant that I had only a few months to win the trust of the participants in this research. If I had taught this class for the whole academic year it would have allowed me more time to become “one with them” which, I believe, would have facilitated more open discussions in the class.
2. *Gender issues*: As a male teacher of an all-female class within an all-female college, I am not allowed to have any one-to-one interviews or discussions with the participants. This means participants had no opportunity to express personal views in private. Were I a female teacher, this barrier would not have existed and participants might have expressed some different views in private.
3. *The language barrier*: Many of the participants in the research find it challenging to express themselves in English and I do not speak Arabic. Since all the class discussions and interviews were conducted in English this meant I was unable to capture the complete, nuanced views of the participants on some issues. Had the class discussions and interviews been conducted in Arabic, I believe the participants would have been better able to express themselves.
4. *Doing the Project and covering the curriculum*. The conflict between: traditional teachings where all students cover the same topics and different groups working on their own projects was a source of tension

in this study. All the projects were done simultaneously and because of this it was not possible to have whole class discussions on the projects before the group presentations. If I had had all the groups work on the same project, at the same time, it would have been easier to have whole class discussions amongst all members of each of the groups. In addition, it was challenging to focus attention entirely on the project because of the pressure to cover the expected curriculum in time for the end of year examination.

Of the above, College policy on course allocation' was the most serious constraint, as it did not allow me sufficient time to win the trust of Section DF203 students, and their parents, before embarking on this research. However, I consider that, despite these constraints, the principal objectives of my research were achieved.

1.5 Outline of the Remaining Chapters

I present below a summary of the remaining chapters in the thesis:

Chapter 2 reviews the literature on education issues related to: mathematical beliefs; the teaching of mathematics using Social Justice Pedagogy; Critical Mathematical Literacy; Productive Pedagogy and Qualitative Literacy. Because the project was informed by several areas of research, it implies that the quantity of literature might be great and hence there was a need to confine the literature to key articles that related directly to the research.

Chapter 3 summarises the methodology employed in the research. The chapter also describes the research instruments adopted and the ethical considerations which underpinned the research.

Chapter 4 presents: relevant details relating to the country, College, students, the subject and the projects developed by the students are also given, and information on how the students' projects presented in the Thesis came to be: a narrative description of the projects; the project groups and group presentations; the "Mathematical Enriched Worksheets" developed with the aim of enhancing the teaching and learning of the topics of percentages,

graphs and time calculations; and the rationale behind the use of the worksheets.

Chapter 5 analyses the data from all the data sources. The analysis is structured around the research aims.

In Chapter 6, the final chapter in the thesis, the research questions are discussed and implications of the study for the implementation of the Practical Numeracy course are considered. Implications of the results on the wider international mathematics education research agenda are also considered. The chapter concludes with recommendations for practice as far as the teaching of mathematics for social justice is concerned and presents recommendations for further research.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

In this study, I was interested in the impact of Social Justice Pedagogy on the teaching of Practical Numeracy (PN) to Diploma Foundation (DF) students at Abu Dhabi Women's College (ADWC). Mathematical beliefs that students bring into the classroom have an effect on the ways in which they engage in learning mathematics. One such belief is that mathematics has no connection to real life. Unfortunately, the kind of mathematics taught in many educational institutions around the world today seems to place great stress on objectivity and neutrality. As a result "mathematics has been tacitly accepted as a color-blind discipline" (Tate, 2006, p. 32). Therefore, it is important to understand what is necessary for teachers to motivate and engage students in mathematics. The study described in this thesis employed Gutstein's (2006a) framework for teaching mathematics for social justice.

The review presented in this chapter provides insights into the research work done on teaching mathematics for social justice. It also offers an overview, of the relevant areas, on adult numeracy, Productive Pedagogy and mathematics education. Each of these aspects of the literature play a role in addressing the research aims in this study.

This chapter consists of 7 main sections. Section 2.2 deals with literature on adult numeracy, Section 2.3 deals with literature on quantitative literacy, Section 2.4 deals with literature on teaching for social justice, Section 2.5 deals with literature on mathematics education, Section 2.6 deals with literature on Productive Pedagogy and the final Section 2.7 presents the summary of the chapter.

2.2 Adult Numeracy

This thesis is about using an approach to develop numeracy. Coben et al., (2003) contend that “Numeracy is a deeply contested and notoriously slippery concept” (p. 9). Some equate numeracy with elementary mathematics and consider it to be superficial, basic, and generally easy to understand. Such view was rejected by Ma (as cited in Coben et al., 2003).

The purpose of numeracy is described by different researchers in various ways. For instance: the Cockcroft Report (DES/WO, 1982) considered its purpose as being for coping with adult life and work; for (Benn, 1997, and Johansen & Wedege, 2002) they contend its purpose to be empowerment and democracy; while for (Benn, 1997a; Johansen & Wedege, 2002) it is for critical citizenship. According to Coben (2000) the nature of the relationship between numeracy and context is contested, nevertheless in many modern definitions numeracy is seen as contextualised, as in the following definition

To be numerate means to be competent, confident, and comfortable with one’s judgements on whether to use mathematics in a particular situation and if so, what mathematics to use, how to do it, what degree of accuracy is appropriate, and what the answer means in relation to the context. (Coben, 2000b, p. 35)

Brown (2002) contended that numeracy included ones competence and inclination to use number concepts and skills to solve problems that one comes across in his or her everyday life and employment. The Australian Association of Mathematics Teachers argued that numeracy involves using some mathematics to achieve some purpose in a particular context (AAMT, 1997).

In 2001, Lindenskov and Wedege introduced the term “numeralitet”, the direct Danish translation of “numeracy”, with a focus on functional mathematical competence in the changing social and technological context. This definition of numeralitet has now been adopted by the Danish Ministry of education (Wedege, 2002).

Gal (2000), as reported in Coben et al., (2003), proposed three different types of numeracy situations, namely: Generative; Interpretive; and, Decision.

Generative situations require people to count, quantify, compute and otherwise manipulate number, quantities, items or visual elements, all of which involve language skills to varying degree. *Interpretive* situations demand that people make sense of verbal or text based messages that may be based on quantitative data but require no manipulation of numbers. *Decision* situations demand that people find and consider multiple pieces of information in order to determine a course of action, typically in the presence of conflicting goals, constraints or uncertainty. (p. 15)

Gal (as cited in Coben et al., 2003) sees adult numeracy education as helping students "to manage effectively multiple types of numeracy situations" (p. 24). She characterises numeracy as a semi-autonomous area at the intersection between literacy and mathematics and asserts that "conceptions of numeracy should address not only purely cognitive issues, but also students' dispositions and cognitive styles" (p. 21).

In 2000, Coben described as problematic the relationships between numeracy and mathematics and between numeracy and common sense. She believed that some adults underestimate their ability in mathematics so much that they consider the mathematics they can do as "just common sense", and they often use the word mathematics only for computations they found challenging to do (Coben, 2000a).

White argues that the word numerate should be used with caution when describing people as numerate or as innumerate because test results of their computational skills is not a sufficient indicator. He added that rather than asking how many people are innumerate we need to ask in what contexts they are innumerate (White, 1974).

The research forum Adult Learning Mathematics (ALM) sees mathematics as encompassing numeracy. On the other hand, O'Donoghue (2003) sees numeracy as encompassing some elements of mathematics, rather than vice versa: "Mathematics and numeracy are not congruent. Nor is numeracy an accidental or automatic by-product of mathematics education at any level. When the goal is numeracy some mathematics will be involved but mathematical skills alone do not constitute numeracy" (p. 8).

In the Adult Numeracy Teaching Pack of Australia (ANT) entitled Making Meaning in Mathematics, numeracy is considered by many as more than mathematics (Johnston & Tout, 1995; Yasukawa, Johnston, & Yates, 1995). This view is believed to be the common position held by most researchers researching in Adult numeracy. For example, Tout (1997), one of the authors of ANT said,

We believe that numeracy is about making meaning in mathematics and being critical about maths. This view of numeracy is very different from numeracy just being about numbers, and it is a big step from numeracy or everyday maths that meant doing some functional maths. It is about using mathematics in all its guises - space and shape, measurement, data and statistics, algebra, and of course, number - to make sense of the real world, and using maths critically and being critical of maths itself. It acknowledges that numeracy is a social activity. That is why we can say that numeracy is not less than maths but more. It is why we don't need to call it critical numeracy - being numerate is being critical. (p. 13)

Yasukawa et al., (1995) defines numeracy as "the ability to situate, interpret, critique and perhaps even create mathematics in context, taking into account all the mathematical as well as social and human complexities which come with that process" (p. 816). Johnston and Yasukawa (2001) define numeracy as a way of negotiating the world through mathematics. FitzSimons, Coben, and O'Donoghue (2003) observe that,

Most researchers nowadays eschew purely functional aims for numeracy in favour of empowering learners through numeracy - however the term 'empowering' may be understood. However, the teleological purposes are not always made explicit – whether they are for individual, democratic, or adaptive development of the learner. (p. 122)

In 1982, in England and Wales, of the United Kingdom, a committee that came to be known as the Cockcroft Committee was charged with the task of considering the mathematics required in further and higher education, employment and adult life generally. The committee published its report as cited in (Coben, 2003), in which it states,

We would wish the word 'numerate' to imply the possession of two attributes. The first of these is an 'at-homeness' with numbers and an ability to make use of mathematical skills which enables an individual to cope with the practical mathematical demands of his everyday life. The second is an ability to have some appreciation of information which is presented in mathematical terms, for instance in graphs, charts or tables or by reference to percentage increase or decrease. Taken together, these imply that a numerate person should be expected to be able to appreciate and understand some of the ways in which mathematics can be used as a means of communication... Our concern is that those who set out to make their pupils 'numerate' should pay attention to the wider aspects of numeracy and not be content merely to develop the skills of computation. (p. 12)

I am of the opinion that all the definitions of numeracy presented above overlap – stating aims and objectives of numeracy in different forms. However, there seems to be three schools of thought with respect to whether or not numeracy is equal to, the same as, or less than mathematics. For example, O'Donoghue (2003) sees mathematics as a subset of numeracy, while the Adult Learning Mathematics (ALM) forum sees numeracy as a subset of mathematics, and in the Adult Numeracy Teaching Pack of

Australia (ANT) numeracy and mathematics are seen as equal. The participants' projects presented in this thesis will provide the students with opportunity to encounter and to improve their skills on the three numerate situations (generative, interpretive and decision) described by Gal (2000).

Cohen et al., (2003) believes that in some countries, for example, the United States of America (USA), and in some contexts, the term "numeracy" is not well established or perhaps even actively avoided. In the USA, the term "quantitative literacy" (QL) is commonly used to refer to text-based activities with numbers. Numeracy is often subsumed within literacy in education. In 2002, this situation was challenged, with respect to Ireland, by Maguire and O'Donoghue. In the same year there was a similar challenge with respect to Australia by Cumming (1996).

2.3 Quantitative Literacy

Numeracy and quantitative literacy are often used interchangeably in the literature. I see quantitative literacy as containing all the goals of numeracy but delivering the goals in a more cross-curricular way. In other words, quantitative literacy could be taught in any liberal arts department – and be seen as okay by the students. On the other hand if numeracy was to be taught in a liberal Arts department, students may see it as not okay. In an interview on the subject of quantitative literacy, Robert Bernhardt, then Chair of mathematics at East Carolina University, was asked ; to what extent is QL part of Mathematics and to what extend does it differ? His answer was,

I would recommend avoiding the question of whether QL is mathematics or not altogether, because even if you could answer it, it would not help you very much. Certain mathematics and statistics have strong roles to play in any viable QL program. That is enough.
(n.d)

Quantitative literacy was defined by Manaster (2009) as the "capacity to be comfortable with numerical data and to use them in meaningful ways, in particular to make well-reasoned decision" (p. 68).

Quantitative literacy was defined by Alsina (as cited in the International Life Skills Survey (ILSS), 2000) as:

An individual's capacity to identify and understand the role that mathematics plays in the world, to make well-founded mathematical judgments and to engage in mathematics in ways that meet the needs of that individual's current and future life as a constructive, concerned and reflective citizen. (n.d)

The Program for International Student Assessment (PISA, 2000) study, created a closer link between school mathematics and the application of mathematics in real life by introducing the concept of mathematical literacy. From the above definitions we can see there are significant differences. Some definitions focus more on the individual's ability to use quantitative tools, others focused on the ability of the individual to understand and appreciate the role mathematics and quantitative methods plays in world affairs. Others emphasise basic skills, like, arithmetic operations. And some focus on higher-order thinking.

Steen (2001) identified the characteristics of quantitative literacy to include: confidence with mathematics; cultural appreciation; logical thinking; making decisions; applying mathematics in context; and, number sense.

Quantitative Literacy, the ability to understand and use numbers and data analyses in everyday life, is everybody's orphan (Madison 2001). Despite the critical role played by QL in human life there is neither an academic home nor an administrative promoter for this crucial competency (Madison, 2003).

In an attempt to better understand quantitative literacy and the educational challenge it presents in the United States (US), the National Council on Education and the Disciplines (NCED) initiated a national examination of issues surrounding QL education, with particular attention to the context of school and college studies Madison (2003). In 2001, NCED published *Mathematics and Democracy: The Case for Quantitative Literacy*, edited by Steen. In December 2001, NCED also sponsored a national Forum,

Quantitative Literacy: Why Numeracy Matters for Schools and Colleges, this was held at the National Academy of Sciences in Washington, D.C., in December 2001 (Madison, 2003).

It is fair to say that there seems to be disagreement about the definition of quantitative literacy, numeracy, and mathematical literacy. However, today the three terms have come to be synonymous, even though they originally came from different perspectives (van Groenestijn, 2003).

Early definitions of the term 'numerate' appeared in the Cockcroft (1982) report on mathematics education for the British government. Today, this definition is widely cited by mathematics educators around the globe. The two themes mentioned in Cockcroft's definition also emerged in the National Adult Literacy Survey (NCES, 1993), in which quantitative literacy was defined as, the knowledge and skills needed to apply arithmetic operations, either alone or sequentially, that is, balancing a checkbook or completing an order form.

On the other hand, the Program for International Student Assessment (PISA, 2000) in Steen (2001) defines quantitative literacy in a much more comprehensive manner as:

An individual's capacity to identify and understand the role that mathematics plays in the world, to make well-founded mathematical judgments and to engage in mathematics in ways that meet the needs of that individual's current and future life as a constructive, concerned and reflective citizen. (p. 7)

In 2001, the Quantitative Literacy Team (QLT), attempted to break these definitions into different elements, to make them easier to understand. In the end, however, they acknowledged that doing so had only illuminated, but not resolved, the linguistic confusions that permeate discussions of QL. The different elements are: confidence with mathematics; cultural appreciation; interpreting data; logical thinking; making decisions; mathematics in context; number sense; practical skills; prerequisite knowledge; and, symbol sense.

Confidence with Mathematics - being comfortable with quantitative ideas and at ease in applying quantitative methods. Individuals who are quantitatively confident routinely use mental estimates to quantify, interpret, and check other information. Confidence is the opposite of math anxiety; it makes numeracy as natural as ordinary language (QLT, 2001).

Cultural Appreciation - understanding the nature and history of mathematics, its role in scientific inquiry and technological progress, and its importance for comprehending issues in the public realm.

Interpreting Data - reasoning with data, reading graphs, drawing inferences, and recognizing sources of error. This perspective differs from traditional mathematics in that data (rather than formulas or relationships) are at the center.

Logical Thinking - analysing evidence, reasoning carefully, understanding arguments, questioning assumptions, detecting fallacies, and evaluating risks. Individuals with such habits of inquiry accept little at face value; they constantly look beneath the surface, demanding appropriate information to get at the essence of issues.

Making Decisions - using mathematics to make decisions and solve problems in everyday life. For individuals who have acquired this habit, mathematics is not something done only in mathematics classes but a powerful tool for living, as useful and ingrained as reading and speaking.

Mathematics in Context - using mathematical tools in specific settings where the context provides meaning. Notation, problem-solving strategies, and performance standards all depend on the specific context.

Number Sense - having accurate intuition about the meaning of numbers; confidence in estimation; and common sense in employing numbers as a measure of things.

Practical Skills - knowing how to solve quantitative problems that a person is likely to encounter at home or at work. Individuals who possess these skills are adept at using elementary mathematics in a wide variety of common situations.

Prerequisite Knowledge - having the ability to use a wide range of algebraic, geometric, and statistical tools that are required in many fields of post-secondary education.

Symbol Sense - being comfortable with the use of algebraic symbols and at ease in reading and interpreting them, and exhibiting good sense about the syntax and grammar of mathematical symbols.

van Groenestijn (2003) stated that, it was the opinion of the Adult Literacy and Lifeskills (ALL) team that an individual's ability on numeracy cannot be tested; rather, numeracy behaviour can be observed. Therefore, in order to create criteria for numeracy assessment, they operationalised the definition in a working form, emphasising five facets (managing, responding, information, representing and activating): "Numerate behaviour involves *managing* a situation or solving a problem in a real context by *responding* to mathematical *information* that is *represented* in a range of ways and requires the *activation* of a range of enabling processes and behaviours" (Gal et al., as cited in Van Groenestijn, 2003, p. 230).

The five facets made it possible to link mathematical knowledge to real-life situations with expected required mathematical actions. The ALL team in van Groenestijn (2003), suggested that by choosing one element from each of the five facets, it is possible to develop a definition for specific situations; for example,

Numerate behaviour involves managing a situation or solving a problem in everyday life by making an estimation with money (acting upon) using information concerning quantity and number that is represented by pictures and numbers in an advertisement in a door-to-

door leaflet and requires the activation of computational and estimation skills. (p. 230)

A comprehensive definition of “Numerate Behaviour”, with examples, is presented below as:

Numerate behaviour involves: managing a situation or solving a problem in a real context (*everyday life; work; societal and further learning*) by responding (*identifying or locating; acting on (order/sort, count, estimate, compute, measure, model); interpreting and communicating* information about mathematical idea (*quantity and number; dimension and shape; pattern and relationships; data and chance; change*) that is represented in a range of ways (*objects and pictures; numbers and symbols; formulas; diagrams and maps ;graphs and tables; and texts*) and requires activation of a range of enabling knowledge, behaviours, and processes (*Mathematical knowledge and understanding; Mathematical problem-solving skills; Literacy skills; Beliefs and attitudes*). (van Groenestijn, 2003, p. 231)

In my research work, the “ALL” team framework as presented in van Groenestijn’s (2003) work, has been used to assess numeracy behaviour amongst the participants and consequently to reach a conclusion on whether or not the participants have achieved expected levels of quantitative numeracy necessary for them to function effectively in their worlds.

2.4 Teaching Mathematics for Social Justice

The social justice approach to learning has arisen out of the critical mathematics tradition. In this thesis Social Justice Pedagogy refers to a way of teaching mathematics which helps learners to understand their world better and also enables them to seek their legitimate share of the benefits in their society while contributing to its positive development. It also includes issues of equal opportunities for jobs and income, civic participation, and information and support related to one’s personal life.

In recent years, a number of researchers investigating issues similar to those being studied here, have successfully documented how students' mathematical understanding and agency can support their capacity to make sense of and act upon situations of personal and social importance. For instance: Gutstein (2000; 2001) 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 (2000, p. 18) (Interestingly, this social justice issue was one of the motivations for Peters to produce his Gall-Peters Projection – favoured by World Vision and other International Aid organizations.). 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 their understanding of measurement and ratios to convincingly argue that their school has less space per student (significantly more crowded) compared to other middle schools in the district; and, more recently, Tracey (2007) documented how students (Maths Club participants) used mathematics as a tool to fight against a plan to close their school. The students based their argument on the costs of bussing them to the new school and the additional issues that the closings would cause, such as overcrowding and the subsequent adverse learning conditions at the receiving school.

Gutstein (2003; 2006a; 2007) offers a particular framework, teaching mathematics for social justice, that integrates issues of equity, the role of mathematical knowledge, as well as an emphasis on reading and writing the world with mathematics. In addition, this framework highlights the need to integrate students' critical, classic and community-based knowledge in the teaching of mathematics. This, of course, builds on the tradition of centering education around students' experiences, as established with the work on funds of knowledge (González, Andrade, Civil, & Moll, 2001; González, Moll, & Amanti, 2005) and bilingualism (Moschkovich, 2002, 2007) in mathematics education. Collectively, these perspectives emphasize the need to use

students' life experiences as the basis for their educational experiences. In other words, Gutstein's framework had both *social justice goals* and *mathematics goals*. The *mathematics goals* are: to read the mathematical world; to succeed academically in the traditional sense; and to change his or her 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.

2.4.1 Mathematics Goals

Read the Mathematical World: Mathematics is so influential in today's world, that a limited understanding can hinder the more complete grasp of important political issues. In other words, if one has trouble reading the mathematical world, she or he may struggle with reading the world with mathematics. Gutstein (2006a, p 29) argues that "reading the mathematical world is equivalent to developing mathematical power". Through the proposed projects in this research work, participants will have opportunities to demonstrate relational understanding of the concepts associated with the topics of percentage, graphs and time calculations, and should use them to present their point of views to the college authorities.

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. As mentioned earlier, I believe my students' participation in these projects will 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: Change orientation occurs when one sees mathematics as a powerful and relevant tool for understanding complicated, real-world phenomena rather than a series of disconnected, rote rules to be memorized and regurgitated (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. At the start of this research work, it was obvious to me that only a few of the participants

had anything positive to say about mathematics. Most of the participants in this research had “poor” exposure to mathematics during their school days; as a result, they hated the subject. The research work in this thesis will document any positive change in the way these students thought of mathematics as a result of their projects.

2.4.2 Social Justice Goals

Read 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, one reads the world with mathematics when he or she uses mathematics to improve their understanding of the day to day events with which they are involved. For instance, if one 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 he or she has read the world using mathematics. Gutstein (2006a) acknowledged that in the absence of concrete direction and guidance, one does not easily become a “reader” of the world using mathematics (p. 48). Frankenstein (2006), argued that,

when students examine data and question them (as is the case in Activity Box” problems), they are introduced to the four goals of critical mathematical literacy – these goals are: understanding the mathematics; understanding the mathematics of political knowledge; understanding the politics of mathematical knowledge; and, understanding the politics of knowledge. (p. 19)

Write 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. In other words, to use mathematics to change the world: and to see oneself as capable of making change and developing a sense of social agency. Gutstein (2006a) 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 higher than just understanding a situation, (p. 88).

Develop Positive and Social Identity. Positive cultural identity is demonstrated, as reported by Ladson-Billing (as cited in Gutstein, 2006a), when the learner succeeds in an academic sense while still maintaining his or her cultural integrity. The 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 utilized in learning to read the world. For all the research in this thesis participants will utilise their local knowledge of the perceived problems to help them work out the best possible ways to seek redress.

In addition to the above-mentioned *social justice goals* for teaching mathematics, Gutstein (2006a) also stated what he referred to as the three attributes of a classroom for social justice, as: “normalizing politically taboo topics, creating a pedagogy of questioning, and developing political relationships with students (p. 133). Gutstein and Peterson (2005) stated that “teachers cannot easily do social justice mathematics teaching when using a rote, procedure-oriented mathematics curriculum” (p. 4). Likewise a text-driven, teacher-centered approach does not foster the kind of questioning and reflection that should take place in all class-rooms, including those where mathematics is studied. They advised teachers engaging in teaching for social justice to:

1. start a little at a time. Identify a concept/skill they are teaching as part of the regular curriculum and relate it to a lesson, and
2. get to know their students and their communities well and listen closely to the issues they bring up.

Discussing politically controversial topics with students is not something that is acceptable in the system where this research work was carried out. However, the “invitational learning” environment created during the students’ projects enabled the participants to air their views freely on any issues of importance to them. Creating pedagogy of questioning and developing political relationships with students were all achieved during the projects.

The mathematical analysis required, in many cases, in teaching mathematics for social justice may not always be high level mathematics. Gutstein (2006a) argued that “one should not assess how well students understand society with mathematics by the complexity of the mathematics” (p. 70). He added that the main goal is that students utilise mathematics as a powerful analytical tool to study their sociopolitical existence. The mathematics should serve as an entry point into deeper investigations and more questioning.

Social justice could be viewed from different perspectives, consequently, resulting in different categorisation. For instance, Cribb and Gewirtz’s study (as cited in Taysum et al., 2008), categorised social justice into three types, namely; distributive, cultural and associative justice. Distributive refers to economic justice. In 1997, Fraser argued that distributive injustice can be classified into three, namely: exploitation; economic marginalisation; and deprivation.

1. Exploitation is, for example, when gains made as a result of a laborious work is distributed to those who were not part of the labour. According to Bourdieu as cited in Taysum et al., (2008), such an action can only cultivate a disenchanting image of both themselves and of their group.
2. Economic marginalization is, for example, when a group of people are denied access to employment. Bourdieu’s work (as cited in Taysum et al., 2008) states that, such individuals are “Condemned to job insecurity and threatened with relegation into the indignity of unemployment, forced to define themselves in relation to the great nobility from the top-rank schools” (p. 191).

3. Deprivation is, for example, where the material standard of living is inadequate and often illegal. There may be an elusive picture of distributive justice, but in reality the equality of opportunity is not addressed. Bates (2006) believes that “social justice is best achieved where public resources are directed towards the least advantaged rather than the contrary” (p. 281).

Taysum et al., (2008) in their investigation of how school leaders understand and describe social injustice in terms of their own lived lives concluded that, “participants who have struggled to exercise agency replicate this in their professional lives, not least through how they interplay their identification with justice through their practice” (p. 192).

2.4.3 Equity

Researchers have long focused more on access to education in the struggle to achieve equity in education and have given very little attention to the social, cultural and political influences on schooling (Gutiérrez, 2007). In other words, researchers focused mostly on issues such as: access to high level mathematics and quality of teachers and outcomes (i.e., test scores, career paths) (Boaler, 2002; Oakes, 2005; Rousseau & Tate, 2003; Schoenfeld, 2002). The research work in this thesis is rooted in an educational paradigm where equity implies that all students have equal access to education and, will experience sufficient educational outcomes to advance economically in their society, and become agents of change within them.

From a critical mathematics perspective, the sociocultural vision of equity in which all students learn and use mathematics is considered as limited. Critical mathematics pushes the vision further by seeking a more sociopolitical understanding of the nature of learning and the purpose of education in society. In other words, it gives more explicit consideration to the structure of power and the subsequent political context of work in the classroom. For instance, in his critique to the National Council of Teachers of Mathematics (NCTM) standards (2000), Apple argued that teachers must be “aware of the social, economic, and political contexts of schooling that can

hinder or facilitate mathematics learning for underrepresented students” (Apple, 1992, p. 1). In 2003, Rousseau and Tate added to Apples’ sentiment by calling for teachers to reflect upon the role of gender, race, history and society in the lives of their students and in their classroom contexts.

Civil (2007), González et al., (2001), Khisty (1997), and Moschkovich (2005), whilst addressing issues of equity in education, focused their attention on how the learning environment forms the basis for student empowerment by viewing the learner’s fund of knowledge; background; and linguistics skills as assets in learning, not as a liability.

2.4.4 Agency

One’s belief in the purpose of education has direct connections to the way he or she approaches equity in education. In critical pedagogy, the purpose of education is identified as addressing inequity and seeking change in the power structure of society (e.g. Freire, 1970/1993; Ladson-Billings & Tate, 2006; Rossatto, Allen, & Pruyne, 2006). Critical mathematics educators, (Frankenstein, 1990; Gutstein, 2003, 2006a, 2007; Skovsmose, 1994; Tate, 1995), argue that mathematics education should aim to both equip students with the skill and understanding to succeed academically, and prepare them to critically investigate, challenge and act upon issues in their lives and communities. In other words, mathematics education should support students’ sense of agency, their sense of themselves as people who can make a difference, and their ability to be critical and active participants in the world. Bruner (1996) and Pruyne (1999) contend that supporting students’ sense of agency is a critical component of schooling as well as an important step towards achieving equity in mathematics education (Ernest, 2002; Gutstein, 2003; Valero, 2002). If, as teachers, we emphasise the struggles of ordinary people for justice, in our classrooms (Takaki, 1993; Zinn, 2003), rather than the great leader making history (Bigelow, 2002), our students can see that “their actions can make a difference” (Gutstein, 2006a, p. 94). Gutstein (2006a) suggests that “a critical component for students to begin to see themselves as subjects capable of making history, able to overcome a sense of powerlessness, was to build on their strengths, especially their

sense of justice” (p. 96). The approach to teaching mathematics as used in this thesis will be based on the participants’ lived lives. It will provide opportunity for the participants to acquire critical thinking skills that can help their journey towards achieving agency.

Researchers differ in the way they see the connections between student agency and equity. Some advocate attending to student agency as a way of encouraging mathematical learning by fostering higher levels of engagement (e.g. Allexaht-Snider & Hart, 2001). Others like to link student agency to broader notions of empowerment and social justice (e.g. Ernest, 2001; Gutstein, 2003, 2007; Valero, 2002, Tuner et al, 2007). The latter believe that, this way, fostering student agency will support equity through both its impact on students’ sense of themselves as doers and creators of mathematics, and its encouraging them to see themselves as capable citizens who have the power to be “key participants in the struggles for equity and justice” (Gutstein, 2003, p. 27).

Pruyn (1999) referred to agency in which students not only see themselves as people whose actions can and do make a difference, but also as those who take such action based on their awareness of oppressive and unjust conditions with the aim of changing the situation for better, as *critical agency*. He defined this enhanced sense of agency as, purposeful action taken by a student, individually or as a group, to facilitate the creation of counter hegemonic educational practices.

2.4.5 *Benefits and Challenges Associated with Teaching for Social Justice*

As with many things in life, teaching mathematics for social justice is not without its challenges. For example, Taysum et al. (2008) said “it is arguably dangerous to attempt to work for social justice in the school when the writers [Leaders] of policy tests are people far removed from the messiness of the day to day realities of the people whose identities they are shaping” (p. 187). Jacobsen and Mistele (2010), in their investigation of the challenges preservice teacher face with teaching for social justice concluded that the major challenge was that of “balancing” (p. 8). In other words, the problem of how to get a balance between the mathematical concepts and the social

justice issues addressed in a given tasks. They added that teachers new to teaching for social justice could also face tension between their backgrounds with traditional mathematics and their new experience of teaching for social justice.

Some researchers and research groups have documented some of the benefits of engaging in Social Justice Pedagogy. For example, the Radical Math website, Radicalmath.org, published benefits associated with teaching for social justice, on its website, to include the followings;

The learner can:

1. Recognize the power of mathematics as an essential analytical tool to understand and potentially change the world, rather than merely regard math as a collection of disconnected rules to be memorized and regurgitated.
2. Engage in high-level thinking about big mathematical ideas.
3. Deepen their understanding of social and economic issues on local and global scales.
4. Understand their own power as active citizens in building a democratic society and become equipped to play a more active role in this society.
5. Become more motivated to learn math
6. Participate in actual (not just theoretical) community problem-solving projects
7. Answer this question for themselves: "Why do I have to know this?"

The teacher can:

1. Differentiate their curriculum more easily
2. Create interdisciplinary units and partnerships
3. Learn about their students families and communities, and develop a socioculture consciousness

4. Assess learning in a contextualized, holistic manner

Similarly, researchers and research groups have documented some of the challenges educators face while engaging in Social Justice Pedagogy. For instance, Gutstein and Peterson (2005) argue that social justice teaching cannot be easily done when using a rote, procedure-oriented mathematics curriculum. Also, a test-driven, teacher centered approach does not foster the kind of teaching environment necessary for teaching for social justice.

The pressure to complete the syllabus and prepare students for mandatory examinations is another challenge standing in the way of teaching for social justice. One single yet most influential factor that stands in the way of many teachers teaching mathematics for understanding is the pressure to prepare students for exams (Lipman 2004; Lipman & Gutstein, 2001; Radicalmath.org, (2007)). Many teachers are compelled to compromise their quest for working towards student understanding because they need to complete external examination syllabus requirements on time.

Sometimes students can add to the pressure on their teacher by insisting on completion of the syllabus to allow time for systematic review before the mandatory examinations. Some students may even exhibit a rebellious tendency toward the teacher. As Gutstein (2006a) succinctly puts it, making students think less about their end of year exam is a challenging task and requires time, because such a culture contradicts students' expectations of what teaching "should be" – and students are not always so quick to accept this new way of teaching. Gutstein's claim is supported by the statement below which was made by Barbosa, et al., (in Gutstein, 2006a),

When first presented with this style of teaching, I was very accepting of the manner in which we were learning math. Later in the course, my attitude toward it changed to distrust and, to a small extent, rebellion. What prompted this attitude were different factors. I remembered having a large concern and not feeling confident in being able to perform well in the required state testing that would be used by high schools in determining where one would attend. (p. 169)

In addition to its published benefits, the Radicalmath.org, (2007), also published challenges associated with teaching for social justice to include the following;

1. Standardized Testing - Because of NCLB pressure, it is challenging to avoid "teaching towards the test." However, it is possible to prepare students for such exams and still teach about social justice.
2. Mandated Curriculums - Many schools have textbooks that they require their teachers to use.
3. Good Math isn't the same as Good Politics! - There are several good math textbooks (although there is much debate over which these are) that have great ideas about group work and skill-development, and are set inside larger contextual problems, but have nothing political in their material.
4. Good Politics isn't the same as Good Math! - It is easy to think that a unit or lesson is a great one just because it covers important issues. But you need to be sure that the math itself is strong, that it allows for multiple access points, has room for exploration and discovery, and was developed with standards in mind.
5. Time - It takes time to write good curricula.

2.5 Other Relevant Issues in Mathematics Education

Today, in envisioning critical mathematics education some researchers have used Gutstein's framework. My research is rooted in Social Justice Pedagogy as described by Gutstein (2006a) but his framework was applied to adult learners.

Researchers, for example, Frankenstein (1983; 1990), Gutstein (2006a), Gutstein and Peterson (2005), and Moses (2001), have connected mathematics education with larger social struggles. Moses (2001), in using the "Algebra Project", addressed the notion that students need access to higher-level mathematics in order to fully participate in society. He also

connected the project work to a larger struggle for civil rights. His work highlighted the emergence of a social movement focused on developing mathematical literacy for marginalized students, and the central role of community mobilization in making this happen. Similarly, Frankenstein (1983; 1990), in her work with adults, developed a critical mathematical literacy, with an emphasis on the organizing power of statistics in society.

Mathematics educators have documented how critical perspectives on schooling might apply to teaching and learning mathematics (e.g. Frankenstein, 1983, 1990; Gutstein, 2006a, 2006b, 2007; Gutstein & Peterson, 2005; Skovsmose, 1990, 1994; Tate, 1995; Turner, 2003; Turner & Font Strawhun, 2007). Specifically, Turner (Turner, 2003) and Tate (Tate, 1995) have both explored the practical application of these ideas in middle school classrooms; similarly, Gutstein (2006a) has explored the ideas in high school classrooms.

Lave et al., (1991) argued that a “critical mathematics” learning environment has the potential to create a particular kind of community of practice that engages students as: critically reflective citizens who address and act upon questions of personal and social importance; capable students that construct a deep understanding of significant mathematics; and, of the potential power of mathematics in their lives. Turner (2003), and Turner and Font Strawhun (2005), referred to the particular kind of critical (sociopolitical) and mathematical agency that is fostered in such learning environments as critical mathematical agency. It implies a students’ capacity to view the world with a critical mind set, to imagine how the world might be a more just and equitable place, and to engage in action aimed at personal and social transformation (critical agency). Such an enhanced sense of agency includes students’ capacity to identify themselves as powerful mathematical thinkers, who construct and use mathematics in ways that are personally and socially transformative (mathematical agency). Learning environments that foster these dual natures of critical mathematical agency have the potential to contribute to ongoing struggles for equity and social justice (Turner. et al, 2007).

2. 5.1 Teacher - Student Relationships

Cummins (1996) suggested that students' relationships with their teachers are an important aspect of their education. He believed that teachers tend to reflect their cultural perspectives and beliefs in their relationship with their students. They tell their students what they believe about the different cultures by the way they teach, their attitudes, and their assumptions about learning. Teachers tend to implement their own cultural beliefs into the curriculum, and they ignore the cultural differences of their students (Gay, 2000; Reed, 1996; Sleeter, 2008).

Paris and Lung (2008) contend that an important role of the teacher is to develop as a responsive, respectful, and effective teacher. A teacher who teaches in culturally diverse settings finds themselves as creators of curriculum, because they are continuously developing curriculum and instruction that meets the strengths, needs, and values of individual students in the class.

Multiculturally competent teachers bridge the gap between the school and home culture (Bennett, 2007). Bennett described a person with multicultural competence as one who “develops competencies in multiple ways of perceiving, evaluating, believing, and doing” (p. 9). He argued that people who lived in two or more cultures demonstrate the ability to encounter different cultures, in addition to their own, serve as facilitators between cultures, act as communication links for others, and show cultural empathy for others. Interculturally competent people are those who can explore their thinking about different cultures consciously (Friedman & Antal, 2007). They negotiate the different cultures by negotiating their own culture with others.

2. 5.2 Mathematical Belief

One's experience of learning mathematics during school days can have a long-lasting effect on the way one subsequently thinks of the subject. Positive experience can lead to the holding of positive self-belief, while negative experience can lead to developing negative self-belief about their ability in mathematics. Bandura (1986) argued that in all areas of life, the behavior of

human beings is impacted by their beliefs. Some beliefs are explicit (the subjects are conscious of them) while others are tacit (the subjects are not conscious of them) (Schraw & Olafson, 2002). Beliefs are cultivated over a long period of time and are generally stable and resistant to change (Kagan, 1992; McLeod, 1992; Pajares, 1992; Schraw & Olafson, 2002; Ecker et al., 2011).

One set of beliefs is epistemological beliefs – which are comprised of individual beliefs about the nature of knowledge and knowing. There are different theoretical frameworks of beliefs. Perry (1970) offered a theoretical framework which characterized the epistemological beliefs of college students as a sequence of developmental stages – progressing from a dualistic perspective in which all questions have right or wrong answers, to a realistic perspective in which answers to questions are relative to certain context. On the other hand, Schommer (1990) offered a multidimensional framework consisting of four relatively independent beliefs about knowledge and learning: simple knowledge; certain knowledge; fixed ability; and, quick learning. In this model students could simultaneously have some sophisticated beliefs and some naïve beliefs. The negative connotations of the words naïve and sophisticated led Muis (2004) to re characterise them as non-availing and availing beliefs, respectively.

In general, mathematical beliefs are categorised into: beliefs about mathematics; beliefs about mathematics teaching; belief about self; and, belief about the social context (McLeod, 1992). Collectively these mathematical beliefs form an individual's mathematical world view (Schoenfeld, 1985).

Grouws and colleagues (in Briley, 2007) offered a theoretical framework for characterising certain mathematical beliefs and the nature of mathematics learning. Their framework consists of seven dimensions, they are: the composition of mathematical knowledge; the structure of mathematical knowledge; the status of mathematical knowledge; doing mathematics; validating ideas in mathematics; learning mathematics; and, the usefulness of mathematics.

Muis (2004) in his review of multiple studies on student mathematical beliefs revealed that, in general, students hold non-availing beliefs about mathematics and its learning. Many students view mathematics knowledge as a collection of unrelated facts and procedures (Brown et al., 1988; Grouws et al., 1996; Schoenfeld, 1992). For this reason, many of them believe that mathematics is learned by memorization (Brown et al., 1988; Kenney & Silver, 1997; Schoenfeld, 1989). These non-availing mathematical beliefs are contrary to the idea of mathematics and mathematics learning advocated by the National Council of Teachers of Mathematics (NCTM) principles and standards (2000), which emphasizes relational understanding rather than memorization.

Teachers who believe that students bring to school a wealth of information, prior knowledge, and a heritage language demonstrate an "additive belief". On the other hand teachers who believe that they have a "mountainous" job ahead of them because their students come to college without knowing English and have to be taught everything demonstrate a "deficit belief" (Cummins, 1996; Freeman, 2004; Nieto, 2002).

Most Diploma Foundation (DF) students now have more opportunities to control their studying and learning habits than when they were in high-school. Therefore, in order to survive the rigours of the increased academic demands of college, they need to have a renewed positive self-belief - this would facilitate their journey towards becoming self-regulated learners (Pintrich, 1995). A self-regulated learner is someone who accepts responsibility for cultivating knowledge and skills, showing initiative and perseverance in their quest for learning (Zimmerman, 1990, 2001). In order to attain their learning goals, self-regulated learners take active control of their metacognition, motivation, and behavior. Self-regulated learners have the ability to use a variety of cognitive and metacognitive learning strategies (Ley & Young, 1998). Learning strategy is one component of self-regulation. Researchers have argued that students' use of learning strategies has a positive correlation with academic achievement (Ley & Young, 1998; Schunk & Zimmerman, 1998; Weinstein & Mayer, 1986; Zimmerman & Martinez-Pons, 1986).

Diploma Foundation students also need to acquire metacognitive knowledge in accordance with Schraw and Moshman (1995). They categorised metacognitive knowledge into: declarative knowledge - knowledge of learning strategies; procedural knowledge - knowledge of how to use what; and, conditional knowledge - knowledge of when to use what. Another aspect of metacognition is concerned with the learners' regulation of their cognition of planning, monitoring, and evaluating their learning progress (Schraw & Moshman, 1995; VanderStoep et al., 1996; Zimmerman, 2000).

Researchers concurred in the view that some of the factors which affect achievement are complex in nature. For example, in 1970, Purkey identified the relationship between self-concept and student achievement. He identifies self-concept as the complex and dynamic system of learned beliefs that each individual holds to be true about oneself. Students will behave in certain ways due to their beliefs and perceptions about themselves and others. He suggested that a crucial part of the teacher's job should be to teach content and develop positive self-concept in students.

Researchers have found students' desire to learn mathematics to be strongly linked to their perceived competence, ability and achievement. When they perceive themselves as capable of doing well in mathematics, they tend to value mathematics and become more inquisitive about the subject of enquiry. Similarly, those who perceived themselves as unable to do well tend to switch off from the subject (Ames, 1992; Dweck, 1986; Meece, Blumenfeld, & Hoyle, 1988; Middleton & Spanias, 1999; Schiefele & Csikszentmihalyi, 1995).

My experience of teaching practical numeracy to DF students points me to believe that, for many, if not all of the participants in this research, their school days' mathematics was taught to them as isolated facts, skills, and procedures, therefore, they have not developed the ability to transfer and apply the key ideas in related situations. As a result, they have developed "non-availing beliefs" (Muis, 2004) about the subject. They perceived mathematics as a discipline with no connections to their everyday life - they have been "robbed of an important tool to help them fully participate in

society” (Peterson, 2005, p.10). Analysing as well as synthesising mathematical findings are alien to them – this is consistent with cognitive theory that predicts lack of retention unless “rich” links within cognitive structures are developed (Bransford et al., 1999; Gagné & White, 1978). One of the aims of this research has been to reverse the participants’ beliefs about mathematics from non-availing to availing.

2.5.3 Engagement in Mathematics Learning

A key to engaging students in mathematics is to make the subject relevant to their lives. Peterson (2005) said “Number numbness” happens as a result of a sterile teacher-centered and text-driven teaching approach. It also has its roots in how mathematics is segregated in schools and kept separate from the issues that confront students in their daily lives. Peterson added that most curriculums rarely encourage linking mathematics to other subjects, as a result, many students see mathematics as an isolated subject with no relevance to their lives. In addition, they are led to believe that mathematics is not connected to social reality in any substantive way. The research work presented in this thesis will provide opportunities for the participants to understand their world better and hence participate in it effectively.

Meaningful learning cannot happen in a classroom in which students experience a mismatch, or discontinuity between their home culture and the school culture (Gay, 2000; Nieto, 2002). Gay believes that teachers can make a difference in the students’ achievement by recognizing the cultural disconnect between what is taught in schools (curriculum), how it is taught (instruction), and the students’ home environment. Nieto argued that the multiculturally effective teacher is one who helps their students to successfully navigate their home and school cultures while learning to use their bicultural identity as the tool to lead them through the educational system successfully. Tate (1995) argued that if a curriculum is centered on problem-solving connected to real experiences of the learner, there is a high possibility that the learner will use mathematics as a tool to change the society. In the research presented in this thesis, participants identified

problems important to them, investigated them, and in the process learned mathematics while addressing some social justice issues.

González (2005); Valenzuela (1999, 2002) argued that education rooted in students' needs, experiences and circumstances has the potential to be transformative. In other words, learners who felt that their own experiences are valued and integrated with their formal schooling are more likely to see school as relevant, as well as to develop critical consciousness. This is particularly important for non-dominant students and communities, who are most often marginalized in schools and classrooms (Ladson-Billings, 1995; Valenzuela, 1999).

From my experience, many students have developed hatred for mathematics – they attend mathematics lessons with “tears” because of the way the subject is presented to them as isolated sets of skills. Richard Winter in Frankenstein (2006) theorised that the “problems so many encounter in understanding mathematics are not due to the discipline’s difficulty abstractions, but due to the cultural form in which mathematics is presented” (p. 28). Henningsen and Stein (1997), in their investigating of the factors in mathematics classrooms that either hinder or support students’ engagement, found that minority students fail to engage in high-level mathematical tasks due to a lack of opportunities to participate in challenging mathematics learning experiences rather than to a lack of potential. Based on their research findings they recommended that teachers provided meaningful mathematics for their students. The opportunity to investigate real issues increases students’ engagement and, also pushes them to construct and apply important mathematical concepts (Turner, 2006). If students are solving problems which have social implications for their lives they are more likely to engage in them because they see such problems as “theirs”: not ones imposed on them by the teacher. Engaging students in mathematics within a social justice context increases students’ interest in mathematics and also helps them learn important mathematics (Gutstein & Peterson, 2005). Woodson, in Tate (2006), believes that mathematics instruction that is built on a student’s life experience invokes two mathematics learning environments: within the school and outside the school. The projects forming

the basis of research for this thesis were decided by the students - they were all relevant to them and recognise social justice issues.

Alleksaht-Snyder and Hart (2001) argue that students' engagement in the mathematics classroom is essential for fostering an equitable learning environment in which each student senses that he or she is an important participant. Teachers can foster engagement in the mathematics classroom by encouraging students to talk about their mathematical ideas. "When students are given the opportunity to share and explain their thinking to teachers and peers, their mathematical abilities are reinforced" (Flores, 2006, p. 127). Participants in this research will work in groups and throughout the project period there will be collaboration in and out of the classroom.

The National Council of Teachers of Mathematics (2000) recommends, as a way of engaging students, a more student-centered mathematics classroom whereby a "relational" approach of teaching is used as against an "instrumental" method. Brown and Walter (2005) present a traditional view of the mathematics classroom where teachers feed information to students – in response many teachers will want students simply to execute what is expected of them (Brown & Walter, 2005). This kind of classroom does not foster motivation. On the other hand, teachers who encourage students to take risks when problem-solving, by choosing their own methods of solving mathematical tasks, often cause students to gain a deeper understanding of mathematical content (Joyce, Weil & Calhoun, 2004), leading to higher motivation and engagement. One of the major premises of problem posing is that students are encouraged to think for themselves. Often, this thinking leads to the posing of more problems and to the asking of more questions. All the projects in this research will be "student controlled" with me, their teacher, acting as the facilitator. The projects will provide opportunities for "substantive conversation" and "higher order thinking" in accordance with the principles of PP, leading to higher motivation and engagement.

Having "fun" studying mathematics is a good indicator of engagement with mathematics. The significance of "fun" cannot be underestimated. Maria Montessori, the founder of the "Montessori Method", now utilised around the

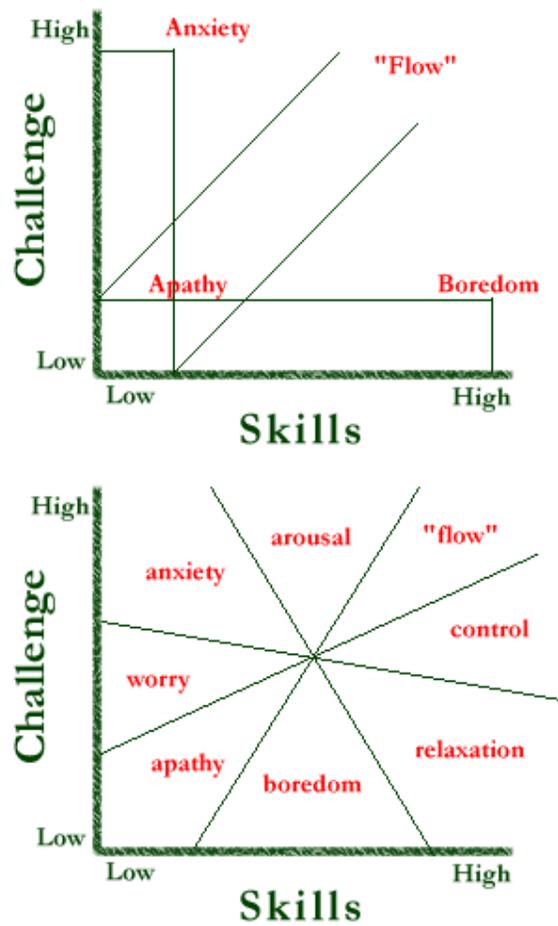
world, said, one test of the correctness of educational procedure is the happiness of the child. And, the greatest sign of success for a teacher is for him or her to see the children working in class as if the teacher did not exist.

When students are engaged they attain a state referred to as flow (Csikszentmihaly, 1997). "Flow" is the intersection of work that is challenging, and abilities that are adequate to the task. Csikszentmihaly (1975) identified some of the feelings associated with this state, as:

1. Completely involved, focused, concentrating - with this either due to innate curiosity or as the result of training
2. Sense of ecstasy - of being outside everyday reality
3. Great inner clarity - knowing what needs to be done and how well it is going
4. Knowing the activity is doable - that the skills are adequate, and neither anxious nor bored
5. Sense of serenity - no worries about self, feelings of growing beyond the boundaries of ego - afterwards feelings of transcending ego in ways not thought possible
6. Timeliness - thoroughly focused on present, don't notice time passing
7. Intrinsic motivation - whatever produces "flow" becomes its own reward

As the graphs below demonstrate, Csikszentmihaly postulates that Apathy is created when both challenge and skills are low; Anxiety develops where challenge is high, but skills are low; Boredom results from low challenge, but high skills. The only place where "Flow" arises, permitting contentment, self-fulfilment and sustained, concentration and focus, is when skills and challenge are both high and approximately matched.

Figure 1.1 : Quality of Experience as Relationship between Challenges and Skills



In this research, evidence of these examples of educational philosophy and psychology of learning will be looked for.

Social justice and Productive Pedagogy have a strong recognised link; hence the two may be used simultaneously. In this research, the principles of Productive Pedagogy will be used as a means to reflect on my practices.

2.6 Productive Pedagogy

In 2001, the Queensland State Government initiated the Productive Pedagogy Project to improve achievement and interest in the study of all subjects across all schools. Productive Pedagogy (PP) model pays attention to many aspects of classroom teaching. Today, PP is widely used as both a

research tool to improve students' learning (Hayes, Mills, Christie & Lingard, 2006) and as a means for self-reflection on practice by teachers (Mills, et al., 2009). However, little research has been conducted on the effectiveness of PP as a framework in cultures other than the Western world.

Part of the appeal of PP is their potential for renewing a focus on gender, race and class as markers of educational achievement, whilst contributing to ways of 'dealing with new student identities, new economies and workplaces, new technology, diverse communities and complex cultures'. (Education Queensland, 2000, p. 2)

Lingard et al., (2001), PP is made up of the following four main dimensions: *intellectual quality*; *connectedness (relevance)*; *socially supportive classroom environment*; and *recognition of difference*.

Intellectual Quality: The main thrust here is that if students are to do well at school they must be made to think by giving them challenging work regardless of their ability or social background. In this approach, students are encouraged to acquire higher-order thinking in their approach to questions and the ability to communicate their ideas effectively and to argue their point of view. It also encourages debates to enhance further their understanding of complex concepts. This strand has strong connections with the concept of "distributive" justice, as it calls for justice in terms of, for example, the quality of the classroom instructions given to students, regardless of their abilities.

Gore in Van Helda (2002) said, intellectual quality is, about getting students to do learning work rather than busy work, [and] but most of all it's about engaging students in big ideas and complex understandings.

Connectedness (or relevance:) Connectedness implies that the learner should be provided with the opportunity to engage in activities in which he or she can see the connection between what he or she is learning with his or her previously acquired knowledge from or out of the classroom. The taught curriculum should be problem based, and be one that helps consolidate and enhance the learner's understanding of his or her world beyond the classroom.

Mills et al., (2009) argued that if the work given to students is connected to their worlds, a learning environment will be created in which they are most likely to demonstrate high levels of intellectual outcome.

For students to demonstrate high level intellectual outcomes they must be provided with a learning environment that stimulates intellectual activity. This type of learning is encouraged when the material covered connects with the students' various worlds, especially for students who have disengaged or are in danger of disengaging from school. (p. 71)

Socially Supportive Classroom Environment. A socially supportive classroom environment should not only be a warm, friendly atmosphere but also one in which it is okay to “fail” (Mills, Educational Conversation, 2010). In other words, students should be made to feel they are free to take risks by trying things and not be afraid of failing in pursuit of the required result. The teacher is only a facilitator not the source and giver of knowledge. The teacher is there to make sure the classroom environment is one which supports effective learning. The teacher provides a scaffold which enables the students to avoid unnecessary frustrations that might arise if they become stuck on the task.

In Van Helda's (March, 2002) article on Productive Pedagogy he reported Jenny to have said, “It's not just making it a warm, happy place to be, but an environment that has high expectations of students and which encourages them to take risks in learning”.

Gore et al., (2004), in their investigation of whether or not PP provided a framework with potential for enhancing the quality of teachers' education and the quality of teaching subsequently produced by the teachers, discovered that of the four dimensions of PP the participants scored highest on the “Supportive Classroom Environment” dimension, hence they concluded that this demonstrated that teachers are better at producing a supportive environment than they are at producing intellectual quality, relevance, or recognition of difference.

However, there is ample evidence to suggest that the supportiveness of a classroom is critical for the achievement of high level outcomes for students, especially for those who have traditionally been failed by the education system (Mills et al., 2009).

Recognition of Difference. Students should be made to feel their work is valued, their differences in terms of opinions, social backgrounds, etc are seen as strengths rather than weakness. This strand has strong connections with the concept of “recognition” justice, as it calls for every effort by the learner to be commended by the teacher. It also encourages awareness of differences and negations surrounding them.

Mills et al., (2009) argued that,

classes in which differences are valued have the tendency for the learners to achieve academic success, especially those learners who time and again feel detached from school because they perceived that their own differences are not respected within the classroom: We would also claim that valuing difference delivers academic benefits to those students who often feel disconnected from schooling due to a failure to have their own “differences” valued within the classroom. (p. 72).

The following Productive Pedagogy elements were addressed in this thesis:

Higher order thinking - this requires the learners to carry out tasks in which they were required to analyse as well as to synthesise their findings. In all the projects in this research, participants will carry out calculations, synthesize and analyse their results and reflect on them. They will be encouraged to make recommendations to the college based on the findings from their project work. I will document how the participants in this research manipulate information and ideas in ways that transform their meaning and implications and how they solve problems and discover new meaning and understanding.

Substantive conversation – there should be substantive discussions which is reciprocal, and which promotes coherent shared understanding. Is there substantial dialogue between students and also between teacher and

students as a result of whole class discussions? For example, If I ask my students to tell me what is the capital of the United Arab Emirates and someone says it is Abu Dhabi, I will follow on to say why not Dubai. Doing this will result in substantive conversation between me the teacher, and the student. Gutstein (2006a) advised that when asking questions - followed by another question as in the above example, one has to be aware that students may lapse into “a relativist position that nothing is knowable” (p. 64). The project proposed will provide opportunity to engage the participants in substantive conversation.

Connectedness to the world - this requires the task to have real life connections to the learner’s world. The best way to achieve this is to ensure the tasks are student initiated; with scaffolding, if need be. Students will almost always come up with a task that has meaning in their life. As stated earlier: all of the project topics in this research will be decided by the participants themselves after brainstorming sessions. All the topics will be of primary importance to the participants pursuing them directly or indirectly. Therefore, it will be obvious that the topics will have real life connections to the participants’ world.

Engagement - it is important from the outset that students are clear on what is expected of them. Scaffolding them when necessary to ensure students don’t lose interest because they were stuck and not making any progress. All the project topics will be chosen by the participants themselves; therefore, they will be fully aware of what to investigate. They will also know what the expectations are both from me and from their classmates. They will receive adequate scaffolding when needed.

Student control - this requires the tasks to be student centered, they need to see it as their own project not one imposed by the teacher. Participants should be part of the decision making in the process of curriculum design. To ensure the participants in this research work see the projects as their own, all the project groups will have team leaders to coordinate group discussions, a recorder to record work completed, and every group member will play their part during class presentations. I will assume the role of an adviser and a

facilitator. Participants will be fully in charge of the way their project work unfolds.

Student support – it is important to let the students know it's okay to make mistakes, no put downs - to achieve this, I will stress to the students the importance of being diplomatic when asking questions, when answering questions, or when making suggestions. I will give them several examples of how people can agree to disagree.

Citizenship - the requirement here is that it is not just enough to be a “clever student” (Mills, SMEC Education Conversation 2010), action needs to be taken as well. For all the projects in this research, participants may decide on what action they would like to take.

The Queensland School Reform Longitudinal Study (QSRLS) team brought together all the already existing models into a simple but effective model (Van Helda, 2002). Robyn (in Van Helda, 2002) is reported to have said, “Every single thing in Productive Pedagogy has been around for years; there is nothing new with this, but it synthesises everything and integrates them all.” Van Helda (2002) summed this up when he said, “A new approach to teaching is reassembling familiar classroom techniques into a workable model that focuses on high quality student learning and improved outcomes.” He added,

In essence, Productive Pedagogy takes existing techniques and learning concepts, and groups them into this simple model. Productive Pedagogy almost seems too basic to have any real effect. However, it is the measurement and evaluation of these factors, combined with the increased awareness of teachers of the most effective techniques that contributes to the program's success.

Gore (cited in Van Helda, 2002), said,

Productive Pedagogy connects with other frameworks. It is not some weird 'out there' new way of thinking. There is an incredible amount of overlap with other frameworks. But what Productive Pedagogy does -

which the others don't - is bring the concern of equity back together with the concerns of quality. If you look at other approaches, some of the dimensions are there. But the "recognition of difference" dimension is usually not present in other models, nor is the intellectual quality dimension as refined.

At the time when PP was accepted by many as successful in its state of origin Queensland, some other States in Australia have adapted it to suit their purposes. Prominent amongst the states is New South Wales (NSW). Many of its schools which have adopted the projects have reported significant improvements in all areas of their students' learning experiences. Two examples of such schools, as reported by Van Helda (2002), were Kootingal Public School and Callaghan College's Waratah Campus. The Principal of the latter school is reported to have said, "Our Basic Skills Test (BST) and English Language Literacy Assessment (ELLA) results have lifted and there has been an overall improvement in results. Equally important is the improvement we've seen in our attendance levels and our suspension rate has been dramatically reduced".

One school which adopted the "radical" (all elements of the productive pedagogy) approach was the Auburn Girls High School. The Principal of the school, Mr. Ralph (in Van Helda, 2002), said,

Teachers meet in professional learning groups to explore each dimension and will introduce them one by one. We're encouraging teachers to experiment with their teaching in the classroom and have professional dialogue with their colleagues about this. It is our intention that it will change their way of thinking and develop their awareness. We are introducing our teachers to individual elements and groups of elements and then asking them to implement, reflect and report back in a collegial and non-threatening way. (p. 4)

Ladwig, in Van Helda (2002), said whether a school adopts the radical or not so radical approach in their implementation of the Productive Pedagogy, the results always point to positive outcomes. He added,

The research shows convincingly there is a strong link between Productive Pedagogy and student outcomes, regardless of whether they are measured and, if they are, whether this is through standardized tests or school assessment tasks. Productive Pedagogy reassembles our understanding of what good teaching is and changes the emphasis from issues we've concentrated on in the past - the processes and techniques of the classroom, which are important, but not ends in themselves. It captures the essence of what is really important - a focus on student learning that's of high intellectual quality. (p. 5)

Productive Pedagogy as a model is not without its own share of concerns - both from within and outside the QSRLS research team members. For example, Mills et al., (2009), a team member of the QSRLS, acknowledges that from their experience some limitations of the QSRLS research includes: "first, its lack of student voice in the research; second, its inadequate focus on teachers' pedagogical content knowledge; and third, methodological issues relating to the depth of content knowledge of observers undertaking observations of lessons in disciplines with which they were not familiar" (p.75). Another team member, Ladwig (2005, 2007), believes that there is no empirical evidence to advocate for the inclusion of recognition of difference, group identity and active citizenship into a model of quality pedagogy. For this reason these dimensions do not appear in the NSW model. He believes that the lack of empirical evidence may be due to one of two things: either very few teachers ever demonstrate particular elements of those dimensions, or some of the items were poorly defined in the observation manual. On the other hand, Mills et al. (2009) believes that a lack of empirical evidence is not good enough reason to justify removal of these elements. They said, "We understand that a lack of empirical evidence for these pedagogies is insufficient for their omission and indeed see the promotion of positive group identities towards a sense of community and active citizenship instrumental in teaching for democracy" (p. 75).

Hayes et al., (2006) argued that there is no clear agreement on how and what is to be observed in research involving classroom observations. They believe, “it is difficult to agree on what to look for even more difficult to agree on what is seen” (p.1). This challenge, which is, lack of agreement about what to observe in the classroom, has led to some healthy debate amongst the academic community about aspects of the Productive Pedagogies framework. For instance, Sellar and Cormack, (2006) in Mills et al. (2006), even though they largely support Productive Pedagogy (PP) research, expressed the view that PP is too focused on the outcome or the production of pedagogy. They suggest that for “deep knowledge” there should be movement towards researching, designing, communicating, transforming, performing and reflecting. They argue that in relation to their framework “processes are complementary to others such as productive pedagogies” (p. 6). They also stress that special attention should be given to the different modes of interrelation in the classroom that lead to outcomes such as deep knowledge.

The recognition of difference dimension of the Productive Pedagogies framework was criticised for its inclusion in the model and for not going far enough in terms of critically defining how differences might be valued. For example, researchers from the University of Western Sydney suggest that there is a need to move beyond the limitations of valuing diversity, as outlined in Productive Pedagogies, to a critical understanding of difference.

Research undertaken in Singapore in which members of the QSRLS team were involved used a coding scheme in which the notion of higher order thinking was dropped from the original Intellectual Quality dimension because of the suggestion that it “proved too high an inference as an observational construct” (Luke et al., 2005, p. 19). Again, Mills et al., (2009), believe that higher order thinking, as one of the original items in the *authentic pedagogy* (Newman & Associates, 1996) framework, is an important element in stretching students intellectually, even more important than other intellectual quality items, like deep knowledge, deep understanding. They added that, even the original QSRLS findings clearly support its inclusion in the model.

2.8 Summary

The review of literature relevant to this thesis has reinforced the need for more research into the teaching of mathematics using Social Justice Pedagogy, especially at college level. In particular, very little work, mostly unpublished, has ever been done in the Middle East. Therefore, there is the need for more research into teaching for social justice in this part of the world. Review of literature has. Review of literature has also reinforced 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 learner's world. Reviews of literature also suggest all the available literature on PP is based on the Western world. Therefore, there is the need for the investigation of PP in cultures other than those of the first world. Finally, the review has also reinforced Freire's dictum: that is, that students can already think, therefore, as teachers we should not waste our time trying to teach them what they already can do, instead we should exchange our ways of thinking with them and look together for better ways of approaching the process of uncovering phenomenon about objects which are important to them. If students are provided with the opportunity to pose problems that matter to them, their desire to seek answers increases their engagement in the subject of investigations and thereby enhances the learning that occurs. Based on what the researchers in this review suggested, I contend that the adoption of Social Justice Pedagogy is long overdue – as it has the best chance of changing the “non-availing” beliefs, which many students hold about their learning of mathematics, to an “availing” beliefs.

CHAPTER 3

METHODOLOGY

3.1 Introduction

This study was about using Social Justice Pedagogy to teach Practical Numeracy to Diploma Foundation (DF) students, in Abu Dhabi Women's College (ADWC), of the Higher Colleges of Technology (HCT), in the United Arab Emirates (UAE). This research work falls into the tradition of Practitioner Action Researcher (PAR).

This chapter is divided into 7 sections. Section 3.2 presents the research objectives. Section 3.3 presents the research methodology shaping the research. Section 3.4 presents the methods of data collection employed in this research. Section 3.5 presents the research procedures and Section 3.6 presents the data analysis method utilised, while Section 3.7 presents the quality of data collection techniques utilised.

3.2 Research Objectives

The objective of this research was to trial an approach which enhances the teaching of a Practical Numeracy course that relates mathematics to the real life of the students whilst addressing some social justice issues within the Diploma Foundation years of the Higher Colleges of Technology HCT.

The research aim is to investigate the results among students after adoption of a social justice approach to teaching, in particular the effects upon:

1. students' learning in mathematics;
2. students' engagement;
3. students' ability to develop agency and
4. the successes and challenges encountered in using this approach to teaching in this particular context.

3.3 Research Methodology

There are many factors which may lead to the selection of the type of research approach used by a researcher. Creswell (1994) identified these factors as: the researcher's view of the world around him or her; his or her training and experience in doing research work; his or her psychological attributes; the nature of the problem under investigation; and, the participants in the research. Others reported that in deciding on the approach to use a researcher needs to consider: the research objectives, nature of the topic and the context of the study (Benbasat, Goldstein, & Mead, 1987; Galliers, 1992; Jenkins, 1985). My belief is that education can, and should, play a leading role in the fight against injustice in all its forms, anywhere in the world. My experience of teaching mathematics, over 20 years across three continents (Africa, Europe, South East Asia), has equipped me with the ability to navigate through diverse cultures, and in the process I have acquired multicultural competencies (Bennett, 2007). I agree with Richard Winter (as cited in Frankenstein, p. 28) that, the problems so many encounter in understanding mathematics are not due to the discipline's "difficulty abstractions," but due to the cultural form in which mathematics is presented to them. I believe that students should be provided with relevant education, in other words, education that has direct connections to their lived lives. Such belief is what influenced my decision to draw upon social justice, Productive Pedagogy, and PAR methodologies in this study. These methods are particularly appropriate and relevant because they are all student-centered and lead to the eventual empowerment of learners.

The research in this thesis designed and implemented for its participants a novel pedagogy for use in teaching Practical Numeracy to adults, in particular, the topics of percentage, time calculation and graphs. It utilised PAR, in accordance with Kemmis and McTaggart's (2008) definition, which is engaging in a process of learning, reflection and action aimed at changing their social world. The process of PAR should be empowering and should also lead to people having, greater control over their lives than before (Baum, et al., 2006). My choice to focus my research on these topics: percentage, time calculations and graphs was a consequence of my experience of

teaching them using the traditional teaching approach and also because I had observed that students at Abu Dhabi Women's College continued to find these topics challenging. In other words, I identified the need for change of approach to teaching these topics. Furthermore, these topics lend themselves readily to student projects and have clear social justice implications, therefore, I utilised Gutstein's Framework for teaching mathematics for social justice (2006a), and the principles of Productive Pedagogy (Mills et al., 2009) as a means for reflecting on my practices. I utilised triangulation techniques for data collection in this research. The initial plan was to teach the three topics identified using students' projects. However, during the early stages of the projects, I noticed participants were all focusing less on the mathematics and more on the social issues they were trying to change. In seeking to resolve this challenge, I utilised the primary data collected by the students to develop "Mathematical Enriched Worksheets" to help the students focus on the mathematics content. These cycles of identifying a problem, data collection, refining of the investigation process, reflection and action are in line with the principles of PAR cycles (Kemmis & McTaggart, 2008). This method is particularly appropriate because, my research is rooted in practical problems which have social implications and are of importance to the participants, and it was carried out with a view to improving the quality of life in the participants' community (college). In the following sections, I elaborate on the research methods used in this research and also describe the method of data collection and analysis employed.

3.4 Methods

3.4.1 Sample

This research was carried out at Abu Dhabi Women's College, which is one of 17 colleges under the Higher Colleges of Technology in the UAE. There were 20 participants in this research. Their ages ranged from 16 – 36 years and all of them were among the body of students whom I taught (class DF203). During this research, I was responsible for teaching mathematics to

3 DF Sections but I purposely chose one of the 3 sections 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 (in Tracey, 2007) purposeful qualitative sampling permits for the selection of participants or sites that can best help the researcher(s) to best understand a particular phenomenon. This type of sampling helps to ensure that useful information is gained so that people will learn about the phenomenon.

Eleven of the twenty participants came from outside Abu Dhabi city. The college provides bus services, at a subsidised rate, to students who are interested. Seven participants used the bus, 2 drove themselves to college and the rest were dropped off and picked up from college by their parents or by the family driver. Those who drove themselves were mostly working students; they studied full-time.

During the research period I was also the coordinator of the Mathematics Club at ADWC. Part of my responsibility was to make the learning of mathematics fun by providing, and/or developing, hands on activities for our students. Therefore, I sought student volunteers (from across all the year levels at the college) and gave them training on the available games/activities at the club; in turn, they helped other students who visited the Club to play the games and other hands on activities. For this reason, the club became like a meeting place for students who like to try out different math games and activities. Many of these students, especially those from Diploma Foundation (DF), identified with my research projects and developed a personal interest in them. Some of the participants in my research used the Club as their meeting place during their break periods. Other DF students would join them and engage them in discussing the projects. Most of their engagements with each other have resulted in useful debates between them, and my many discussions with these students provided me with additional significant rich data.

3.4.2 *Instruments*

In qualitative research, it is important that the identification and analyses of the various forms of data be triangulated. According to Cooper (2001) a well-designed qualitative research study is reliable and valid through using a number of different strategies for data collection. Therefore, to ensure reliability in this research, “triangulation method” was adopted, that is, data was generated through:

1. the use of focus groups;
2. the use of my own reflective journals;
3. the use of critical friends;
4. student presentations;
5. participants’ test results from the end of module and
6. participants’ filled out reflective questionnaires.

Focus Groups

Focus groups are principally group interviews which rely on interaction within the group, based on topics that are supplied by the researcher, who typically takes the role of a moderator (Morgan, 1997). They provide the avenue for gaining insights that would be less accessible without the interaction found in a group. Focus groups may be used in 3 ways. It could be used as a self-contained method – serving as the principal source of data. It could also be used as a supplementary source of data - serving as the source of preliminary data which, for example, may be used to generate survey questionnaires. Finally, focus groups could be use a multimethod studies – combining two or more means of gathering data in which no one primary method determines the use of the others. According to Morgan (1997), over the years, “a number of rules of thumb” (p. 340) regarding the use of focus groups for data collection has emerged. According to these rules, focus group projects most often (a) use homogenous strangers as participants, (b) rely on a relatively structured interview with high moderator involvement, (c) have 6 to 10 participants per group, and (d) have a total of three to five groups per project.

In this research, I formed 3 focus groups, consisting of students who did not mind their conversation being recorded on tape. One group worked on the Car Parking project, another group worked on the Career Aspiration project and the third group worked on the Time of Travel project. For this research I had 3 focus groups but, I only had 3 students in one group and 4 students each in the other two. This was because, initially, many of the students agreed to take part in interviews but some parents declined the invitation for their daughters to be recorded on tape, even though the students indicated they wanted to take part. This was a significant setback for me because 3 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. Therefore, in total, I had only 11 students out of the possible 20 who got the go ahead for interviews. Fortunately, for me, there was at least one student who had permission to take part in the interview from each of the 3 groups. This was particularly important for me because this means that the views expressed by students, who were refused permission to take part in interviews, could still be communicated to me by their peers. Although less than ideal, it proved less of a constraint than might otherwise have been the case.

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. These group interviews were conducted on April 21st, 23rd and 26th, 2009, for the Car Parking, Time of Travel and Career Aspirations groups respectively. At the beginning of each interview I asked the group, “tell me about your experiences on learning mathematics during your school days?” I then followed with “what do you expect to achieve in this project?” The interviews were not recorded but I made notes in my journal on what was discussed and the views expressed by the participants. Then I conducted relatively structured interviews with the group(s) 2 weeks into the start of the project to address any challenges faced by the students. I began each interview by asking the group “tell me about your progress?” These interviews were conducted on May 3rd, 5th and 7th 2009, for the Car Parking, Time of Travel and Career Aspiration groups respectively. On May 17th, 19th

and 21st 2009, which was the fourth week into the projects, I repeated the relatively structured interviews for the Car Parking, Time of Travel and Career Aspiration groups respectively. I began each interview by asking “tell me about the mathematics required for your project?” I followed this with “are you enjoying what you are doing?” These 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 Car Parking group met and presented their finding to the College Director on May 31st 2009. I had the final focus groups interviews on May 24th, 26th and 28th 2009, with the Car Parking, Time of Travel and Career Aspiration groups respectively. The final interview questions 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.

Reflective Journal

Reflective journal does not only present an approach to assessment, teaching and learning within institutional contexts, but also provides a valid method for researching teaching and learning (Phelps, 2005). It can also provide a method of gathering data from the learner, as well as from ourselves as teachers and researchers. In addition, reflective journals can be used to capture reflective insights, sometimes described as the “a-ha experience (Phelps, p. 42). Understanding the nature and effect of such a-ha experiences is very important for teachers, yet data on these types of experiences is very challenging, if not impossible, to collect.

Throughout this project, 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 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. Some very interesting views were expressed, during whole class discussions, by some of the students who were refused permission to take part in interviews; these views were all noted in my journal. In my

journal, I recorded: 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; team work; 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 cannot 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 session with some of the participants.

Critical Friend

A critical friend is one who takes on a proactive role through the building and maintenance of a partner relationship with the researcher (s) throughout their project. Literature on guidelines on how to perform the role of critical friend is scarce, Kember et al., (1996). In my research, two colleagues played the role of critical friends. One of them Peter (not his real name) was an Information Technology teacher and the other one Marilyn (not her real name) was a mathematics teacher in the same department as me. Both Peter and Marilyn had been working at ADWC for the past 10 years, therefore it was reasonable to assume that they had very good knowledge of the HCT curriculum. My choice of critical friends from these 2 departments was deliberate as I wanted people with some mathematics background to play the role of "quality control" on my part. This was important, as the saying goes "two heads are better than one". We had an initial "Rapport Building" (Kember et al., 1996) meeting during which I informed them what my research work was about, and then presented my planned role in the students' project to them for advice. We had "Coffee Maker" (Kember et al., 1996) meetings fortnightly, i.e., we met over a cup of tea or coffee, during which I updated them with the progress made and challenges faced in the research and to seek advice from them. I also met them whenever there was the need. I recorded their advice in my diary.

My meetings with them were ongoing through to the end of the projects. I also had many academic discussions with other colleagues who were simply interested after they heard from students about their projects. In almost all

cases, they offered useful advice based on their own experiences of teaching at ADWC.

Student Presentations

Marilyn (my critical friend) had her lessons covered to attend all the group presentations. Her attendance was very useful for me because I had her crosscheck my notes after the presentations. There were 4 groups, each had 20 minutes to make their presentations to the whole class, and 10 minutes was allowed for questioning. It was not possible for all the 4 presentations to be completed in a day because only 50 minutes was allowed per lesson, therefore, three lessons were utilised for the presentations. Students' presentations were not recorded because it involved students who were refused permission to take part in interviews. However, during the class presentations, I took notes on: the way the students (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. I also made notes of any of the Productive Pedagogical elements demonstrated by the students in their presentations and answers to questions asked by me and by their peers. At the end of each presentation, the group leaders handed in a copy of their presentations to me. These data were also analysed.

Test Results

Usually, at the end of each Module, all the DF students would take the same pen and paper end of module examination. Usually, all the sections would take the examination on the same day agreed earlier on by all the teachers who taught the course. The examination was 50 minutes long, taken from an already existing Test Bank made of questions contributed by the teachers who taught the course. The test results of participating students were also used to compare to those of 3 other cohort groups. Two of the groups were taught by me while the other one was taught by a colleague who also played

the role of critical friend in this research. These 3 groups were taught all the 3 topics in this research (percentages, time calculation and graphs) using the college booklets, in other words, they were taught using the traditional methods. While this was not a major component in the design of this study, I needed to be aware of any possible decline in achievement of these students at the Trial Examination (set by ADWC) and in the final Assessment (set by the HCT Central Services) that they undertake in the subject.

Students' Reflective Questionnaires

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 at interviews now had their chance to express their views. All 20 students in my DF203 class completed the questionnaire. There were 4 open ended questions (see Appendix 1). The questionnaire was completed after the students' project in June 2009. 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. Only 4 students chose to write in Arabic and I, subsequently, had the content translated by an expert in the local Arabic dialect. The questions were open ended. For example, "what do you like or not like about the mathematics projects you have completed this semester?"

3.5 Procedures

The academic year at HCT starts in August and consists of 2 semesters (that is, August to December and January to June). Students are taught 8 modules during each academic year, usually 4 modules in the first semester and 4 in the second semester. The Modules targeted in this research, namely, percentages, time calculations and graphs, are currently taught in the second semester. As stated earlier, my choice to focus my research on these topics was a consequence of my experience of teaching them using the traditional teaching approach and also because I had observed that students at ADWC had continued to find these topics challenging. Furthermore, these topics

lend themselves readily to student projects and have clear social justice implications. The choice was also convenient because the 3 topics are normally taught in the second semester of the academic year. This allowed me to use the first semester to pursue my search for additional literature within the field of Social Justice Pedagogy.

The Practical Numeracy course at HCT is taught using 8 modular booklets. The length of time taken to cover a module ranges from 3 to 5 weeks, depending on the content to be covered in the booklet. The module containing percentages is taught over 5 weeks, the module on time calculations is taught over 2 weeks, whilst the module containing graphs is taught over 3 weeks. There were 5 contact periods per week - 55 minutes each.

3.5.1 Student Projects

Three projects were completed in this research work, namely Time of Travel, Career Aspirations and Car Parking. Two groups worked on the Time of Travel project; one of the groups consisted of all students living outside Abu Dhabi city. The second group consisted of students from Abu Dhabi, except one. Another group worked on the Car Parking project whilst a fourth worked on the Career Aspirations project. In each project, students worked in groups, conducted research and made a presentation to the whole class. The topics for their projects were chosen based on participants' interests and all dealt with one or more issues that have social justice implications.

The Time of Travel group investigated ways in which the transport provided by the college could be improved by using mathematics as a tool to understand the challenges they face and make recommendations to the College Transport Coordinator on how to change and/or improve this very important aspect of their college life. The Car Parking group thought the parking allocation at ADWC was unfair (teachers had more space per head than students). Therefore, they used mathematics as a tool to investigate the car parking space allocation at ADWC. The group presented their findings to the College Director. The Career Aspirations group used mathematics as a tool to investigate and inform the College Career Coordinator on how

informed, or otherwise, the students in DF at ADWC were with regards to the career opportunities available to them.

I utilised the data collected by the participants to develop Mathematical Enriched Worksheets and used it to cover the material outlines in the ADWC Diploma Foundations Mathematics Course Outline. Each student in my class attempted all the rich worksheets; first, on their own in class and at home; then, they discussed their results within their groups - answered questions, raised their own questions and, finally, the “main group” working on the topic presented their findings to the whole class. Each presentation was followed by question and answer sessions.

The decision to engage in investigating these project topics was arrived at by the students themselves after brainstorming sessions in my class. It is not surprising that the Time of Travel and Car Parking projects came up here as a preferred choice for some of these participants. As mentioned earlier, students who drive their own car to college face severe challenges with regards to the availability of parking spaces. Those travelling to and from college on the bus also face the need to leave their homes as early as 05:30 in order to arrive on time for the start of the College day.

Five hours every week for the duration of 6 weeks were devoted to the projects. In these projects students worked in groups to select an area of interest, conducted some research on it and made a presentation to the whole class. The topics for these projects were chosen based on the individual participant’s interests and all dealt with one or more issues that have social justice implications. Thus the rationale for these projects were based on further development of mathematical skills and concepts covered in the 3 chosen modules and also showed how the applications of mathematics to social justice issues were achieved.

The projects were conducted in 4 stages:

Stage One (2 Weeks): Students at this stage brainstormed issues that were of concern to them, or to their community, and narrowed down to one topic

that they then investigated. As the projects required novel data to be collected, in small groups students designed appropriate questionnaires and data collection sheets and used these to collect the data that they needed to inform themselves about their selected topic. Some data were collected using the Internet. Scaffolding to the students was crucial at this stage due to the novelty of the task and the support that these students needed in language. Consequently, I did support them, where necessary, in order to avoid unnecessary frustrations.

Stage Two (1 Week): This was when the questionnaire developed by the students and used for the Career Aspirations project was typed and piloted, and 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. To ensure that the questionnaire asked the right questions, the group tested their questionnaire by asking students from another class to fill them in. A review of some questions was made. After this I asked my colleagues to distribute and collect back the completed questionnaires from their students. I did this for 2 reasons: first, to minimise any possible disruptions to my colleagues' lessons; second, I wanted to make sure that each question was fully explained to the students before they answered it. Seven classes out of the nine classes in DF Semester 2 completed the questionnaires.

Stage Three (1 Week): This was where all the groups tabulated their data and did the necessary calculations and then decided on the appropriate way to demonstrate their results.

Stage Four (2 weeks): Recorded focus group interviews and the Director's interview by the students were conducted in this period. In this period students also prepared and delivered a presentation of their findings to the whole class. Each group was given 20 minutes for their presentation and this was followed by general questions and discussion from the whole class. In addition, the Car Parking project group presented their findings to the ADWC Director on 31st May 2009. Both the Car Parking and Career Aspirations groups wrote letters to the Transport and Careers Coordinators, respectively,

in which they explained their findings and also made recommendations for change.

In this research, I wanted to design a classroom environment that allows Social Justice Pedagogy to flourish, and I found certain characteristics of Productive Pedagogy useful as a means for reflecting on my practices. In addition, the participants' involvement in these projects was in line with the principle of Productive Pedagogy.

3.6 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. In particular, I employed an approach set by both, Strauss and Corbin (1998), Charmaz (2008) and Atkinson and Abu Al Haj (1996), to organise and interpret the raw data in this research. Their processes involved coding and then segregating the data by codes into data clusters for further analysis and description. This meant that I had to build coded schemes to categorise participants' (students and teachers - critical friends) opinions. This approach enabled me to constantly reflect, and refine the research process, while making the necessary adjustments on how I facilitated the groups and collected and collated my data.

In order to avoid having to deal with very large data for analysis, I commenced an analysis of data as it was collected. I also wrote up my findings as the data was analysed. I found NVivo, a qualitative analysis software program, very useful in helping me to organize and code my data. This program has enabled me to keep track of my generated codes and has made the many rounds of coding, plus the revision of the coding and sorting the data prior to coding, less stressful. Glesne (2006, p. 152) defined coding as, "A progressive process of defining and sorting those scraps of collected data that are applicable to your research purpose".

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 on page below respectively show: the themes, definition, sub-themes; and universal themes generated, respectively.

Table 1
Themes and Definitions

Themes	Definition
MPPC_ mathematics profile and positive change	Expression of likeness for mathematics from the initial position of a math phobia participant.
SELG_ student engagement with local and global issues	Demonstrates interest in issues in ones immediate environment and the world, with the aim of understanding them and making a difference.
SEM_ student engagement with mathematics	Improved interest in: the study of mathematics and/or in engaging in college mathematical events. Substantive conversation.
FEM_ fun and enjoying mathematics	When participant makes a statement demonstrating happiness with the task in hand. A feeling of support.
MCL_ mathematics content and learning	When participant's work/presentation/point of view demonstrates relational understanding of a mathematical concept.
SE_ student empowerment	Participant demonstrates a sense that he/she can make a difference. Feels in control.
RWM_ reading the world with mathematics	Using mathematics to better understand both local and global issues.
WWM_ writing the world with mathematics	Using mathematics as a tool to seek improvement of an unjust situation.
FN_ fairness	Expression of satisfaction/dissatisfaction
EP_ empathy	Describes an argument in support of others.
GT_ gratitude	Expression of thankfulness.
PS_ problem solving	Demonstrates the ability to think "out of the box" - critical thinking ability. High order thinking.
EF_ examination fever	Expresses anxiety about the end of year assessment.

The above preliminary themes were grouped into 4 universal codes, which are the key aims of my study, with the PP theme cutting across 7 of the sub-codes, as follows:

Table 2
Universal Themes

Universal Themes	Sub-Themes
SJ _ social justice	SE, RWM, RWM and FN
MT _ mathematics	MPPC, MCL and PS
ATW _ attitude to work	SELG, SEM, FEM, GT and EP
PP _ productive pedagogy	SELG, SEM, FEM, SE, RWM, EP and PS

I was particularly careful to ensure that the themes which I identified reflected the participants' views rather than my own. To ensure that this was the case, I familiarized myself with the collated data by reading it several times and also by listening to the taped interviews many times. I burned the recorded interviews onto CD and played it to and from work every day, throughout the period of data analysis. This proved a very useful exercise because it enabled me to know the data inside-out and hence to identify a preliminary list of issues and put them as codes. Some of the issues eventually recurred more frequently than others.

As I reviewed more data, I started to create and define some as sub-topics of broader categories. Consequently, by grouping them together, I came up with a final list of broad themes. With the primary themes in place, I then established topics and defined them as secondary sub-sets of them. I then arranged the actual text into primary themes, hence I was able to group actual phrases together and consequently identify the sub-categories that emerged directly from the participants own words. I saw this process as cyclic. I continued until I was satisfied that the codes I created were exhaustive, that is, I was no longer generating new codes (Charmaz, 2008).

As a result of this approach, I was able to identify topics of most importance to the participants. I then collated all the phrases and whole narratives on various sub-categories and summarised the contents into key issues. I was particularly interested in statements that relate one sub-category to another, either in terms of influence or priority. I used direct quotations from the participants to support some of my data analysis throughout this thesis. To build up an overall picture, I identified the relationships both between primary domains and sub-categories as appropriate to my research objectives.

3.7 Quality of Data

My research work is rooted purely in the qualitative paradigm. Qualitative research methods can be defined as simply as, “a research work that produces results not reached at by means of statistical procedures or other means of quantification” (Strauss and Corbin, 1990, p. 17). Patton (2001) (in Golafshani, 2003) argues that “validity and reliability are two factors which every researcher using the qualitative paradigm should be concerned about while designing the study, analyzing the results and judging the quality of the data” (p. 601). The sentiments expressed by Patton are in agreement with the question raised by Lincoln and Guba (1985), which was, “How can an inquirer persuade his or her audience that the research findings of an inquiry are worth paying attention to?” (p. 290). In particular, they used the word “dependability” for “reliability” (p. 300) and, they emphasised “inquiry audit” (p. 317) as a means of achieving such dependability in qualitative research. Lincoln and Guba (1985) contend that since validity cannot be attained without achieving reliability, this implies that demonstrating validity is sufficient to imply reliability was achieved (p. 316). One strategy for improving the validity and reliability of research findings is by triangulation, because it strengthens a study by combining methods of data collections (Patton, as cited in Golafshani, 2003).

To ensure trustworthiness, the triangulation method was used for data collection and analysis. Data was collected from multiple perspectives to ensure its quality. Doing so enabled me to look out for common themes across the different data sources. This is particularly important in qualitative

research work. Stake (2003) states, “Triangulation has been generally considered a process of using multiple perceptions to clarify meaning, verifying the repeatability of an observation or interpretation...it serves also to clarify meaning by identifying different ways the phenomenon is being seen” (p. 241).

Another important aspect of the triangulation method, for observation and interpretation of data, is to get those interviewed to review 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. 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. This process usually provides valuable feedback (Stake, 2003). 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.

To further ensure the trustworthiness of my data analysis, my research objectives (questions) remained as such rather than a set of preconceived views. I constantly revisited my codes, analysis and themes for explanations that might be different from what I expected based on my experience, theory or my attempt to make this project a positive experience for the participants. In addition, I constantly asked myself the questions stated below, as reported by Glesne (cited in Hollway & Jefferson, 2000), that is:

1. What have I noticed?
2. Why did I notice what I have noticed?
3. How can I interpret what I have noticed?
4. How can I know that my interpretation is the right one?

In this research thesis quotes from individuals, as well as from focus groups, were used extensively to portray the true feelings and emotions expressed by the participants.

Throughout the data collection and analysis period, I remained open to a variety of perspectives on my research objective; this enabled me to constantly evaluate my interpretation and analysis (Maxwell, 2005).

Also throughout the data collection and analysis period I was cautious to make sure my voice hid behind those of the participants in accordance with the advice from Fine and Weis (1997). In other words, I was cautious not to allow my personal views on issues discussed to influence those of the participants'; as an outsider to their "own worlds". This is very important when teaching for social justice; the participants must not be influenced by the researcher's opinions, they should be allowed to construct their own.

Throughout the research period, I engaged in constant reflection and dialogue with the participants and my critical friends in order to remain conscious of these issues and not misrepresent how the participants perceived their learning experience in their chosen projects.

CHAPTER 4

CONTEXT AND IMPLEMENTATION OF THE RESEACH

This chapter has 4 main purposes. The first is to provide information on the context of this research necessary for a full understanding of the findings of the project. The second is to provide a narrative on how the students' projects presented in this thesis came to be. The third purpose is to provide factual information on: the projects; the project groups and groups' presentations. The fourth is to present the rationale and form of the "Mathematical Enriched Worksheets" I developed with the aim of enhancing the teaching and learning of the topics of percentages, graphs and time calculations. In other words this chapter uses narrative style to report on the project. The following chapter outlines the analysis of the resulting data.

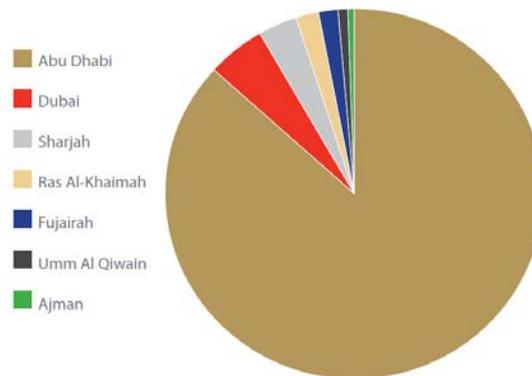
4.1 Research Context

Understanding the context of this study is vitally important because social justice interpretation is always contextual. The context is discussed in detail to facilitate better understanding of the uniqueness of the place where this study was carried out.

4.1.1 *Context of the Country*

The United Arab Emirates (UAE) consists of 7 States known as Emirates. The 7 Emirates are: Abu Dhabi, Dubai, Ras Al-Khaimah, Ash Sharjah (also known as Sharjah), Fujairah, Ajman and Umm Al Qiwain. Each Emirate is ruled by its own hereditary ruler.

Relative Areas of the Emirates to each other, (Abu Dhabi Statistical Yearbook, 2009)



Abu Dhabi is the seat of power and the capital city. Dubai is the largest city in the country and is known for its international role as a business centre. The UAE became an independent country in 1971. Oil was discovered in 1950, the bulk of the country's oil being found in Abu Dhabi thus making it the wealthiest and most powerful of the 7 Emirates. Oil reserves in the UAE make up almost one-tenth of the world's total, with about 85 percent of that oil located in the Emirate of Abu Dhabi. In addition, estimated natural gas reserves amount to about 3 percent of the world's total, with Abu Dhabi again possessing the largest share. Today, the UAE boasts one of the highest standards of living in the world, (Malcolm, 2006). However, despite the UAE's obvious wealth, there are disparities in standards of living between UAE Nationals (Emirati people). Overall poverty levels are very low because the country's leadership has devoted a large part of Abu Dhabi's wealth to the welfare of the poorer Emiratis. However, there is a huge disparity in standards of living between foreign workers. A natural corollary of this situation is the disparity in living standards between the majority of foreign workers and most Emiratis.

The UAE's constitution, promulgated in 1996, established a Federal Government that devolves much power to the individual Emirates. The Federal Government has executive, legislative and judicial branches, but the executive branch dominates the political system. There are no political parties and no popular elections. The highest political authority in the UAE is

the Supreme Federal Council (SFC), sometimes called the Supreme Council of the Union (SCU), which consists of the Rulers of the 7 Emirates. This Council establishes general UAE policy and usually meets 4 times each year. Each ruler has a vote, but on substantive matters the dominant Emirates of Abu Dhabi and Dubai can exercise veto power. Politically, the country is stable, with the Emir of Abu Dhabi, Sheikh Zayed bin Sultan al-Nahyan, leading the country from its inception until his death in late 2004. His eldest son, Sheikh Khalifa bin Zayed al-Nahyan, succeeded his father as ruler of Abu Dhabi and became the new President of the UAE.

The native Emiratis are Arabs and generally a different tribe dominates each Emirate. In recent years, as prosperity has increased, the ratio of immigrants to 'native' Emiratis has risen. Currently, the population of UAE is approximately 8.19 million, out of which 20% are Nationals and 80% foreigners - a ratio of 1:4, (Abu Dhabi Statistical Yearbook, 2009). This has, rightly, caused concern particularly over the possible impact on the country's security and social and cultural values. Such concern was expressed by the first President of the UAE, the late Sheikh Zayed Bin Sultan Al Nahyan, in one of his annual speeches, when he mentioned that the influx of foreigners into UAE poses a danger to the culture and way of life of the people. He said,

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, posted on 2nd Dec, 2003)

All UAE natives, and a majority of expatriates, are Muslim. The constitution guarantees religious freedom and other religions are represented. Clothing styles in the UAE are both Western and indigenous. Most Emirati men wear

the “Kandura”, a white, loose-fitting garment that is comfortable in hot weather. Most women wear the enveloping black “abaya” and a face mask called the “Niqab”. Many women, young and old, still dress in a conservative way which covers all the body. This is important, both religiously and culturally, as other men are not supposed to see a woman's face. This way of dressing is also very common in schools and colleges, including ADWC.

In all Government owned primary and secondary schools education is free to UAE Nationals. Primary education is compulsory between the ages of 6 and 14. Arabic is the language of instruction in all Government schools. Therefore, it is no surprise most teachers, at all levels, are from other Arab countries. All the schools are single sex: boys attending boys’ schools and girls, girls’ schools. Young girls are very much protected, so much so that they are never allowed to go out without their parents or a family member (male over 9 years old). Therefore, it is very possible to have an 18 year old (the age of most the students at HCT) Emirati woman who has never spoken to any man other than one of her close family members.

At schools, parental consent is always asked before the girls are included in photos. It is a serious offence to take an Emirati woman's photo without asking her parents or husband for permission, even if she herself volunteers. This is also true for any voluntary work in which the students might want to take part. For instance, it was impossible to include the photos of many of the participants in this thesis as they engaged in different activities, because permissions were not forthcoming. Even the most enthusiastic of all the participants told me that the last thing her parents would accept is for her photo to be published in a “book”, in this case my thesis. It might be argued that the teaching methodologies employed in most Emirati state schools are essentially formal and traditional when compared to some countries. Teaching remains, essentially, teacher led and teacher directed. The curriculum is somewhat rigidly organised and tends to be focused “to the test”. The test itself, which the students take at the end of their college course, is itself a “make or break”, pass/fail examination which determines an individual student's future.

Parallel with the UAE's state school system are private, "fee paying" schools attended by the majority of expatriate children. Here the language of instruction is English and the curriculum reflects the national origin of the institution's founders. Some Emirati children attend these schools too - mostly those whose parents are planning to send them abroad (to Australia, the UK or the US) for their University education. There are many such expatriate schools seeking to fulfil the needs of expatriate parents in the education of their offspring.

4.1.2 Context of the College

The Higher Colleges of Technology (HCT) were established in 1985, by Sheikh Zayed Bin Sultan Al Nahyan, who was a member of the Supreme Council of UAE. HCT admits only Emirati men and women: usually, students who could not gain enough points for admission into universities in the UAE.

Four colleges were opened in 1988: Abu Dhabi Women's (ADWC); Abu Dhabi Men's; Al Ain Men's; and Al Ain Women's. HCT now has 17 colleges around the UAE, with approximately 18,000 students, 67% of whom are women. Most of the men aspire to work in the oil sector: accordingly, they tend to seek admission into institutions offering career paths in this area. All programs are delivered in English and the colleges are dedicated to student-oriented learning. Teaching and administrative staff are recruited worldwide for their academic, industrial and technical expertise. They all work together with the students to enhance the teaching and learning experience and create lifelong learners. As a significant departure from the cultural norm, in recent years HCT has modified its policy to permit mixed gender teaching staff at both Male only and Female only colleges.

Some of HCT's programs, for example the Bachelor of Education, have international accreditation by the University of Melbourne. The Mission Statement of HCT states that:

The Higher Colleges of Technology are dedicated to the delivery of technical and professional programs of the highest quality to the students, within the context of sincere respect for all beliefs and

values. Graduates of the Colleges will have the linguistic ability to function effectively in an international environment; the technical skills to operate in an increasingly complex technological world; the intellectual capacity to adapt to constant change, and the leadership potential to make the fullest possible contribution to the development of the community for the good of all its people. (The HCT Learning Model, 2006)

ADWC has 5 main teaching departments: Education, Health Sciences, Business, Applied Communications, and Information Technology. Diploma Foundation, which is the focus of this thesis, falls within the Education department. ADWC also offers a Work Readiness Program to meet the needs of those Women who did not fulfill the entry requirements for any of the 5 main departments. It prepares the students for careers within the public or private sector.

The academic year at HCT consists of 2 semesters of twenty weeks each. Usually, in semester 1 there is a couple of breaks due to religious activities; for example, the start of the Holy month of Ramadan, Eid al Fitr and the National Day. These breaks tend to help both students and teachers to refresh and finish the remainder of the semester less stressfully. However, in semester 2, there are no breaks at all. Students and teachers work for the whole twenty weeks nonstop. From my own experience of teaching at ADWC, this very long teaching period tends to tire both students and teachers and in some respects could be considered counterproductive from the point of view of loss of intensity in the second half of the semester.

4.1.3 Context of the Students

More than 50% of the population of students at ADWC comes from outside Abu Dhabi city (known as the Islands). The college provides bus services, at a subsidised rate, to students who require the service. Some students are dropped off and picked up from college by their parents or by the family driver and some drive themselves to college. Those who drive themselves are mostly working students: they study full-time as well as holding down a full time job, though with working hours adjusted by agreement with the

employer. Those students who catch a bus not only have to travel for more than an hour to get to college every morning, they also have to catch the bus as early as 05:30 because the bus driver has to pick up other students, from different locations, which are often far apart.

Lessons start at 07:30 and finish at 14:30 for most of the morning students. For the afternoon students, lessons start at 11:00 and finish at 17:00. Those who drive themselves to college have to look for a parking space on the college grounds – and these are very limited. A typical class at ADWC would consist of students from all the different categories mentioned above: full-time students; working students; students who drive; and those who don't etc.

All the Government owned High Schools in the UAE are single sex: with only male teachers teaching at the male schools and only female teachers teaching at the female schools. Therefore, having a male teacher is not the norm for ADWC students. This is why the departure from this norm at HCT colleges is so significant.

As is the case with most UAE nationals, all the participants in this research have Arabic as their mother tongue. Arabic is the language of instruction throughout their primary and secondary education. In the month of March/early April, of their final school year, all high school students in the United Arab Emirates (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 "achieving" students (those with high CEPA scores) will normally gain admission into Universities in UAE, while the middle and lower ability ones tend to seek admission into HCT.

Those admitted into HCT fall into two categories. At entry, students with reasonably good grades are admitted into the Higher Diploma Foundation Program (HDF) and the remainder into the Diploma Foundation Program (DF). During this research I taught the DF students mathematics. In other words, I taught those who are perceived, by the system, as mathematically weak. DF students are not streamed according to ability or achievement

within the course. Therefore, it is possible to have a class with more than 50% speaking little or no English. This is why the students are usually timetabled to have 15 hours of English lessons per week to enable them to pick up the necessary vocabulary they require in order to survive the course. This leaves only 5 hours for mathematics and 2 hours of Professional and Personal Development (PPDV) where they are taught organisational skills, personal hygiene etc. All students also have 3 hours of computer studies per week. The DF course is one academic year long. Upon successful completion of the course students are admitted into Diploma year one to pursue Health Science; Information Technology; Interior Design; or Business Studies.

Some students may start their study with HCT but leave half way into the year for personal reasons. The doors are still open for this category of student to come back, whenever possible. Therefore, our DF students range in age from 17 to 36. During the 2009/2010 academic year, I had a student in my class who was 36 years old and at that time she told me that her first daughter was already studying at university. This particular student was married at the age of 16, which is a common practice in this part of the world. It is pertinent to mention here that she was one of the most enthusiastic students I have ever taught in the HCT system; perhaps “age begets wisdom”.

4.1.4 Context of the Subject

For all the students in the UAE who went through the elementary and secondary government Education Institutions, the language of instruction in all subjects (including mathematics) is Arabic. Mathematics is one of the compulsory subjects. Most of the students who come for higher education at ADWC (and in particular within the DF course) are in one way or another already fearful of mathematics as a subject.

The DF Mathematics Course consists of 8 learning outcomes. Its course description states that:

This course focuses on basic numeracy skills required by all Diploma Programs. It provides an introduction to numbers, operations and related problem-solving. It introduces information finding skills and reading data from, and representing data on tables and graphs. The course explores problems involving time and measurements and emphasizes the application of real skills required in the workplace. Course delivery includes materials and processes that develop global awareness, self-understanding and professional attitudes and practices. Class and project work incorporate critical thinking and problem-solving at a level of complexity appropriate to the level of the course and students. (Math 0155 HCT Course Outline, 24th August, 2009)

During the foundation year, students take 4 subjects - English; Mathematics (consisting of 8 modules); Computing; and Professional and Personal Development (PPDV). The 8 mathematics modules consist of Module 1 (Whole Numbers), usually taught for 5 weeks; Module 2 (Time), usually taught for 4 weeks; Module 3 (Fractions and Decimals), usually taught for 2 weeks; Module 4 (Measurement), usually taught for 4 weeks; Module 5 (Fractions, Decimals and Percentage), usually taught for 5 weeks; Module 6 (Ratio and Proportion), usually taught for 3 weeks; Module 7 (Time calculations), usually taught for 3 weeks; and, Module 8 (Tables, Graphs and Formulas), usually taught for 3 weeks. At the end of each module, a test is conducted which is one element of the continuous assessment. The average of all the test scores on the 8 modules, plus project work based on some of the modules, is the final coursework score for the mathematics course.

A similar assessment procedure is followed for the other 3 subject areas. The students must pass the coursework on each of the 4 subjects and the final exam in English and Mathematics. Students complete coursework during the year prior to their examination (KCA exam). If they fail coursework (<60%) they fail the course and are not allowed to re-sit the examination: in practical terms, they are excluded. A student who passes the coursework, but fails the KCA examination, is entitled to one re-sit. The final grade is determined using the formulaic ratio COURSEWORK: KCA EXAM of 7:3.

My Thesis focuses on 3 content areas, namely: percentage; time calculation; and graphs. These content areas are associated with: Learning Outcome 02 - read, write and solve applications involving date and time; Learning Outcome 05 - use percentage to solve applications using language such as discount, commission, increase, decrease, change; and, Learning Outcome 08 - extract information from tables, charts and graphs, construct tables and make simple calculations. In the year of this research, I taught mathematics to 3 DF sections, but only one section was engaged in this research. The reason for this was I wanted the majority of the participants in this research to be those with “reasonable” levels of written and communication skills in English. Of the 3 sections, only my *DF203* class was close to meeting the criteria mentioned above.

4.2 Implementation

This section is divided into 3 parts, Section 4.2.1 provides information on how the students’ projects presented in this thesis came to be, Section 4.2.2 provides factual information on: the projects; the project groups and the groups’ presentation. Section 4.2.3 presents the rationale and form of the “Mathematical Enriched Worksheets” developed with the aim of enhancing the teaching and learning of the topics discussed.

4.2.1 How it All Came to Be

Sunday 19th April 2009 saw the start of what turned out to be a glorious and unforgettable experience for my *DF203* class. I was to start teaching them the topic of percentages. Traditionally, we teach all 8 Modules to our DF students using mainly the Modular books. From my experience of teaching at ADWC, I believe part of the reason for doing this is the pressure we, the teachers, are under to prepare these students for their end of year Key Common Assessment (KCA) examination. Additionally, although HCT management encourages innovative teaching, no one is really sure how such an approach would be received because innovative teaching is a relative concept (subject to interpretations). In other words, what is perceived as innovative pedagogy by one person might be perceived differently by another. Therefore, although I would have loved to teach the topics in this

research purely by using the projects, I did not do so because I had to save time in order to allow for systematic revision and examination preparation. I had to strike a balance between using the modular “set” books and the projects that were developed in this thesis. Therefore, I decided I was going to teach the topics using the project approach in 3 out of the 5 lessons each week.

I began by telling the students that I would be teaching them the topics of percentages, time and graphs using an approach called Social Justice Pedagogy. Immediately Sarah, who is a very vocal student, raised her hand and asked, “What does that mean”? I then went on to explain to them that the Social Justice Pedagogy of teaching is when the teacher uses mathematics as a tool to empower the students: about their rights and responsibilities in their communities; to resolve a potential problem or a problem that is important in their lives and to become agents of change in their communities and country, in general. The whole class went quiet for few seconds; you could hear a pin drop. This was not surprising to me because I knew this was the first time anyone had said something like that to these young women. Then, Sarah broke the silence again and said, “This sounds good teacher. So we can choose any problem we want to discuss and use math to solve it”? I replied, “Yes, but your group and I have to agree that the topic is suitable, meaning that it can be completed within the time limit and it is culturally acceptable”. I added further, “The project is voluntary. Anyone who does not want to take part in the project is free not to do so”. My plan was to allow anyone not interested in the project to continue working directly from the Modular books and the available worksheets on Black Board Vista provided by the college and I was prepared to give them all the support they would have asked for.

From this point, I asked the students to form groups of a maximum of 5. Within seconds 4 groups were formed. I was pleasantly surprised with the speed at which the students formed their groups as usually they are rather slow when asked to form groups. I expressed the hope to myself that this early enthusiasm would continue throughout the projects! I then put up the following 3 questions on the Promethean board using my tablet computer:

1. Think of one, or more, topics that you would like to work on for this project. Write down what those topics are.
2. Write down things that you think you would need for this project.
3. What ways do you think this project would help you or your immediate community or both?

Participants were allowed 15 minutes to discuss the above questions.

I went around the class and I was indeed very surprised by the topics raised within the groups. Their choices of topic demonstrated to me how good these students are, or can be, when given the freedom to think for themselves. Some of the topics were overtly controversial, others were too sensitive for me as a male teacher to supervise, but many others were suitable. Examples of topics raised were: Healthy Food; Career Choices for Women; Favourite Food; Divorce Rate; and, Equality of Men and Women. As the teacher, it was my responsibility to ensure cultural sensitivity was maintained.

For instance, I knew that the majority of the students in my DF203 class would not like to discuss issues concerning rate of divorce with me for 2 reasons: first I am a complete stranger in their culture because I am not an Arab and I don't speak the language; and second, I am a man. Therefore, I felt that it would be culturally insensitive for me to allow such discussions to start because it might not yield any fruits plus some students might be offended and switch off completely from the discussions. Issues with direct connections to the Islamic religion, like marriage, are left for the parents and religious leaders. It is also pertinent to mention here that I am contracted not to engage in any discussions that have religious bearing with the students. For this reason, I noted their topics and I assured the students that we would discuss their suitability or otherwise in our next lesson.

On Day 2 of the project, as I walked into the class the first thing I heard was, "Teacher! We have to continue with our project and we have changed our topic". I looked up and this was Bedur, a very shy student who had never

spoken a word to me until that day. I answered: “Yes! We will continue today.”

The students were all already in their groups discussing their topics. As a teacher in the College for over two years prior to this research work, I was fully aware of how sensitive some of our students could be when they come up with an idea and a teacher publicly disagrees with them. Therefore, instead of writing up all their topics on the board and having a general chat about suitability, I decided to go around their tables and have a chat within each group. In this way I was able to educate the students about how culturally sensitive some of their topics were and I was also able to suggest a few more topics to them.

The final topics chosen by the young women themselves were: Career Aspirations, Time of Travel, Car Parking, Healthy Eating, Import and Export in UAE and Smoking and the Health Service. I then asked for explanations as to why these topics were important to those groups who chose them. This was an open question to the whole class. Salama said the career project would be good because it would help them to understand the different career opportunities in the UAE. She said, “Maybe we can know about how to start our own business and also about private companies in UAE and not only work for Government”. Salama’s response impressed me as a good reason because it showed how some of these students can think beyond life at college. Halima said the time of travel project was important because she used the college bus to travel to and from college. She said, “We need to solve the problem we have with the college bus. It is too expensive”. Halima believed the college bus was too expensive, and their findings from this project might help resolve the perceived problem.

Jawahir said she drives her car to college and finds it hard to get a parking space at the college. The car parking space available for students is small compared to that available for teachers even though there are more students than teachers at the college. She said, “This project is very important because the parking is not fair. Teachers have many parking spaces and students don’t have enough”.

Amna said healthy eating is very important to all of them because eating healthy food will help build a healthy life. She said, "If you eat healthily you will lead a healthy life which is good for your future". Mouza said it is important to know about what UAE produces and what it imports into the country. She believes that many young women, including herself, know very little about the imports and exports of the UAE. She said, "It is all part of our education to know about our imports and exports".

There were no contributions from the students on the issue of Smoking and the Health Service. Therefore I decided to take the lead and asked, "What are the dangers associated with smoking"? This question opened up the floor and contributions started to flow. Nada said, "It causes lung cancer and is very expensive to cure". Zainab said, "It affects small children when the parent smokes at home".

I then asked the following questions:

1. Hands up if you drive to college.
2. Hands up if you work part time.
3. Hands up if you use the college bus.

After the show of hands, I then said to the students that it would help if they joined a group that was working on something with which they had firsthand experience. For example, if you drive your car to college, it would help if you joined the group working on the car parking; if you have a part time job, it would help if you join the group working on career aspirations. However, I made it very clear to the students that this was their project; therefore, they were free to join any group. From here on, the students organized themselves into groups. As a result, 4 groups of 5 students each emerged to work on: Career Aspiration, Car Parking, Time of Travel and Healthy Eating projects. I was delighted to note that the group on Car Parking had students who drive their car to college, the group on Time of Travel had students who use the bus, the group on Career Aspiration had students who had part-time jobs and the group on Healthy Eating had a student who previously had told

me she was not happy with the available choices of food in the college cafeteria.

The third, and last, lesson focused on preparations for the projects. All the students had been working in their teams trying to agree on what data they needed and how to go about seeking it. I went around for a quick chat with each group on what their plans were. I immediately noticed that the Healthy Eating group was struggling because 3 of the young women seemed not too happy with the topic. After a further discussion with them they agreed to be a second group working on the Time of Travel project. This was convenient because now, for the Time of Travel project, I had one group which consisted of students from outside Abu Dhabi city and the other group consisting of students from within Abu Dhabi city, except one. The relevance of this will become clearer later in this thesis.

With the 3 days I initially allocated for the projects in this first week being over, our next 2 lessons were to be me teaching the students using the college prescribed books. On the day of the first of these lessons, as I walked into the class, the class representative walked up to me and said, "Teacher! All the girls want to continue with the project". I said to her, "Okay, we will talk about this in a moment". I took my students' attendance, which is a requirement at HCT, and then asked the class if what their class representative told me represented their view. There was an overwhelming yes! One part of my mind told me to stick with my initial plans. However, then I remembered that, in teaching for social justice, it is important for the learner to take the leadership role. They continued working on their plans in their groups and I went around the class offering support where necessary. All the groups had great ideas on what they wanted to put on their data collection sheets or questionnaires but struggled with their construction because this was the first time they had been engaged in a project where they were fully in charge.

4.2.2 Composition of the Groups

As mentioned earlier, the different groups engaging in this research emerged as a result of brainstorming sessions in my class.

Two groups worked on the Time of Travel project. One of the groups consisted of all students from outside Abu Dhabi city, the other group had all students from Abu Dhabi city, except one. I negotiated the groups in this way. This was because I believed those from outside Abu Dhabi would have different experiences as all of them use the bus, whereas those from within Abu Dhabi don't have a bus service. These 2 groups worked together to design the data collection sheets used. I advised them to seek opinions from all class members on whether the data collection sheet captured what it was intended to. This meant they had to go around the other groups and have a "chat" about their project. This is all part of the kind of collaboration encouraged in teaching mathematics for social justice.

One group worked on the Career Aspiration project. This group decided they wanted to use a questionnaire to collect their data. Therefore, they had the challenge of deciding what kind of questions they should include. I also advised them to seek opinions from all class members on what to include, which meant they too had to go around the other groups and have a "chat" about their project. They did just that and in the end they came up with some very good questions. I then supported them (mostly with writing in English) through the remainder of the process without interfering too much, after all this was their project. The questions were all nicely typed and piloted in the class during the next lesson. It was then my duty to negotiate with the participants in order to ensure that no offensive or culturally sensitive questions were included. I was very cautious in my negotiation with them to avoid making them feel disempowered by falling into traditional roles of depending on teachers' decisions. We had a discussion about what I perceived as not culturally suitable for men to discuss with women in this society and the students decided to drop such questions. The participants' decision was encouraging for me, as it indicated they may have now accepted me as one of them. This is particularly important in teaching for social justice. Participants will be willing to speak their minds more if they see the researcher as "one of them".

The final Career Aspiration questionnaire (see Appendix 2) was filled out not only by DF203 class but by 7 out of the 9 Semester 2 DF Sections, which is

about 78% of all DF Semester 2 classes. The students in this group collated all the questionnaires, tallied all the entries and calculated the percentages for each response. They also presented their findings to the whole class and answered questions and sent a letter to the college Career Coordinator, dated 8th June 2009, with a summary of their findings and recommendations. (See Appendix 3 for the letter.)

Another group worked on the Car Parking project. This group of students did not need questionnaires but they had the challenge of going out to the field to measure the length of all the car parks in the college. I was impressed with the way they seemed to have all their plans well in place with very little help from me. I asked them what they planned to use to measure the dimensions with and Aishat said, "That is what we wanted to ask you teacher". I asked if they had seen a measuring tape before, and their answer was, "no!" Therefore, I went to the college Facilities Department and arranged to borrow a 30 meter measuring tape for the next lesson. On the day they were to measure the dimensions, I went out with them to make sure they measured the correct lengths. We were all there in the sun (37 degrees Celsius) sweating but definitely enjoying what we were doing out there. That was the first time anything like that had happened at this college. The security guards were watching with interest how the young women were using the tape to measure lengths. Other students were curious and they came over to ask what we were doing. One thing that was very clear for everyone to see was the smile on the students' faces and the enthusiasm they demonstrated throughout the time they spent out there in the sun measuring the dimensions. After taking their measurements, they carried out all the calculations, discussed their findings with me and reached conclusions about their work. This group also presented their findings to the whole class. There were questions asked, first by me, followed by questions from students. All the group members answered questions with confidence. During my discussion with this group they informed me that it was important that the College Director know about their findings, hence, they were going to seek a meeting with him. They asked for my advice on how to go about this and I advised them to e-mail the College Director telling him what they wanted to

discuss with him and why this was important. The group leader Ayesha sent an e-mail to the College Director, Dr. Bradley Cook, seeking an audience with him to enable them to present their work to him. He granted them their audience on 31st May 2009. After the meeting they presented the Director with a letter. The e-mail and the letter are in Appendixes 4 and 5 respectively.

4.2.3 The Mathematical Enriched Worksheets

Why the “Mathematical Enriched Worksheet”? During the early stages of the projects presented in this thesis, I had informal discussions with each of the groups during which I noticed that, they were all focusing less on the mathematics and more on the social issues they were trying to change. This was a major challenge for me because the aim of my research was not only to address social justice issues but also to provide opportunity for the participants to learn mathematics. This challenge is one of the key areas which researchers need to pay extra attention to when employing Social Justice Pedagogy in their teaching. There is the tendency for students to get over involved in the project and neglect the mathematics used. In seeking to resolve this challenge, I utilised the primary data collected by the students to develop “Mathematical Enriched Worksheets” to help the students focus on the mathematics content.

As mentioned earlier, all the student in my DF23 class attempted all the “Mathematical Enriched Worksheets”; first, on their own in class and at home; then, they discussed their results within their groups - answered questions, raised their own questions and, finally, the “main group” working on the topic presented their findings to the whole class. Details of the group presentations are presented in Appendix 6. However, it is pertinent to mention 2 points here. Firstly, for the 2 groups working on the Time of Travel project, only the primary data of one group member was used by each group for calculations and presentation. The reason for this was because there was not enough time for every group member to present their individual results. The participants themselves decided whose primary data to use. Secondly, in

the UAE the working week starts on Sunday – the significance of this information will become clearer later in this thesis.

Time of Travel Mathematical Enriched Worksheet (1)

Aims:

At completion of the Time of Travel “Mathematical Enriched Worksheet”, participants should have developed significant ability to:

1. Calculate percentage of a given quantity and use the result to make future predictions.
2. Calculate percentage change.
3. Add, subtract and convert times from one unit to another (e.g. hours to seconds, etc.).
4. Use given information to compute the cost of travel, and use the result to analyse a given scenario.
5. Discuss social justice issues.
6. Reflect, based on their experiences from the projects, on the merit and otherwise of the Social Justice Pedagogy employed in this context.
7. Use mathematics as a tool to read and write the world.

The “Mathematical Enriched Worksheet” and detailed students’ presentations are in Appendix 5 and Appendix 2 respectively.

Career Aspiration Mathematical Enriched Worksheet (2)

Aims:

At completion of the Career Aspirations “Mathematical Enriched Worksheet”, participants should develop significant ability to:

1. Express a given quantity as a percentage of a whole.
2. Calculate percentage of a given quantity and interpret the result in the context of their project.
3. Calculate percentage change in real life contexts.
4. Voice opinions on social justice issues.

5. Reflect critically, based on their experiences from the projects, on the merit and otherwise of the Social Justice Pedagogy employed in this context.
6. Use mathematics as a tool to read and write the world.

The “Mathematical Enriched Worksheet” and detailed students’ presentations are in Appendix 4 and Appendix 2 respectively.

The Analysing Graphs Mathematical Enriched Worksheet (3)

Aims:

At completion of the Graphs “Mathematical Enriched Worksheet”, participants should demonstrate significant relational understanding of the concept of percentages, and, or the ability to read and interpret graphs beyond mathematics and to use mathematics as a tool to read their worlds.

The “Mathematical Enriched Worksheet” and detailed students’ presentations are in Appendix 6 and Appendix 2 respectively.

CHAPTER 5

DATA ANALYSIS

5.1 Introduction

As stated earlier, the purpose of this research is to trial a pedagogical approach which enhances the teaching of a Practical Numeracy course within the Diploma Foundation (DF) years of the Higher Colleges of Technology. The pedagogy aims to relate mathematics to the real life of the students whilst, at the same time, addressing some social justice issues. This research work falls into the tradition of Participatory Action Researcher (PAR), and I have employed the principles of Productive Pedagogy as a means to reflect on my practices in this research work.

The research aims in this thesis were to investigate the results among students after adoption of a social justice approach to teaching, in particular the effects upon:

1. students' learning in mathematics;
2. students' engagement;
3. students' ability to develop agency and
4. successes and challenges encountered in using this approach to teaching in this particular context.

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; Merriam, 1998). The data in this research were collected from multiple sources: focus groups; student presentations; participants' reflective questionnaires; participants' test results from the end of module; reflective journals maintained by the researcher; and, the use of critical friends.

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

In this chapter, the analysis is presented in 4 main sections all based on the 4 research aims. Section 5.2 presents data in respect of the learning of mathematics achieved by the participants. Section 5.3 presents data concerning students' engagement due to the teaching methodology employed in this research. Section 5.4 presents data regarding how the participants achieved critical mathematics agency and Section 5.5 highlights the success and challenges encountered in using a social justice approach to teaching in this particular context, while Section 5.6 summarises the main results. Analysis based on the first research aim is presented in the next Section.

5.2 Resultant Students' Learning in Mathematics due to the Adoption of a Social Justice Approach to Teaching.

The data collected from focus group interviews, participants' reflective questionnaires (see Appendix 1), group presentations (see Appendix 2), end of module assessments and researcher's journal suggest that the social justice approach adopted in this research has provided students with opportunity to learn significant mathematics. In particular, it shows that the participants have developed significant understanding of the concepts of: geometry; percentages; graphs and time calculations. They have also improved significantly in their ability to *solve problems* as well as their abilities in *meaningful rounding*. In addition, there is some evidence that the participants enjoyed this experience of mathematics much more than previous experiences with it.

In Section 5.2.1, below I provide supporting data to back up my assertions about the resultant students' learning of Geometry due to the social justice approach adopted.

5.2.1 Geometry

Data collected and analysed (mainly on the Car Parking project) from focus group interviews, group presentations, students' reflective questionnaires and researcher's journal strongly suggest that the participants in this research have achieved significant understanding of Geometry in the context of their project.

At the DF level students are not previously taught how to calculate the area of compound shapes or how to sketch draw. Therefore, of particular interest for me was that the data suggest that the participants have achieved very good understanding of how to sketch draw and how to calculate the area of compound shapes. In addition, the data suggest that participants have demonstrated very good understanding of units of measurement. Analysis of the data also show that students need to be reminded regularly of the importance of reading questions more than one time before attempting to solve them.

Measurement

Data analysed from focus group interviews, class presentations, students' reflective questionnaires and the researcher's journal suggest that this research has provided the participants with the opportunity to demonstrate their learning of units of measurement in the context of their project.

By deciding on meter as the most appropriate unit to measure all the dimensions of the car parks, it showed that the participants had achieved significant understanding of the different units of measurement as in the example below.

It is pertinent to mention here that although measuring lengths may be considered an easy task in some countries, the participants in this research said they had never seen a measuring tape before this project. Therefore, for them, this experience was one they will never forget. I recorded the amusement of one of the participants' at seeing a 30 meter measuring tape, as, "...wooh..., this is very long. Is all new to me, how come no one shows us this before?"

Despite being new to the idea of measurement, I was pleasantly surprised at the unique speed at which the participants picked up measuring skills with minimal assistance. This shows that if a topic is interesting he or she will make every effort to succeed.

At the beginning of their measuring of the dimensions, an interesting conversation occurred between the students, which I recorded in my journal, about what unit was appropriate for the dimensions. Ayesha (*all the names in this thesis are pseudo names*) said, “we cannot use kilometer because is too long for the park”. Hauwa said “but centimeter will take us a long time to measure”. Abeer said “yes that is true, maybe we can use meter”. They all kept quiet. I then asked them what do you think will be the best out of all the three units that you have mentioned so far and why? Ayesha answered “the best one is the meter because is in between kilometer and meter, but if we want to find the length of something small [like], my book, then we use centimeter”. I then asked, “what about finding the distance from here to say your house? Abeer immediately said “that will be kilometer because it is long”. I asked again, what about finding your own height? She kept quiet, but then Ayesha said “that can be in meter or centimeter because is not too long or too short”. I added, how about the thickness of our hair? Ayesha replied “that is even very very small, it will be a small unit”. “Like what”, I asked? Abeer said “it is millimeter because is the small of them all”.

The “substantive conversation” above shows that this research has given the participants opportunity to question the appropriateness of units of measurement. My sentiment was supported by Abeer’s response on her reflective questionnaire, she wrote, “This project make me to know the difference between when to use cm, m, km. Because we argue during measuring the car park. I understand it very well now”.

Below is the evidence on sketch drawing and calculating area of compound shapes.

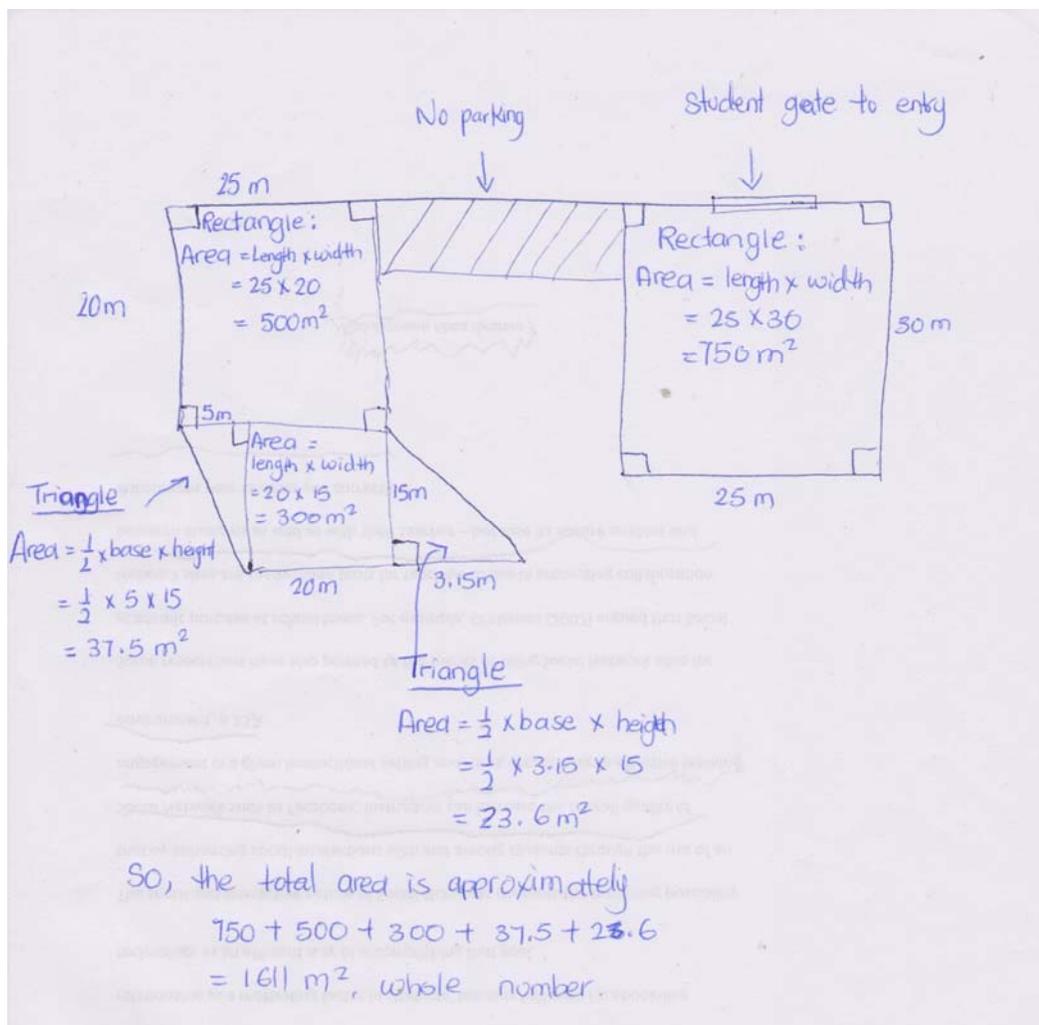
Scale Drawing and Area of Compound Shapes

Data collected from focus group interviews, class presentations, reflective questionnaires and the researcher's journal suggest that this research has provided the participants with the opportunity to demonstrate their learning of sketch drawing (see diagram below) and how to calculate the area of compound shapes.

Sketch of Students' Car park and calculations

All the formulas used in these calculations were decided by the students.

Figure 5.1: Students' Car Parking Area



One interesting thing about the students' work in figure 5.1 was that we don't teach sketching and calculating area of compound shapes at DF level. The fact that participants were able to draw the sketches of the car parks and to

calculate the area of the compound shapes points to 3 possibilities: a family member had explained to them how to do it or they had searched for information on-line on how to do it or they were able to recall how to do it from their school days' mathematics. The latter is highly unlikely as both Dalal and Afra hinted in their responses (see Appendix 1) to one of the questions on the students' reflective questionnaire: "What do you like or not like about the mathematics projects you have completed this semester?" My guess on this was confirmed by Ayesha when she wrote on her reflective questionnaire that, "this project has made us to search for information about area of shapes and drawing that we didn't know before".

I was pleasantly surprised to see these students thinking out of their comfort zones as this does not happen often at the DF. My guess is, because we never provided them with the opportunity to work on problems that were relevant to their lived lives our DF students never saw the reason to go the extra miles.

By drawing the sketches of the student and staff car parks, the participants demonstrated that they had developed very good knowledge of scale drawing. Also, by splitting the students' car park into rectangles and triangles they demonstrated very good understanding of calculating the area of compound shapes. As Muneera wrote in her reflective questionnaire,

I [am] happy now because I know how [to] calculate area of compound shape without the teacher showing me. This is good way to [learn] mathematics, more fun not like before in school. I hope math will be like this for my sister in her school.

Muneera has clearly indicated that she has learnt how to calculate the area of compound shapes and she also expressed satisfaction with the fact that it was not her teacher who taught her how to carry out the calculations.

In Section 5.2.2, below I provide evidence to the assertions made about the resultant students' learning of percentages as a result of the social justice approach adopted.

5.2.2 Percentages

Data collected from group presentations, focus group interviews, reflective questionnaires and researcher's journal suggest that this research has provided the participants with the opportunity to demonstrate their learning of (a) the concept of percentage, (b) how to calculate the percentage of a quantity, and (c) how to work out percentage change, and say whether it is an increase or decrease.

Percentages in Real Life

Exposure to rote learning style during school days meant DF students were not used to understanding or interpreting results of calculation. However, data collected, in particular, from class presentations, focus group interviews and reflective questionnaires, in this research show that the students have indeed overcome their unfortunate experiences and have now developed relational understanding of the concept of percentage. Relational understanding (Skemp, 1976) of percentage was demonstrated by the participants on different occasions as shown below.

During my discussions with the participants, as I walked around to observe progress, I asked them to explain what they understood by the word percentage and why they chose to use percentages to explain their findings. One of the students, Muneera, said,

Percent is something out of 100. It is easier to understand than raw numbers. For example if someone say 20 percentage of the student fail an exam it is easier to understand than if they say 10 students fail out of 50.

Muneera's explanation of the meaning of percentage and the example she provided was a breakthrough for me. I am not sure she would have been able to provide such an eloquent answer without their project.

Similarly, during whole class presentations I asked the class to explain to me what they understood by percentage. Some of the answers were: "is more

meaningful than using number”; and, “people understand it more than just saying 5 out of 15 people pass an exam”.

Zainab, stood up and said “I explain my answer on the board, sir?” I said, “Yes, go ahead Zainab”. Zainab asked the students to put up their hand if they had a car and drove themselves to college. Four students put up their hands. She wrote on the board (a) 4/20, (b) 20%. She then said, “looking at (a) it does not make much sense if I say 4/20 students drive to college. But, if I said 20% drive to college it is more understood”. She added, even in grammar it is easier to use 20% than 4/20.

In all the examples above the participants have demonstrated ability to give examples of percentage in real life which is evidence of relational understanding.

Percentage of a Quantity

Data analysis has also shown that this research has provided the participants with the opportunity to demonstrate their learning of how to calculate the percentage of a given quantity. Many students said that initially they had difficulty understanding this concept but through their projects they have fully understood the meaning and are now competent carrying out computations involving this skill. Below I present instances which support my assertion.

On the Career Aspiration questionnaire (see Appendix 3), participants collected raw data for each response, and calculated the percentage of each quantity as shown in figure 5.2 on the next page. Figure 5.2 Diagram A shows the raw data collected for all the 7 DF sections. Figure 5.2 Diagram B shows how participants calculated the percentage of students who selected each response. On Diagram A, question 1 below: total number of responses was 145; 81 students chose the first option (i.e., I always think about it). Therefore, on Diagram B the participants calculate the percentage of the

response as $\frac{81}{145} \times 100 = 55.8\% = 56\%$

Similar calculations were carried out for all the responses on the questionnaire as shown in Diagram B below.

Figure 5.2: Summary of Data as a Raw Figure and as a Percentage

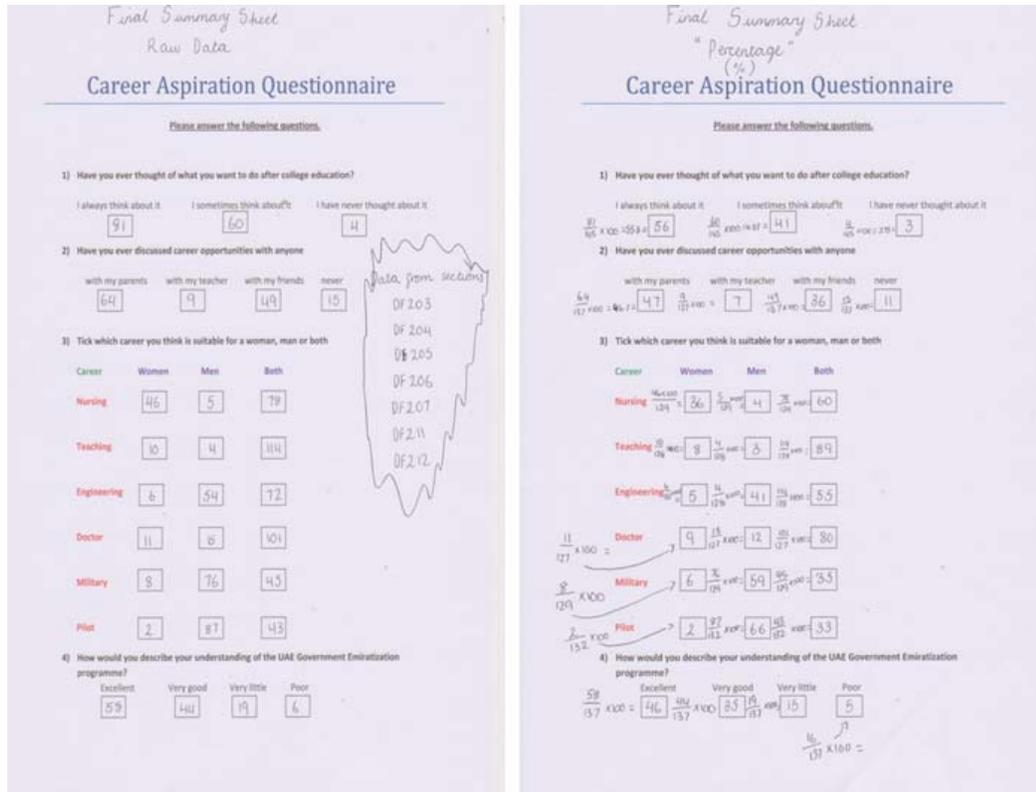


Diagram A

Diagram B

It was interesting to note that the participants, on their own, decided to write all the answers as whole numbers. This was a significant development because usually they would ask the teacher what to do when they encountered this, but here the participants took responsibility for their decision. During group presentation I asked why they rounded their answers to whole numbers. The group leader replied "we did that so is easier to follow because they will all not have decimals. Also, we can see they add to 100%". I then asked; "but in question 2 (Diagram B), the total did not add to 100%?" She replied "is because we round to whole number, too many overestimate values". At this point I asked the group if this could be avoided. They all kept quiet, I then asked the whole class if anyone had any ideas on how this could

be avoided. Ayesha said “I have an idea. We calculate the percentage for the first 3, then round to whole number, add them and minus from 100%”. I started clapping my hands and the whole class joined. I was aware that there might still be some students who did not follow Ayesha’s explanations, therefore, I asked Ayesha to explain what she said in Arabic. English is the only official medium of communicating with our students; however, I took this action because it was important that every student in the class understood what Ayesha said.

As I mentioned before, all the participants were given the raw data (figure 5.2) and the Career Aspiration “Mathematical Enriched Worksheet 2” (see Appendix 4), to attempt prior to group presentations. I noted in my journal, the following difficulties that some participants had initially in calculating the percentage of a given quantity because they lacked relational understanding of the fundamental concepts.

Hafsa

Her initial response on Question 1(see Figure 5.2 Diagram B) was,

$$\text{I always think about it} = \frac{81}{100} \times 145 = 117.45\%$$

When I asked Hafsa if her answer was right she said “I am sure is wrong because is more than 100%, and I have other 2 to calculate”. Hafsa seemed aware that the percentage for all the 3 responses should add up to 100%, but she did not remember or know how to calculate the percentage of a quantity because she never understood the concept relationally during her school days, she simply memorised the rules. Another students who had difficulty with the calculation was Shamsa, I presented her work below.

Shamsa

$$\text{I always think about it} = \frac{145}{81} \times 100 = 179\%$$

When I asked Shamsa to explain her thinking to me she said “ I divided the total by 81 and multiply by 100”. She added “I don’t think my answer is

correct”. Why? I asked. She replied “179 is big number, my number should not pass [more] 100”. Similar to Hafsa, Shamsa was confused on what to do.

Some students made mistakes because they did not read the questions carefully. For example, Ayesha initially wrote all her answers in decimal instead of writing them as percentage.

$$\text{I always think about it} = \frac{81}{145} = 0.56$$

When I asked Ayesha to explain her answer to me she said with confidence “you divide 81 by the total of 145 and that is the answer”. I asked her to tell me the kind of number her answer was. She replied “is a decimal number, 0.56”. I said okay, read the question for me. Ayesha smiled and said “or I made mistake, I did not read the question well”.

Percentage Change

Data collected from group presentations, focus group interviews, my reflective journal and questionnaires suggests that there is evidence students have successfully carried out computations using the concept of percentage change. The analysis also shows that some students had difficulties in finding the percentage change. Their error was, not understanding which value to divide the change value with. The commonest mistake was where students simply divided the change by the bigger value of the two given values, and they did not know when a change was an increase or decrease. Below are some examples of students work.

On the Time of Travel “Mathematical Worksheet 2” (see Appendix 5), the question below required students to demonstrate understanding of percentage change.

From your table, calculate the percentage change between the total number of hours travelled on Sunday and Thursday. Say whether it is an increase or decrease.

Here I present two examples

Nabeela's work

*On Sunday I travel 48 minutes to college and 40 minutes to go home.
Total time is 88 minutes = 1hr 28 minutes.*

*On Thursday I travel 42 minutes to college and 37 minutes home.
Total is 79 minutes.*

Change = 88 – 79 = 9 minutes

Percentage change = $9 \div 88 \times 100 = 10.27\%$, 2 decimal place

It is decrease because the original value is 88 minutes and the final value is 79 minutes.

Nabeela's work demonstrated good understanding of percentage change. However, the next example shows a case of a student who did not know to divide the change value with.

Afra's work

Sunday time is 1 hour 10 minutes to go college and my house

Thursday I travel for 1 hour 25 minutes.

Change = 85 – 70 = 15 minutes

Percentage change = $15 \div 85 \times 100 = 17.7\%$

Percentage is increase because 17.7 is bigger than the change 15.

Afra was one of the students that I asked to explain their answers to me. She said, "I divided the change by 85 because it is the bigger value and multiple by 100 to get my answer". I then asked her why she decided the answer was a percentage increase not decrease. She replied, "because my answer 17.7 is bigger than the change 15".

Clearly, Afra was procedural in her dealing rather than conceptual, this shows lack of understanding of the concept of percentage change, and increase and decrease. After groups collaborations, I was delighted when Afra came back to me and said "I understand how to do it now, I talk in my group about it and is easy". I asked her to explain how to work out the problem and this time she was perfect. However, it was not possible to ascertain if Afra understood the concept or she simply repeated the process to me because knowing the nature of my students if I had asked her more questions she may misinterpret

my intention as mistrust. My reasoning may not sound convincing, but given the context of the students it is highly likely to be the case.

In Section 5.2.3, below I provide evidence to the assertions made about the resultant students' learning of Graphs due to the social justice approach adopted.

5.2.3 Understanding Graphs

Data collected from class presentations and collaboration shows that the participants have achieved good understanding of how to compare and contrast Bar graphs. It also reveals that the participants have acquired the analytical skills required to understand the hidden messages in graphs, especially Bar Graphs. The analysis also revealed that some students are easily confused when interpreting graphs.

Below are some justifications for my assertion above.

On the Analysing Graph "Mathematical Enriched Worksheet", the question was,

Use mathematics as a tool to analyse these two graphs.

Figure 5.3 and Figure 5.4) below (see Mathematical Enriched Worksheet 3 (Appendix 6)), were published by the Higher Colleges of Technology (HCT), as part of its, Focus of the Week, publications.

Figure 5.3: Graduates by Gender

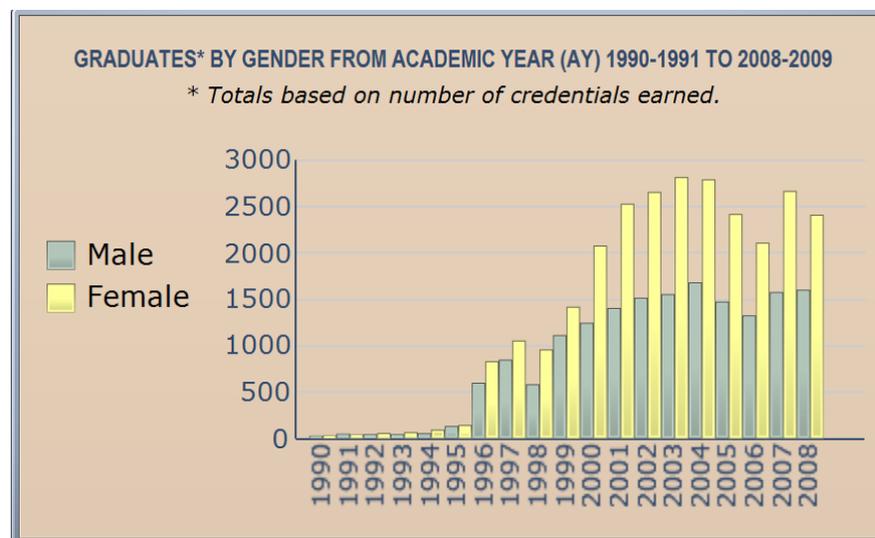
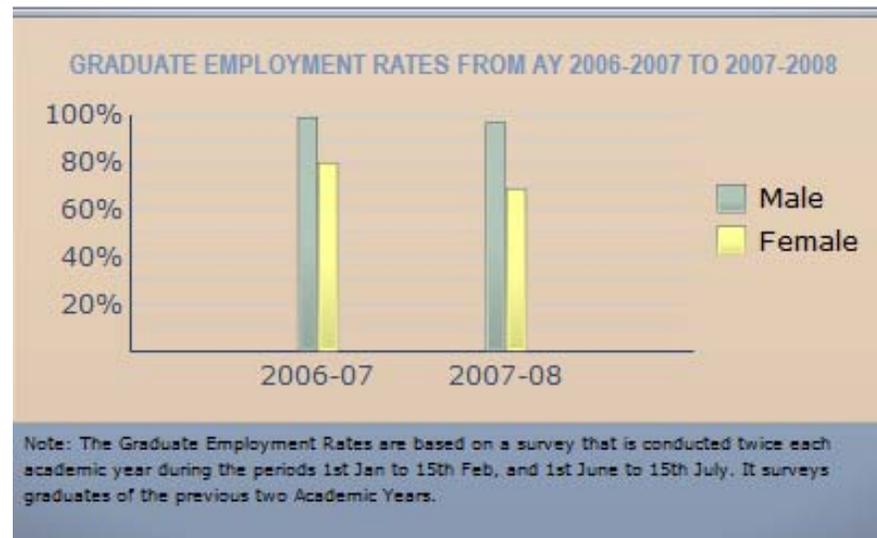


Figure 5. 4: Graduate Employment Rates



This was an open ended question, an ultimate test of the participants' understanding of graph reading. Here, participants were required to utilise their understanding of mathematical concepts to read and interpret the two graphs. The choice to present Ayesha's and Zainab's work was deliberate. Ayesha was a fairly confident student and the team leader for the Car Parking project group, while Zainab was a very shy student who hardly spoke to me.

Ayesha's work

Detailed calculations carried out by Ayesha are presented in Appendix 7. Ayesha started her analysis of the graph by setting out the steps she would follow in solving the given task. She then demonstrated very good understanding of both concepts of percentage of quantity and percentage change by carrying out calculations and interpreting her results. For percentage change she warned that if the trend in the data used for the 2 graphs were to continue, there would come a time when there would be very few female graduates as compared to males. She also believed that more data would be required in order to reach a reasonable conclusion – this was indeed a significant point. She wrote,

The two calculations show me that the number of male graduates is increasing at 4.67% rate, but the women's is decreasing at 13.08% rate. If this continue like this then more men will graduate than women and we reach time when very small women will go college. (Ayesha, Graph, May 27th, 2007).

Ayesha also calculated the percentage of graduates employed based on the information from the 2 graphs, and used her answers to calculate change, between men and women for each year, and interpreted her results by saying the employment gap was decreasing. By doing this she showed significant power to use mathematics to analyse gender equity in employment: "Now I can see the gap is reducing between man and women. This is good to achieve equality in the society. I am happy to see the gap getting smaller and one day it will be zero" (May, 27th).

Ayesha argued in her report that if women graduates gained employment with ease, this would encourage other women to pursue higher education, hence giving them more power to decide their future.

She also believed that the graphs are outdated and don't represent the current status of the UAE labor force. She argued that if the same survey was done in 2010, the result would be different: the numbers of male and female might be the same or show even more women. In other words, Ayesha is reading the graph critically. Many meaningless graphs used in mathematics do not allow this. Similar to Ayesha's work on the two graphs, Zainab's work is presented below.

Zainab's work

Detailed calculations carried out by Zainab are presented in Appendix 8. Zainab started her analysis smartly by stating that since figure 5.4 had only data for 2007 and 2008, in order to achieve best comparisons possible, she would only analyse figure 5.3 for 2007 and 2008. This is a clear indication that Zainab has, indeed, acquired critical thinking skills from her study of mathematics in my class.

She calculated percentage changes, for both male and female, for 2007 and 2008 from graph 2. This was followed by calculations of the number of males and females employed, using figure 5.3 and figure 5.4. With her answers in place she concluded that a higher number of women were employed than men, in both 2007 and 2008, and warned that by looking at figure 5.4 one might think more men are employed. She wrote, “more women are employed than men in 2007. But looking at the graph somebody think more men have [were] employ” (Zainab, graph analysis).

Zainab was skeptical and thought figure 5.4 was wrongly calculated and drawn.. Therefore, she decided to carry out her own calculations of what she believed were the correct percentages. From her results, she drew a new bar graph and warned people not to accept graphs without checking. She wrote,

We have to be careful with other people graph..., graph (2) [figure 5.4] has mistake[s]. I know this because I calculate[d] myself. This is why math is good, it give power to you to agree or no, not just [to] accept graph from other people. I don't accept this graph and I [have] prove[d] my point with math.

This was an educative moment – a breakthrough moment. Zainab was mistaken in her work; figure 5.4 is a part of figure 5.3. However, she demonstrated her critical mind and went as far as to attempt to prove her point using mathematics. In the process, she has learned more about percentage change, increase and decrease and interpretation of results. I had a chat with Zainab during which I explained to her where she had made mistakes and it seemed to me Zainab had realised the mistakes. I have observed, during the course of this research, that Zainab has become increasingly argumentative (in a good way) about simply accepting other people's views.

However, she was very accepting of, and grateful for, the explanation which I gave her. We had very useful discussions about the 2 graphs and we were joined by the other students, too. This is what teaching for social justice is all about; giving the learners a voice to speak their mind. Zainab has clearly

come a long way and now she is not afraid to speak out and defend her point of view using mathematics.

In the examples above, both Ayesha and Zainab successfully analysed their graphs. Their work is only one example of the many graph works completed by my students.

In Section 5.1.4, below I provide added evidence to the assertions made about the resultant students' learning of Time Calculations due to the social justice approach adopted.

5.2.4 Time Calculations

Analysis of data collected from group presentations, focus group interviews and reflective questionnaires and my journal in this research suggests that there is some evidence that the participants have developed understanding of how to (a) convert time from one unit to another, for example, hours to minutes, (b) add and subtract time and read time. The data also indicates interference from the students' prior knowledge in their ability to make sense of adding and subtracting times - previous misconceived ideas of addition and subtraction was hindering their understanding here. In addition, the result of the data analysis supports Richard Winter's (as cited in Frankenstein, 2006, p. 28) dictum that the problems so many encounter in understanding mathematics are not due to the discipline's "difficulty abstractions," but due to the cultural form in which mathematics is presented.

Diploma Foundation students find the concepts associated with time calculations challenging, for example: changing hours to minutes; hours to seconds; minutes to seconds, etc. An example of a question which required participants to demonstrate understanding of Time calculations is below, from the "Mathematical Enriched Worksheet" on Time of Travel.

From your table, calculate the percentage change between the total number of hours travelled on Sunday and Thursday. Say whether it is an increase or decrease.

To answer this question successfully, participants had to add and subtract times and, change minutes to hours, etc. Most of the participants were able

to add and subtract time but many more found converting minutes to hours challenging. For example, Nouf worked out the difference between 3:40 pm and 4:10 pm as 1:30. Clearly she simply subtracted 3 from 4 to get 1 and did the same for 10 and 40 to arrive at 30. Nouf lacks the understanding of how to subtract time and how to convert minutes to hours. Clearly, she did not think of the time as in real life but simply as a taught algorithm. What also became clearer with these skills (of adding and subtracting times) was the interference by their prior knowledge. For example, in one instance I asked the whole class to tell me what the answer should be for the following expression: $3.8 - 1.9$. Many of them said the answer is 2.1. Again they subtracted 8 from 9 to get 1 and 1 from 3 to get 2. It became obvious to me that their previous misconceived idea of addition and subtraction was hindering their understanding here. I knew I had to do something about it, therefore, I addressed this challenge by revising with the whole class the concepts of addition and subtraction of decimal numbers. I was pleasantly surprised they picked it up with very little difficulty. I then proceeded by providing them with examples of how to subtract time: for example, 09:15 – 07:35. I started by asking them the question: If you don't have enough money to buy, say a car, who is the closest person to you that you would ask for money? They all said they would ask their families. I then said okay. If you need 35 minutes and you only have 15 minutes will go to your family for help? They all said yes. Then I said okay, this is exactly what is happening here. Your family who had 9 hours will help you with 1 hour which is same as 60 minutes. You then add it to the 15 minutes you had before to make it 75 minutes, now you can use 35 minutes and still have 40 minutes left. Similarly, for the hours your family now has 8 hours left and they can use 7 hours and still have 1 hour left. Therefore, $9:15 - 7:35 = 1:40$ which is 1 hour 40 minutes. This was how I got the participants on track with the addition of time. The method used in resolving the misconception the students had with regards to subtraction of numbers (in this case time) is contrary to the paradigm of teaching proposed in this research and might even be strange to some educators. Nevertheless, it is one that was very effective in this circumstance, and was based on the participant fund of knowledge (Molls et al., 2004). I deliberately used the family scenario to explain the concepts

because family is greatly valued here in the UAE and my experience of teaching here shows whenever I mentioned family or use family to explain a mathematics concept all my students pay attention and they understand the concept with ease (Leonard et al., 2010).

In Section 5.1.5, below I provided evidence to the assertions made about the resultant students' learning mathematics due to the social justice approach adopted.

5.2.5 Problem Solving

Data collected from group presentations and the researcher's journal suggests that the participants' abilities to problem solve have significantly improved as a result of their projects.

One of the indicators of a good problem solver is their ability to come up with a plan right from the outset, their ability to think critically, and also their ability to communicate their mathematical ideas effectively, verbally or in writing or both. The data collected from class presentations and group interviews in this research shows that, for all the activities carried out in my research, participants had (a) a good plan on how to complete the activities, (b) they brainstormed on ideas, and (c) they communicated their idea verbally or in writing or both. The analysis also showed that problem-solving skills are not easily achieved; it requires patience and perseverance by the learner.

Usually, problem-solving in mathematics would be an uncharted territory for our DF students, because they were only used to rote learning during their school days. For each of the projects in this research, right from the outset, participants' brainstormed to reach a concrete plan of how to investigate their topics, and consequently executed their plans effectively and presented their result to me in writing and to the whole class during group presentations. They also thought critically in many instances during collaborations, in class. For example, in the Car Parking project, after calculating the area of all the car parks, participants decided it was reasonable to use the area of an average (not a small or large car because most students would drive a small to average car) to calculate the total

number of cars that could park at the parking areas, at any given time. By deciding to use the area of an average car, the group demonstrated critical thinking skills. However, there was one major error in their calculations. They forgot to take into consideration the gap that should exist between parked cars (both between cars, to allow for occupants to open the doors to enter and exit, as well as the necessary road space for cars to enter and exit between rows). But, this error in calculation was consistent throughout, hence, in my opinion, this setback, though significant, does not adversely affect the interpretation they provided for their result. More importantly their involvement in the project gave them a chance to develop their understanding meaningfully.

Good problem-solving skills were demonstrated by the participants in their response to the following questions, on the Time of Travel “Mathematical Enriched Worksheet”:

Find out how many students come from outside Abu Dhabi in your class.

Write down your answer here. _____

For this academic year (2008-2009), there are approximately 2500 students registered at ADWC. Based on your answer above, calculate the percentage of students you would expect to come from Abu Dhabi City.

To arrive at the correct answer participants had to work out the fraction of students from Abu Dhabi in their class, then multiply by 2500 to get the number of students in the whole school who came from Abu Dhabi, and then divide the answer by 2500 and multiply by 100 to get it as a percentage. The question involved multiple skills and steps: hence, it was not like the direct questions that our students were used to in their Modular workbooks. Consequently, it was challenging for some students. For example, there were 20 students in Sumaya’s class. She did not read the question with care, as you will see below. Sumaya wrote:

Number of students from outside Abu Dhabi = 11

Number of students from Abu Dhabi at ADWC = $(11 \div 20) \times 2500 = 1375$ students

So, percentage = $(1375 \div 2500) \times 100 = 55\%$

Sumaya's answer was wrong because the number of students from Abu Dhabi is given by the expression $(20 - 11) = 9$. Even though, Sumaya's work shows she has a good understanding of percentages but she failed to read the question carefully. If she was asked to write the number of students in her class who were from Abu Dhabi and then followed up the above question she would surely have arrived at the required answer. However, the framing of the question versus the information provided led her into making the error of using the "outside Abu Dhabi" statistic as a directly substituted input to calculate the numbers from Abu Dhabi City. The question required her to think in a critical way and she failed this time around. The failure to solve this challenging question was exhibited by most participants in this research. Only 2 students used the corrected (complementary) information to arrive at the required answer. One possible explanation here is that this problem may have been because the questions on the "Mathematical Enriched Worksheet" were not generated by the students, thus a misreading has occurred.

Other students, for example, Haleema did get the answer right. Below I present her solution to the same question.

Students from outside Abu Dhabi in my class = 11

So, students from Abu Dhabi in college = $[(20-11) \div 20] \times 2500 = 1125$ students

So, percentage = $(1125 \div 2500) \times 100 = 45\%$ of student are from Abu Dhabi. From here we see more students are from outside Abu Dhabi because $100 - 45 = 55\%$.

Haleema went beyond what the questions asked by interpreting her result – saying, we see that more students come from outside Abu Dhabi.

Another example where participants demonstrated good ability to solve problems is given below. On the Time of Travel "Mathematical Enriched Worksheet", one of the questions was:

Express the total number of hours spent on the bus on Monday as a percentage of the total number of hours spent for the whole week.

Below is Naema's work on this question:

Total number of hours and minutes on Monday = 2hr: 15min = 2.25hr

Total hours and minutes for whole week = 10hr: 52 min = 10.87 hr

Number of hour on bus = $(2.25 \div 10.87) \times 100 = 20.70\%$

This show me that I stay on the bus for many hour. For example, every 5 hour in my day I spend 1 hour on bus. This very big time on the bus

Here, Naema successfully changed minutes into fractions of hours. She also interpreted her answer in terms of the number of hours she would have spent in a day. Naema has clearly demonstrated good problem-solving abilities by dividing 2.25 by 10.87 and multiplying her answer by 100, and interpreting her answer in real life.

Students are always likely to believe that an answer based in mathematics is correct. In this research, participants also demonstrated a sense of agency in their awareness of the limits of mathematics. For example, the following question appeared on the Time of Travel "Mathematical Enriched Worksheet",

10. A journey on a bus from Abu Dhabi to Dubai will normally last for two hours, and every passenger pays Dh15, for this journey. Use this information to calculate how much it would have cost you to travel to college using public bus.
11. From your answer in question (10), do you think those of you who travels by bus to college are getting a good deal? Explain your answer fully.

Here I present an example of a participant's response.

Shaikha's work

Time	Dh
120 minutes	Dh15
533	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.

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 - that is why interpretation based on the individual's needs is so important. Shaikha has clearly interpreted her result beyond mathematics.

In Section 5.1.6, below I provide evidence to the assertions made about the resultant students' learning of Meaningful Rounding due to the social justice approach adopted.

5.2.6 Meaningful Rounding

Meaningful rounding is a rounding system that does not only depend on mathematics but also on the context of the problem to be solved. For example, if we were given a population of people (as 300) who needed to be transported on a bus from one point to another and were also given the capacity of a bus (as 19), and asked to work out the number of buses

required the answer will be rounded up ($300/19 = 15.79$) 16 busses. However, if we are told that an apple cost 30 cent and asked how many apples can be bought with \$3:50, the answer will be rounded down to ($350/30 = 11.66$) 11 apples.

As we can see from the example above, understanding when to round up and when to round down requires relational understanding of approximation, and the best way to achieve such understanding would be to base the learning on the real life experiences of the learner.

The data collected from class presentations and focus group interviews indicates that participants in this research have achieved good understanding of meaningful rounding. First, they utilised such knowledge in deciding on the number of cars that can park in each car park. Second, participants used the concept of meaningful rounding to reach their conclusion that the ratio of: Teacher to Parking area is 1:2, that is, each teacher has got two parking spaces; while , Students to Parking area was 2:1. Below is their reasoning.

During my discussions with the Car Parking group, dated 10th May 2009, they explained to me the way they arrived at the ratio of car parking area to number of students as 1:2. Ayesha said, “the ratio of 214 to 300, is the ratio 1:2”. I asked why and she replied, “It is actually 1:1.4 but we rounded up to make sure there will be no student without space to park her car.” Similarly, during our focus group interviews, dated 11th May 2009, the group explained to me how they calculated the number of car parking spaces available. They divided the total parking area by the area of an average car. Their answer was not a whole number, so they decided to round down the answer. Ayesha said, “so..., it means for the students car park we have approximately $1611 \div 7.52 = 214$ ”. I asked them why they did not round up this time around, and Ayesha said, “Because rounding up will lead to more cars than there is space for. Is better to have free space than have car with no where to park”. I then asked if the answer was, say 214.72, would they still round down? She said, “Yes”.

The two examples above demonstrate significant understanding of meaningful rounding by the participants.

One of the indicators that participants have achieved good understanding of those concepts was demonstrated in their summative assessment on those topics. They all passed their end of module tests (on percentages, graphs and time calculations) as well as the end of year Key Common Assessment (KCA) examination. In other words, they had succeeded in an academic sense.

5.2.7 Test and Examination Results

While the majority of the evidence in this research is qualitative, in this section I will consider the quantitative evidence as an additional support.

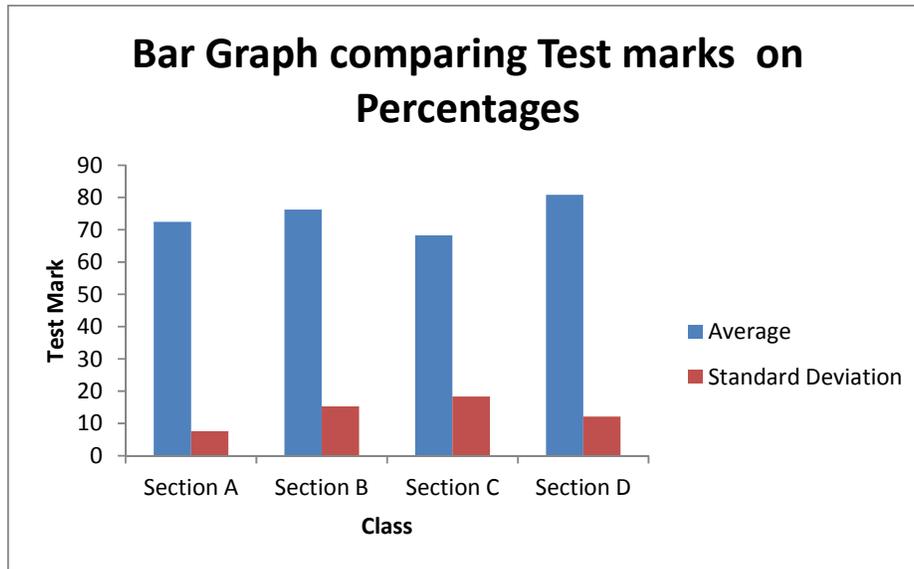
Data collected from students' end of units test results and end of year Key Common Assessment (KCA) strongly suggest that there was no decline in achievement of the participants through this research. In addition, data collected from class presentations, group interviews and researcher's journal suggest that the participants have developed significant relational understanding of the 3 topics investigated. Their results were more consistent in all 3 end of unit tests compared to the 3 other cohort groups. As stated earlier, this was not a major component in the design of this study, however I needed to be aware of any possible decline in achievement of these students at the Trial Examination (set by ADWC) and in the final Assessment (set by the HCT Central Services) that they undertake in the subject.

Below I provide evidence to the assertions made about the resultant achievement by the participants in their end of units test.

Table 3: Summary of Test Results (Sections A, B and C were taught by me but only Section A were exposed to teaching for Social Justice)

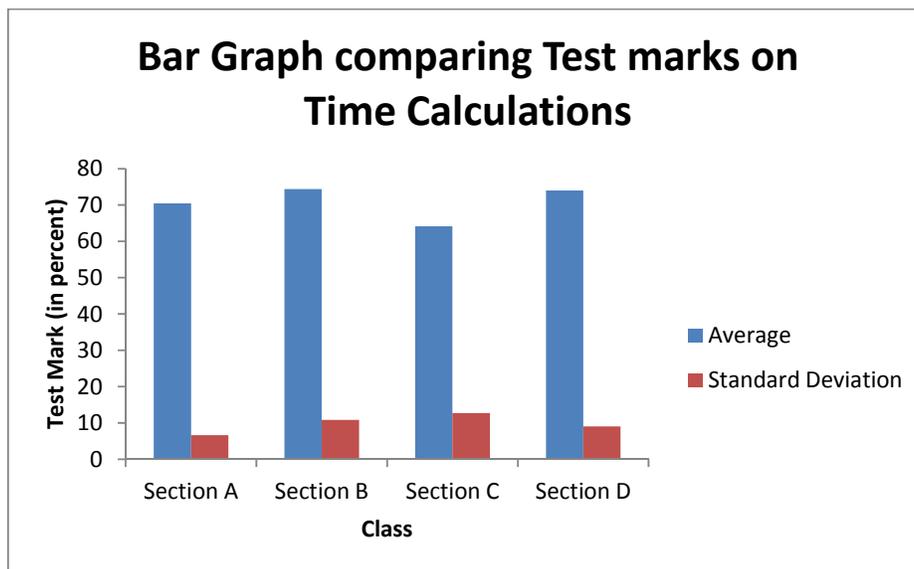
SUMMARY OF RESULTS												
	PERCENTAGE				TIME CALCULATIONS				GRAPHS			
	A	B	C	D	A	B	C	D	A	B	C	D
Section												
Student Number	20	19	20	18	20	19	20	18	20	19	20	18
Mean	72	76	68	81	70	74	64	74	78	69	62	71
STDEV	8	15	18	12	7	11	13	9	10	12	18	12

Figure 5.5: Bar Graph Comparing the Test Marks on Percentages



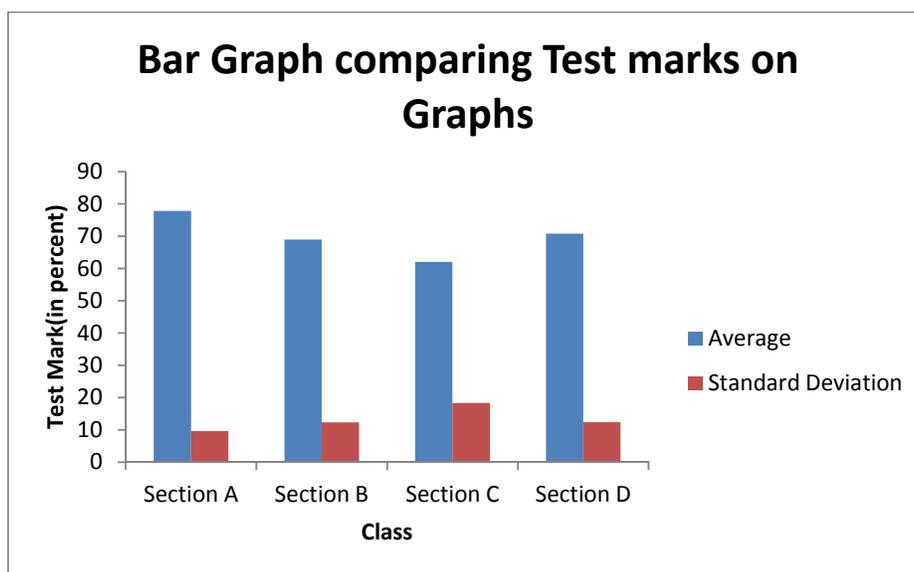
For the end of unit test on percentages, all the students in Section A and Section D passed the test. One and 6 students failed the test from Section B and Section C respectively. This represents approximately 10% grade F and 90% pass rate. Although the class average for Section A was not the best, its standard deviation is lower, which means the participants test marks were more consistent. It is pertinent to mention here that most of the test questions on this test were recall in nature (procedural and the use of formulas) with very few apply questions.

Figure 5.6: Bar Graph Comparing the Test Marks on Time Calculations



For the test on time calculations, all the students from Section A and Section B passed the test, with 3 and one students failing from Section C and Section D respectively. This represents approximately 6% fail and 94% pass rate. In this test, Section A had the lowest standard deviation – which means for the second time their marks were more consistent. Similar to the test on percentages, most of the questions on this test were recall in nature with very few apply questions.

Figure 5.7: Bar Graph Comparing the Test Marks on Graph



For this test, all the students in Section A passed. There were 3, 6 and one failures from Section B, Section C and Section D respectively. This represents approximately 15% F grade and 85% pass rate. Unlike the tests on percentages and time calculations, the test questions on graphs were mostly apply questions requiring students to demonstrate an understanding of reading graphs. It was interesting to note that this test recorded the highest failure rate, perhaps because it required students to demonstrate understanding as against recall of procedure. It was equally interesting that Section A had both the best class average and standard deviation in this test. This shows that there is no decline in developing mathematical expectations in traditional sense and also it shows uniformity in results. Less variation means gaps in understanding between top and bottom students are less pronounced.

In addition to passing the entire test on the topics of this investigation, the participants also passed their end of year Key Common Assessment (KCA) examination. In other words, they have succeeded in an academic sense.

Recognition from others supports the arguments presented here. For example, following the participants successes on the 3rd test, I recorded in my journal the comment written by the Head of DF studies, in my end of year appraisal, as follows;

[Mr. Tanko's] doctoral work is very practical and one area, that of social justice pedagogy (in which he will offer a PD [professional development] session soon) has been piloted with some of his Sections, *with excellent results*, in terms of *student focus, interest and achievement*. We have decided that our integrated projects in foundations will benefit from including a significant element of this type of work, and will be exploring this in the near future. (2008/09 appraisal report, italicised for emphasis).

In addition, in the same year (2008/09), amongst all the HCT Colleges, ADWC achieved the best mathematics result in the end of year KCA examination. Was this just coincidental? In my opinion the answer is, "No!" Our College's Acting Director, Dr. Abubakar, in his letter to my Supervisor Mrs. Mateen, dated Sunday, 30th August 2009, wrote,

I would like to congratulate you both on the excellent Foundation results shown.... They reflect extremely well on your Departments and on the College. Please pass on our congratulations to your teachers. Now you just have to do even better this year! Again, well done!

This letter was strong evidence that my students have not only had a positive change of interest towards mathematics, but that they were recognised to have "*succeeded in the traditional mathematical sense*".

In Section 5.2.7, below I provide a summary of the findings on the resultant students' learning of mathematics due to the social justice approach adopted.

5.2.8 Summary

Participants in this research were initially haunted by the rote learning experience they went through during their secondary school education. They could not recall basic concepts associated with mathematics. As a result they saw themselves as not capable of doing mathematics, and had developed negative self-belief about the subject and even hatred towards mathematics. In addition to the rote learning style they were exposed to during their school days, lack of real life connections of mathematics to their lived lives was also another principal reason for their lack of interest in mathematics. However, as the participants got exposed to the teaching for Social Justice Pedagogy, they overcame their past negative self-belief about mathematics and regained their confidence in solving problems involving geometry; percentages, graphs and time calculations. Consequently, they have now developed significant relational understanding of: different units of measurements; sketch drawing and calculating area of compound shapes; percentage, percentage of a quantity; percentage change; time and its different units. In addition, they have also developed significant abilities in reading graphs, meaningful rounding and problem-solving.

The participants in this research have also “succeeded in the academic sense” by passing all their end of Modular assessments and the end of year Key Common Assessment (KCA) examination.

5.3 Resultant Students’ Engagement due to the Adoption of a Social Justice Approach to Teaching

Data collected and analysed, from focus group interviews, reflective questionnaires, the researcher’s journal and class presentations, strongly suggest high levels of engagement throughout the project period. Evidence of such engagement was demonstrated by the participants in the way they enjoyed their projects, and the consequent increase in the profile of mathematics amongst DF students. Data analysis also shows the reasons for such engagement by the participants to include: real life connections with

their projects; using a democratic process in choosing the project and participants' expectations of the outcome of their project.

In the sections below I present evidence with regards to the assertion made above about students' engagement as a result of the adoption of Social Justice Pedagogy. Section 5.3.1 deals with students' Enjoying their Projects. Section 5.3.2 deals with the Profile of Mathematics in the College. Section 5.3.3 deals with the Reasons for Engagement.

In Section 5.3.1 below I provide supporting data to back up my assertions about the participants' engagement because they enjoyed the projects.

5.3.1 Enjoying the Projects

Data analysis shows instances during which participants have directly, or indirectly, expressed their sense of joy at the tasks in which they were engaged. It also suggests that the participants enjoyed their study of mathematics. For example, on the day students working on the Car Parking project went out to the field for measurements, other students were looking at them and wondering what they were doing outside on such a hot day (a temperature of about 45 degrees Celsius). They continued with the task in hand, with big smiles on their faces and speaking in Arabic as we walked passed other students. I could see the positive expressions on their faces. None of them complained about the heat or asked to be excused because it was too hot; they were clearly having fun.

Another attribute which is normally demonstrated when learners are enjoying what they are engaged in is that they are very conscious about being late to class. It is not uncommon for students who don't enjoy mathematics to skip the lesson by staying in the canteen with friends. Throughout the project none of the participants were late or absent from any classes. During my interview with them on 11th May 2009, one of the participants said, " is kind of fun because we learn new thing by math and the project is very interesting and fun, not the boring stuff that we used to do...." Another one said "I did not know math can be enjoyable like this, all my fear is not there anymore". They reiterated this view also during their presentation to the college Director by

saying, "...we can spread the word [findings] to the students so that they can use math as a fun, not like [raw] numbers [without meaning]".

Participants affirmed enjoying mathematics and their projects during interviews. For instance, during our Time of Travel project interview, a member from the first group, Noura said, "We learn math in better fun way not like before. This makes us like the subject of math more. Before we fail the subject but is okay now. We need more project like this one".

A member from the second group, Yasmeen said,

Mathematics is fun when it is teach [taught] using something that has meaning like in this project. We want to do more project like this one. We don't feel is [we are in] math class because everybody is so happy doing the work.

The group who worked on the Car Parking project wrote in their report, "We have understood the topic of percentage in a relaxed way. Doing mathematics without the fair [fear] of the subject like before. This is good way to learn mathematics". The group working on the Career Aspiration project wrote, "We are happy to be part of looking for solution to our problem. This is good way to teach mathematics, we understand it more now than before We like math like this one".

From all the groups' quotes above it is evident that the students have enjoyed their projects. Additionally, participants' responses on reflective questionnaires suggest this was clearly not the case with their previous projects. For example, Zainab wrote "I don't like project work, too noisy. This project is good because girls did not disturb other students. Maybe because all girls know what their project want [is about] and are busy with the work [trying] to complete on time".

Participants' positive attitudes to their learning in the second semester of the academic year were another indicator that they enjoyed their projects and mathematics in my class. Semester 2 at ADWC is a very long one with very few breaks and usually towards the end of the semester many students are

tired, and consequently, they start to resist learning as much as possible. But I can report here that the students in these projects never showed any such reluctance throughout the semester. Instead their hunger for learning grew and grew. For example, throughout the 3 projects, not a single student ever asked why they were doing what they were doing. They simply came into class, enthusiastically, day in day out with hunger for more knowledge on their faces. Those reluctant learners amongst my students who would go to the “rest room” in the past and spend a considerable amount of time there before returning to class, never asked me to be excused to go to the “rest room”. Everyone was enjoying what they were working on because it made sense in their world. I have never seen anything like it in my years of teaching at ADWC and elsewhere.

Data analysed also reveals that as a consequence of enjoying and hence engaging with their projects, the participants’ confidence has increased significantly. English being a second language for the participants in this research implies they were likely to face some challenges in expressing themselves verbally and in writing. Also, as I mentioned previously, the participants in this research had long time exposure to rote learning during school days. As a result, they might struggle within a methodology in which they are responsible for their learning.

The data analysed shows that although there were instances where participants felt frustrated in this area they generally persevered working on their projects enthusiastically and as a result their confidence improved significantly. For example, during group presentations every group member had to play a role by presenting some part of the work to the class. I noted in my journal that Warda, who was a very quiet and shy member of the Car Parking group, was the one who presented on how to calculate the area of a triangle. Although she struggled to articulate her explanation of why the formula is $\frac{1}{2}(base \times height)$, she persevered with a smile on her face and eventually the message got through. After the presentation Warda came to me and said “I [am] happy I try to explain without fear. I told the students what I know about area of triangle”. Here, Warda has expressed her

satisfaction for engaging her fellow students about the area of triangles. The fact that she had some difficulty in expressing herself fluently was never mentioned because she saw that as part of the learning process.

Similarly, data analysed suggests that initially, there were instances in which participants were still relying on me for directions on what to do. However, as I provided them with the necessary scaffolding without interfering too much with their decision making, the participants gained confidence and took control of their learning. My claim was supported by Zainab as indicated on her reflective questionnaire when she wrote,

From the beginning I find this way [of learning] difficult, because we have to think everything by yourself. But, I try my best to think and also Goma help us sometimes. Then I become confidence. Now I like this way of learning math.

In the above quote, Zainab illuminates us on the initially difficulty she faced with the new pedagogy, however, as she persisted by engaging with their project her effort paid dividends and now she sees herself as someone with significant confidence at mathematics. Nouf added to Zainab's dictum by writing on her reflective questionnaire that,

It was difficult to think by ourself in the start of this project. Now we have gained confidence, we have [also gained] experience and can solve problem on our own. Good to be able to think yourself without teacher telling you [what to do].

In the entire examples above, the participants' persistence to successfully complete their projects have resulted in significant confidence in their mathematics and hence engagement.

It is routine in all HCT colleges for students to evaluate every one of their teachers at the end of every semester. My evaluation report from DF203 had everything that any teacher would be proud of: praise; gratitude; prayer; and expressions of hope. I was particularly interested in their comments about our projects. A few of the comments are presented here:

Zainab wrote, “thank you Goma for making me like math with project”; Ayesha wrote, “Your class was interesting in learning math more than my school day”; Halima wrote, “so math is like this, I don’t [didn’t] know [this] before. Now I like [to study] more math”. Nouf wrote, “may you get what you want [wish for now] in your future”.

In all the quotes students made it clear how useful their project had been in helping them to overcome their fear of mathematics. It is also obvious that they did enjoy working on their projects. Similar to their engagement as a consequence of their enjoying the projects, participants’ engagements were also demonstrated by the increased profile of mathematics in the college.

In Section 5.3.2 below I provide supporting data to back up my assertions about the increased profile of mathematics amongst DF students in ADWC.

5.3.2 Increased Profile of Mathematics in the College

Analysis of data from focus group interviews, students’ reflective questionnaires and the researcher’s journal suggests that the students’ surge around the mathematics stand during the Ajiyaluana celebration and my invitation to take part in the National Day Identification Parade Competition at ADWC were as a result of the popular interest my students’ projects had generated amongst DF students in the college.

Ajiyaluana Day

Ajiyaluana Day at ADWC is a day of celebrating students’ excellence. Certificates of merit are presented to students who have made significant contributions academically or socially in the college community. On this day, each Department is expected to display students’ work and staff a table with activities.

As the Maths Club coordinator, I was asked to staff a table in which I displayed the club activities (mathematics games). Student volunteers were mainly Diploma Foundation (DF) students from Section A. My students’ table was the busiest of all the tables in the Hall. What was even more interesting is most of the students who visited the Mathematics Table were from DF. For

the first time we had the Mathematics area overshadowing the rest of the Departments. This was clearly an indication of DF students' positive change in interest towards mathematics.

In the year before my projects, and consequently my taking charge of the Remediation Program, the Mathematics Department was always overshadowed by the other departments during Ajiyaluana days; we struggled to get students to even come to have a look at the Mathematics Table due to their fear of, and negative past experiences with the subject.

National Day Identification Parade

The National Day Identification Parade Competition is a competition whereby some teachers are asked to dress as local Emiratis and they are paraded in front of the students, and the students had to identify them.

The degree of positive change in orientation demonstrated by my students towards mathematics as a result of their projects made me very popular with many DF students at ADWC. Such popularity led to my Supervisor inviting me to take part in the National Day Identification Parade Competition.

My participation in the parade has further raised the profile of mathematics amongst DF students at ADWC – I noted an increase in the number of students visiting our Mathematics Club and our Department saw a rise in the number of students attending remediation sessions. The “Remedial Programme” is a drop-in session whereby students who need help with mathematics are encouraged to attend, and those who were identified (by their teachers) as at risk of failing mathematics are contracted to attend. It was a struggle to get students to attend because of their lack of interest in mathematics. The increase in the number of DF students visiting the club could as well be coincidental not necessarily due to my participation in the parade. Nevertheless, I recorded in my journal a remark made by Ayesha who regularly went to the club room with her teammate to work on their project work. Ayesha said “Goma this room is not enough; we need a big class because too many students now come here”. Ayesha was referring to the overcrowding at the club as a result of students who attend their

remediation lesson there. I believe the attendance soared because students heard about my class projects from my students, and since I was now in charge of the remediation sessions they believed that the extra classes would be useful for them. Most of the students visiting the club were from Diploma Foundation (DF) department – their visit provided them with the opportunity to engage in their study of mathematics.

In UAE there are strong families ties, most of our students are related in one way or another. Therefore, I believe many of these students would continue to spread the news about how mathematics is connected to our everyday life and how “cool” it can be to study mathematics - important elements that were indeed missing in their educational journeys until this project.

In Sections 5.3.3 below I discuss some of the participants’ reasons for their engagement.

5.3.3 Reasons for Engagement

Data analysed strongly suggests the following 3 reasons for the participants engagement.

Real Life Connection to the World

Data collected suggests that the high level of engagement demonstrated by the participants was because their projects were connected to their lives. A key to engaging students is to make their learning relevant to their worlds.

For example, during a focus group interview with the Career Aspiration group, I asked the group to tell me what they liked or did not like about this method of teaching. Muneera said, “it is interesting”. I asked her, to explain what she meant by “it is interesting”. She added,

Because, if you bring (like) real issue you are making us involved in our society not just books, you will be more interested in finding the answer. You want to find the answer, like; I want to find the percentage because I want to understand the case more, because is from my side

from my country or from the same girls as me. I think it will help definitely it will help [to teach mathematics this way].

Muneera's quote show students are most likely to engage when the topic of investigation is relevant to their worlds because they would be more excited and eager to find the possible solutions.

Below are 3 more examples of what the participants said with regard to their mathematics projects and its connections to their world:

Example 1:

I like all the three projects. But I choose to do only the Career Aspiration one because I work in office in the afternoon after college. This project made all the student know about different jobs in UAE, different company and how they take [recruit] worker to work for their office. We never get this chance before. This is first time any girl in my class does this project like this. I didn't know about the job [functions] of Emiratization [department] but now I know. (Rahma, Reflective Questionnaire)

Rahma's quote show all the 3 projects were seen by the participants as useful. In addition, it showed that participants are most likely to join the project group which their "funds of knowledge" could add value to the group discussions. Therefore, in her case she joined the Career Aspirations project group because she is employed.

Example 2:

I decided to do the bus project because I come to college with bus. Before many girls think college bus is too expensive. I like the career project because we know about jobs in private sector and about government program Emiratization. I like the car parking project because the college knows that we need more parking for student. In all I like all the project because we learn math in fun way. We even forgot is math we are doing. We argue and I like the presentation by all

the groups. I think my group is best. It makes us more confidence to speak in public. (Nouf's, Reflective Questionnaire)

Nouf's quote show that by presenting their findings to the whole class the participants' in this research developed significant confidence in their ability to engage their classmates and hopefully people outside the classroom.

Example 3:

I join the car parking group because I drive my car to college every day. I like many things about the math project we do. (1)Is about our problem we try to solve using math. This makes everyone try to find the answer. (2) It is more fun to do. I measure big area with tape for the first time in our life. I won't forget this project work. (3) I feel important after meeting the college Director to talk about our work. He was very friendly and he like our result. (4) We learn math without fear because is all simple and fun way measuring field for car parking area. (Ayesha, Reflective Questionnaire).

Ayesha's quote reiterates the importance of creating a relaxed learning environment in mathematics classrooms. It shows students are most likely to engage in learning mathematics if they don't feel threatened by the subject. In addition, it show students like their efforts, no matter how little, to be valued by their teacher and by the person in a position of power.

In all the above quotes, participants stated that they chose their project topic because it was relevant to them. They also expressed positive experience with the way their mathematics lessons were facilitated. Each of these young women clearly enjoyed mathematics lessons in which their projects were discussed, and as a result they engaged with it – they gave it full effort because they saw its connections to their own worlds. Were all these observations coincidental? No! All this happened because it was obvious to the students that they were working on real world problems which were not totally teacher directed and which meant a lot for them. In addition, they felt it may help improve their lives not only on campus but also in the community.

Below I provide supporting data to back up my assertions that the participants' perceived potential for the projects to better their lives was also responsible for the significant participants' engagement.

Participants' Perceived Benefits from the Projects

Data collected shows that participants' were engaged because they believed their projects had the potential to better their lives in college and out of college.

So often students are not given the opportunity to ask questions or think why what they are taught or asked to do is important. This is surely a catalyst for disengagement. In most traditional mathematics classes learners are simply expected to sit, listen and copy notes and do homework. This was not the case in this research. I observed and recorded high levels of engagement, demonstrated by all the participants, throughout this research work because of the hopes they had in their projects to better their lives in and out of college. They all knew why they were engaged in these tasks. They became more and more curious and engaged in their search for information to help them find solutions - because they wanted to find solutions to what they saw as their own problems. At various times during the projects my claim was confirmed by the participants themselves as follows.

During the Car Parking project discussions, they stated, succinctly, their reason as to why this project was important as, "there is not enough parking for the students so we really need this project...Also, the exit and entrance gates are the same".

Here, the students have highlighted the problem with car parking space and hinted that they needed to find a solution.

The Career Aspiration group said the project was important because most DF students were not aware of the career opportunities available to them here in the UAE. They said, "We need this project because a lot of Diploma Foundation (DF) students don't know anything about available jobs in the

UAE, and the course they need to pursue to achieve the requirements for the careers”.

This group also hinted that the project was needed because it had the potential to help many of them in terms of their knowledge of potential employers after college life.

Many participants expressed very strong views as to why the Time of Travel project was important to them. Mona said, “The bus is too early, I don’t have time to have breakfast before coming to college, and we need this project to help us change the time for the bus [pick up]”.

In all the examples above, participants have expressed the view that they were engaged because they knew what the possible benefits would be.

Democratic Processes of the Projects

Data analysis also strongly suggests that participants engaged with both mathematics and their projects because the project topics were chosen by them.

I recorded in my journal how, at the start of their project participants engaged in mathematical discussions by brainstorming on possible project topics and reasoning on why it was an important topic to be pursued. I also recorded high level of engagement in the form of passionate debates amongst participants on some issues, for example, why the military is perceived as no suitable career for women. The participants told me they have experienced a democratic process for the first time in a mathematics classroom at ADWC. Many of the participants were pleasantly surprised by this development in their mathematics class. During focus group interviews with the Time of Travel group Zainab said,

I want us to get answer to the car parking problem. We chose this topic so we should get the answer. One of the thing[s] I learn in math this year is how to decide in whole class by debating. I never see this

before. Is like politics, right! The project make this way of learning possible, without the project it will be like our time in school.

Similarly, during group presentation by the Career Aspiration group, Ameena said, “The project is easy to find the answer because we chose the topic ourselves, we are not tired to work extra hour to find the answers. I like this politics in math”.

Both Zainab and Ameena affirmed that they went the extra miles to complete their projects because the topics were chosen by them.

5.3.4 Summary

The teaching mathematics for Social Justice Pedagogy employed has resulted in an unprecedented level of engagement with the projects and mathematics by the participants. They have developed a keen interest in mathematics so much that they discussed mathematics in and out of the classroom. Such keen interest has resulted in students’ participation in other mathematics activities, for example, Remediation Program and Ajiyaluana Day celebration. In the past, both these activities have struggled to attract students. It was a struggle to get students to attend the Remediation lessons because of their lack of interest in mathematics, and during Ajiyaluana celebrations we struggled to get students to even come to have a look at the mathematics table due to their fear of, and negative past experiences with the subject. Data suggests the reasons for the engagement to be because (a) their projects were connected to their lives, (b) they believed their projects had the potential to better their lives in college and out of college, and (c) the project topics were chosen by them.

In addition, during lessons, those reluctant learners who would go to the “rest room” in the past and spend a considerable amount of time there before returning to class, never asked to be excused to go to the “rest room”. Lateness for mathematics lessons became a thing of the past - everyone was eager to arrive and reluctant to leave at the end of the lessons. The participants enjoyed what they were working on because it made sense in their world.

5.4 Developing a Sense of Agency.

The data collected and analysed in this research shows that the participants have developed a sense of “social agency” Gutstein (2006a, p. 27). Through this project students made history, as their actions led to (a) an increase in the students’ car parking area, (b) change in the lessons starting time for students’ from 07:30 to 08:30, and (c) career fairs at ADWC featuring information on part-time jobs, not only full-time jobs as was the case before this research. To achieve the milestones mentioned, participants utilised mathematics as a tool to understand their worlds (in this case, their problems with parking space at the college, travel times to and from college, and career aspiration) and they followed their understanding with action to redress the perceived injustices. In other words, after reading the world with mathematics, they also wrote the world with mathematics.

In addition, data analysed also suggests that participants have demonstrated a sense of agency (a) by becoming Self-Regulatory Learners, (b) by their ability to confidently voice an opinion in class amongst peers and out of class, and (c) by demanding equity for all.

In the sections below I present evidence with regards to the assertion made above about students’ agency as a result of the adoption of Social Justice Pedagogy. In Section 5.4.1 I present evidence on how students’ developed a sense of “social agency”. In Section 5.4.2 I present evidence on how students demonstrated a sense of agency. Section 5.4.3 contains a summary of the findings from this particular research aim.

5.4.1 Social Agency

Gutstein (2006a) stated that this kind of agency does not simply mean psychological or motivational factors, for example, students’ sense of self efficacy, individual achievement/attainment, or effort optimism. Social agency is developed when “the learner sees himself or herself as capable of contributing to historical processes” (p. 27). An excellent example is, writing the world with mathematics after reading the world.

The next 2 sections contain evidence of reading and writing the world with mathematics.

Reading the World with Mathematics

Data collected shows that participants have developed the ability to “read and write the world with mathematics” (Gutstein, 2006a), in other words, they have developed the 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 ADWC was unfair. They went out on the fields with a measuring tape and measured all the lengths of both the students’ and teachers’ parking areas and utilised mathematics as a tool to work out the number of cars that can park on each, and based on their result they reached a conclusion. These students have clearly used mathematics to understand the parking allocation at ADWC. Similarly, 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 (Dubai to Abu Dhabi - Dh15). Again, based on the result of their calculations they reached conclusions. These students have clearly used mathematics to better understand their world: in this case, the transport provided by ADWC. Similar to the 2 examples above, the Career Aspiration group investigated career aspirations amongst DF students. They designed a questionnaire 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 uncovered that DF students didn’t like attending Career Fairs, usually organised by ADWC 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 these students have used mathematics to understand their worlds.

Writing the World with Mathematics

To “write the world” with mathematics occurs when, after reading the world, one then follows through with action to try to change the situation. Action could be by meeting face to face with the authorities to discuss findings and make recommendations, or by simply writing a letter and making recommendations, or by taking civil action, or both. Learning to write the world with mathematics was as complicated, if not more so, than learning to read the world (Gutstein, 2006a, p. 88). Writing the world might “sometimes occur after school life when the students enter the workforce and civil society” (Atweh and Brady, 2009, p. 270).

Data collected shows that participants have developed the ability to “write the world with mathematics” (Gutstein, 2006a), in other words, they have developed the ability to use mathematics as a tool to justify the actions taken, as demonstrated in the examples below. It is pertinent to mention here that because reading the world with mathematics can be complicated especially for students who are doing it for the first time, the teacher has the responsibility to support the students to change the world. Therefore, I supported the participants by given them ideas on actions to be taken by them.

On the Car Parking project, the participants decided that it was important that the college Director was made aware of their findings. The team leader sent him (Director) an e-mail (see Appendix 9), requesting a meeting and he accepted to have the meeting with them. They had the meeting on 31st May 2009, during which they presented their findings to him (see Appendix 9), and made recommendations for change. In his remarks after the students’ presentation, the Director promised the students that he would add their case to the next management meeting agenda for discussions. As a result of this “writing the world” action, the student car parking area is now increased. Similarly, for the Time of Travel project participants took action by sending a letter (see Appendix 10), to the Student Services Coordinator at the time. In the letter they made recommendations on ways to improve the bus services at the college. The coordinator confirmed to me that she received such a

letter from my students and said she would forward it to the college Director. As a result of their project, the starting time is now 08:30, not 07:30 as in previous academic years. The Career Aspiration project students took action by writing a letter (see Appendix 11), to ADWC Career Coordinator explaining their findings and making recommendations. She also confirmed to me that she had received such a letter from my students; she said the letter would be forwarded to the Directors' office. As a result of their project, Career Fair shows at ADWC now include information on part-time jobs.

Also, data collected revealed that the participants demonstrated great pride in their work so much that they engaged in discussing their projects even out of the class. I recorded in my journal how on many occasions the participants saw me in the corridor and engaged me in discussing their project. For example, on Tuesday 27th October 2007, Abeer, one of the students who worked on the Car Parking project, saw me and she immediately came over with excitement and said to me, "Goma, they have increased the parking for students!". I said, "Is that right?", and she said, "Yes! Go and have a look!".

It was a humbling experience, as I had never, before these projects, been engaged by a DF student in this way.

Similarly, on August 31st, 2009, which was the start of the 2009/10 academic year, another student Nada saw me and she said, "Goma, the start time in college is now 08:30, not 07:30! Maybe our project worked!" I smiled and said, "I think so Nada!" and I added, "thank you for all your efforts in the project. Now we are starting to see some results!"

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. 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 lunch time for the project instead of enjoying the time with their fellow student 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".

In this quote Haleema said she works on the project even at home because she wanted to change what she believed to be unjust (bus service). This is a clear indication of my students attempting to write the world with mathematics.

Prior to their projects, these students were not use to taking action, therefore, the action taken by them was, indeed, unprecedented 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 ADWC administrators to make the changes mentioned above. Therefore, I contend that after "reading their world" with mathematics the participants have also clearly "written the world" with mathematics.

The actions taken by the participants in this research, which led to the successful outcomes were historic. Therefore, I contend that they have developed a sense of "social agency" as defined by Gutstein (2006a, p. 27).

The next 2 sections contain evidence on how the participants in this research developed from shy to confident individuals who are no longer afraid to voice an opinion.

Confidence to Voice an Opinion in Class amongst Peers and out of Class

Data analysis strongly suggests that the participants have gained significant confidence in their ability to voice an opinion without fears. I recorded in my journal when, after one of the class presentations, Afaf walked to me and said, "I like my math class now because is not just math, you also learn how to talk without fearing anyone".

As I mentioned earlier, for some of the young women this was the first time a man who was not a member of their family was standing before them and talking to them. Added to this was the fact that, traditionally, Arab women, in particular, Emiratis, are expected to demonstrate some level of shyness

when a man is talking to them. In the Arab culture, eye contact is not encouraged either as it is sometimes considered as a sign of arrogance or being disrespectful to the other person. It will be apparent that these requirements placed unusual restrictions upon the pursuit of the programme of teaching for social justice as demanded in pursuit of data for the presentation of this thesis. Therefore, it was not surprising that some of the challenges that I faced, at the initial stages of this research, were that students were too shy to speak in class and they were also reluctant to have any form of eye contact.

Such confidence was also demonstrated during whole class presentations; a presentation by the Car Parking group to the College Director; and also during other times. This sense of agency that comes through being equipped to articulate their case was confirmed by the students in the following quotes:

Now we talk to each other more in class before some girls don't talk much but now we all talk. For me it makes me more confidence when I do math or even talk about math with my friends. Also now graph is easy to understand when I see it in newspaper or bank advert. (Afra, Reflective Questionnaire, June 4th, 2009)

Afra was a very shy student who hardly spoke out during lessons. I am delighted that Afra's confidence improved towards the end of the semester and she became one of those who always wanted to have the first say during whole class discussions. Other participants expressed similar sentiments to Afra's on their reflective questionnaires. For example, Bedour wrote, "This project give me more power to speak in group... I didn't like math before but now I go to class early no [never] late again (Bedour, Reflective Questionnaire, June 4th, 2009). Similarly, Rahma wrote, "This project give student power to change the college problems, like with the car parking and bus projects... We learn math without fear like we fear before to speak our mind. Now no one fear (Rahma, Reflective Questionnaire, June 4th, 2009).

During the Car Parking project group presentation, it was pleasing for me when I saw one of the students called Warda, who I would also describe as

shy, stood before all her classmates to explain how to calculate the area of a triangle. As I stated earlier in section 5.3.1, after the presentation Warda came to me and expressed her satisfaction for engaging her fellow students about the area of triangles.

The examples and the quotes above show that the participants in this research have developed a sense of agency, in this case, public speaking skills, and consequently are no longer troubled to voice an opinion.

Equity for All

After the presentation by one of the Time of Travel group, many students from Abu Dhabi city who didn't have college bus services asked why they were not given the choice to use the bus. Nura said, "we should have the choice like the other girls to choose the bus or not". Moza, a student who uses the college bus asked why students are asked to pay. I asked her why she felt it should be free. Her answer was, "we are the future of the country so we should be given free bus to college". When I reminded her that the buses were run by ADWC not UAE government her reply was, "is all the same, the college is in UAE so the bus should be free too".

I am not sure whether any of these students has ever thought of asking the college to provide buses for those of them who are from Abu Dhabi City. I believe they didn't even know they were free to suggest having one. But through this project they have realised that they could and they are, indeed, asking for the privilege given to their peers to be extended to them too. This is the beauty of teaching for social justice; it educates people to realise their rights and responsibilities and to express their voice. The participants' actions, as discussed above, demonstrate that they have realised some form of injustice was done and were therefore, seeking remedy. This clearly shows that they have developed a sense of social agency.

Similarly, a sense of agency was demonstrated by the participants when they asked questions such as, "why is the bus service not free for all and why are students from Abu Dhabi city not provided with bus services as well?"

Section 5.4.2 below presents evidence on how the participants demonstrated a sense of agency.

5.4.2 Learner's Agency

A sense of agency was demonstrated by the participants' by becoming self-regulatory learners.

Self-Regulatory Status

The data collected and analysed suggests that the participants have developed significantly in terms of their journey to becoming self-regulatory learners. Self-regulated learners accept responsibility for cultivating knowledge and skills; they demonstrate initiative and perseverance in their quest for learning (Zimmerman, 1990, 2001).

For many of the participants in this research, their project work provided them with opportunities to have some control of their studying and learning habits. It is reasonable to expect say that this new experience would create many challenges for the students. Therefore, in order to survive the rigour of increased academic demands of college, they needed to develop into self-regulated learners (Pintrich, 1995).

All the projects in this thesis were “student controlled” – every member of the different project groups played their part enthusiastically and with confidence. Students' responses, on reflective questionnaires, were indicative of their being in control. Muneera wrote on her reflective questionnaire that she had never been a team leader before and that being one had provided her with one of the most unforgettable experiences of her life. She said,

I never be a leader before [*sic*]. This project has given me the chance to be leader. To organize my group girls in meeting and presentation to class. I like the project because students are in control not teacher. We decide and the teacher only advice us. This is good experience for my life and all the girls in my group, never forget it.

Muneera's quote show by allowing the participants to be in charge of their learning they have developed significant managerial skills. In addition, it showed that such experiences and the skills developed may remain with the participants for the rest of their lives.

Ayesha added to Muneera's verdict by saying,

This is my second time to be a leader in class. I was a class leader in my school. But this one is different because we are in charge of what we do and how we do. Teacher gives advice only to us. Also we choose the topic by ourselves not the teacher. This gives us good control of the work and good experience for our future after we finish college. All the students in my team are happy with this way to do project work.

Ayesha's quote show being in charge of their learning is a completely new experience for all the participants. Good experiences that they all enjoyed and one that may help shape their future lived life after college.

Nada's reflection is also in agreement with those of Ayesha and Muneera, when she wrote,

I like this project because it is our work. Nobody decide the group and topic for us we choose because is important to us. Sometime we even meet to discuss our work during break without teacher because we want solve the problem. Everyone is happy and give their best to this work because we are control everything not the teacher.

Nada's quote show students are most likely to go the "extra miles" in terms of their effort if they were in charge of their learning processes.

In their quotes, Muneera, Ayesha and Nada have hinted that their project led them to become self-regulators. The fact that they believe they can now plan their studies for themselves implies they have developed a sense of agency.

Searching for information independently is also an indication of self-regulation. The projects in this research encouraged the participants to seek

information on the web; this helped them to better understand the world around them. As Afra wrote, “It makes[s] us search information on internet about age of driving in other country. This make me know about things outside my country. It make[s] us more aware of our country” (Afra, Reflective Questionnaire, June 4th, 2009). Dalal added to Afra’s dictum when she said, “It makes[s] me proud that I can look [search] for information by myself about anything I like. Is like I have power to control what I read, this is good for my study in college” (Dalal, Reflective Questionnaire, June 4th, 2009).

Here, both Afra and Dalal have expressed a sense of self-fulfillment that they are now able to carry out independent search for information.

5.4.3 Summary

The participants in this research utilised mathematics as a tool to better understand: the challenges some of them faced with parking space at the college; the challenges they all faced with travelling to and from college and the career aspirations of DF students. By doing this, they have read their world with mathematics. They also made history because they took actions which led to: an increase in the students’ car parking area in the college; a change in the lessons start time for students from 07:30 to 08:30; and, career fairs at ADWC featuring information on part-time jobs not only full-time jobs as was the case before this research. By taking such actions they have written their world with mathematics, which shows that the participants have indeed developed a sense of “*social agency*” (Gutstein, 2006a, p. 27).

In addition, participants have also demonstrated a sense of agency by developing the ability to accept responsibility for their learning and they showed initiative and perseverance in their quest for knowledge. They also showed agency in their ability to confidently voice an opinion in class amongst peers and out of class without fear, and also by interpreting their mathematical calculations beyond mathematics.

5.5 The Successes and Challenges Encountered in Using the Social Justice Approach in this Particular Context.

The data collected strongly suggests that the teaching methodology employed in this research work, that is Social Justice Pedagogy, has recorded successes and challenges similar to most of those recorded in the few, yet significant, research works carried out on teaching mathematics for social justice.

This section is divided into 4 parts. Section 5.5.1 deals with the successes recorded in using Social Justice Pedagogy in this particular context. Section 5.5.2 deals with the challenges encountered, while I present the reflection on my practices in Section 5.5.3. In the final Section 5.5.4 I present a summary of the Section.

In Section 5.5.1 below I provide supporting data on the successes recorded in using the Social Justice Pedagogy in this context.

5.5.1 The Successes Recorded

Data analysed shows successes were recorded as described below.

The successes recorded and discussed earlier on in various sections of this thesis include: (1) the use of “Mathematical Enriched Worksheet” to scaffold students’ thinking; (2) the use of projects rather than prescribed text books to motivate students to learn significant mathematics; (3) maintaining students’ interest in mathematics; and (4) showing that DF students are interested in social justice issuers. In addition, a major success was achieved in the implementation of some elements of Productive Pedagogy simultaneously with Social Justice Pedagogy. The elements implemented are (1) Higher Order Thinking, (2) Substantive Conversation, (3) Connectedness, (4) Engagement, (5) Student Control, (6) Student Support; and, (7) Citizenship.

Higher order thinking – the data analysed shows that the Social Justice Pedagogy employed in this research has provided the participants with opportunity to develop Higher Order Thinking. For instance, for many of the

students who use the bus provided by college, it would be cheaper for them if they used public transport but they interpreted their result beyond mathematics and concluded that they preferred the college bus. Their conclusion was a milestone in terms of their journey towards acquiring Higher Order thinking skills.

In addition to Shaikha's work presented in section 5.2.5, below are additional examples which show the participants have demonstrated Higher Order Thinking skills.

Mouza uses the college bus, based on her calculations she spends a total of 5.6 hours on the bus per week. Below is Mouza's calculations and interpretations.

2 hrs: Dh30

5.6 hrs: X

$$X = (30 \times 5.6) \div 2 = Dh84$$

It will cost me Dh84 in one week to travel on public bus. We have 20 weeks in semester two, so it will cost me for the semester $84 \times 20 = Dh1680$. Now I pay Dh1900 for [the college Bus] one semester. So, is cheap to travel by public bus. But I like to use the college [bus] because I make new friends and is safe because all [of us are] students.

Salama is another student who uses college bus. According to her calculations she spends a total of 827 minutes on the bus per week. She wrote,

$$120x = 15 \times 827$$

$$x = \frac{15 \times 827}{120} = Dh103.375 = Dh103.38$$

$$\text{We have 20 weeks in one semester} = 20 \times 103.38 = 2067.60$$

It cost me Dh2067.60 to travel to college with public bus in one semester. I only pay Dh1900 for college bus. The bus is

cheaper. This is good deal for all the girls. I like the bus because it is cheaper for me. My parents don't worry to bring me to college, I enter the bus. The bus picks me from front of my house, my parents see me enter the bus is important here in UAE. I am grateful to the leaders in college who think to help students with bus.

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. (Shaikha, Solution to "Mathematical Enriched Worksheet 1").

Both Mouza and Shaikha said traveling by public transport would be cheaper for them but they still preferred the college bus because they believe it provides them with the opportunity to make new friends. Salama who pays less to use the college bus also interpreted her result beyond mathematics by saying it was safer and culturally appropriate to use the college bus because they are picked from the front of their houses. These students have clearly combined facts (their calculations) and their ideas (their "funds of knowledge") to interpret their calculations and arrive at some conclusion. I argue that by combining facts and their ideas the participants have demonstrated Higher Order thinking skills.

Similarly, Higher Order Thinking was also demonstrated by Ayesha in her work on understanding the graphs; the 2 graphs given to the participants were about "Graduate by Gender" and "Graduate Employment Rates", as presented earlier in section 5.2.3. Ayesha analysed and synthesised the 2 graphs and reached the conclusions that if more women gained employment after completing their college education, it may encourage more women to go to college and that the data shown on the graph was not a true representation of the current situation in the UAE. Ayesha has also combined her calculations and her "funds of knowledge" to interpret her calculations

and arrive at some conclusion. Many meaningless graphs used in mathematics do not allow this kind of thinking.

Substantive conversation – the data analysed also shows that the Social Justice Pedagogy employed in this research has provided opportunity for a substantial dialogue between the participants and me and among the participants themselves. Data analysis shows that there were many occasions whereby substantive conversations occurred in this research. I present few of them below.

The first substantive conversation occurred during brainstorming sessions on possible project topics and why it was important to pursue these topics. Each group had to explain to the whole class why they chose their topic and the mathematic skills required to complete it. This was an open question to the whole class. For example, as stated earlier in section 5.4.1, during presentation by the Time of Travel group, students asked why those of them from Abu Dhabi were not given the choice to use the bus. Some asked why students are asked to pay for the bus service. I asked why they felt it should be free. One student replied, “we are the future of the country so we should be given free bus to college”. When I reminded her that the buses were run by ADWC not UAE government, her reply was, “is all the same the college is in UAE so the bus should be free too”.

Substantive conversation also took place during group presentations as a result of passionate debates amongst participants on some issues, for example, why the military is perceived as unsuitable career for women. On career suitability Muneera said,

[Even] out of [our] tradition, her ability and body is not the same as man. We cannot say all women can do the same as a man. As I mentioned before, like heavy machines, heavy trucks, hard environments, the woman cannot do like the man.

Hajara disagreed with Muneera and said, “The traditions need to change because everyone is same man or woman in our religion”. On many occasions I had to intervene in order to avoid potential confrontation because

participants were becoming too passionate about their view point. All the student-student and teacher-student exchanges described above promoted coherent understanding of the subject discussed.

Another example of substantial dialogue between me and the participants occurred when I asked Shamsa, as presented in section 5.2.2, to explain to me her thinking behind the calculation below.

$$\text{I always think about it} = \frac{145}{81} \times 100 = 179\%$$

Shamsa said “ I divided the total by 81 and multiply by 100”. She added “I don’t think my answer is correct”. Why? I asked. She replied, “179 is big number, my number should not pass [more] 100”. I then asked Shamsa to check what the answer would be if she divided the 81 by 145 and multiplied the answer by 100. She said, “the answer is less than 100”. What is the number? I asked again. She replied, “it is 55.86%”. My discussion with Shamsa has clearly helped her to understanding how to calculate the percentage of a quantity. This is a clear example of “talking to learn and understand” (Hayes et. Al., 2006, p. 44).

Similarly, another example of “talking to learn and understand” occurred during my discussions with the Car Parking group, when I asked them to explain to me how they arrived at the ratio of car parking area to number of students as 1:2. Ayesha said, “the ratio of 214 to 300, is the ratio 1:2”. I asked why and she replied, “It is actually 1:1.4 but we rounded up to make sure there will be no student without space to park her car.” During focus group interviews as well as class presentations, the group explained how they calculated the number of car parking spaces available. Ayesha said, “For the students car park we have approximately $1611 \div 7.52 = 214$ ”. I asked them why they did not round up this time around, and Ayesha said, “Because rounding up will lead to more cars than there is space for. Is better to have free space than have car with no where to park”. I then asked if the answer was, say 214.72, would they still round down? She said, “Yes”. From the examples described above it is reasonable to assert that the interaction resulted in coherent shared understanding of ratio and sensible rounding.

Connectedness to the world – the analysis of data shows the Social Justice Pedagogy employed in this research provided participants with the opportunity to engage in activities which connected what they are learning with their lived lives. As a result, they demonstrated high levels of intellectual outcome.

As I stated earlier in section 4.2.2, the groups that worked on the Time of Travel project consisted of all students from outside Abu Dhabi city, except one; the group that worked on the Career Aspirations project consisted of students who are employed and study full time and, the group that worked on the car Park Parking project consists of students who drive themselves to college. Therefore, it is reasonable to claim that the participants were expert in their own right on the project that they were engaged in because it has a direct connection to their life in college. 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). Ayesha clearly indicated that she had rich “funds of knowledge” on the parking problem at the college. In addition, on the reflective questionnaire participants were asked “Are the project(s) you have just completed the same or similar in form with the ones you may have done in the past? Explain your answer.” Some of the responses were: “All of them are about making our future better” (Muneera). “We are working to solve our problem” (Zainab). “This project is all about our life and this is different from before. Before they give us the number to use but now we use our number (Rahma). Muneera, Zainab and Rahma have clearly indicated that their project is different from any project they might have done in the past because this one is connected to their lived lives.

Academic engagement – the data analysis also shows that the Social Justice Pedagogy employed in this research has provided the opportunity for the participants to academically engage in doing mathematical tasks. As stated earlier, DF students are perceived as mathematically weak. The data analysed suggests that the participants have enjoyed their engagement with mathematics throughout the period of their projects. These participants told

me during class conversations that this was not the case during their school days. The first of such academic engagement occurred during brainstorming sessions on possible project topics and the subsequent justification by each group on what mathematics was required to successfully complete their projects. By suggesting topics and reaching agreement on which ones to pursue I can argue that the participants have demonstrated the ability to take initiative and contribute to group work.

In section 5.3, Noura said they had fun learning mathematics in my class unlike doing mathematics at school and that this methodology of teaching, i.e., Social Justice Pedagogy, had made her like mathematics. As a result she learned the subject. Yasmeen said most of the time they never felt they were in a mathematics class because everyone was happily engaged. The Car Parking group said they understood mathematics in a relaxed way and as a result they had worked to the best of their ability to complete their project. The Career Aspiration group said they liked to learn mathematics now because it made sense to them and they were no longer afraid of it. It is pertinent to mention again here that the participants' responses on reflective questionnaires suggest this was not the case before their projects. For example, Bedour wrote "I don't like math before [this project] but now I go to class early no late gain". Afra said "I don't like to leave my math class again [anymore] because we do fun stuff..., we are busy talking about our work, and arguing about what is right or wrong".

Student control – the data analysis also shows that the Social Justice Pedagogy employed in this research provided the participants with opportunity to take control of their learning in a mathematics classroom for the first time in their life. As a result, they have developed significant ability to self-regulate their learning. Right from the outset all the projects in this research were student centered, and the participants saw them as their own projects not ones imposed by me. This was achieved by ensuring that the entire project groups had team leaders to coordinate group discussions, a recorder to record the work completed, and every group member knew they would play their part during class presentations. I played the role of an adviser and a facilitator. My claim was affirmed by Muneera, and Ayesha as

detailed in section 5.4.2. Muneera said this was the first time she ever team led a group and doing so had provided her with an unforgettable experience. She added that the projects were enjoyable because the students controlled what went on in the class. Ayesha said that although she has been a class leader during her secondary education, her experience as a leader on this project was different because the students were in charge of what to do and how go about doing it. She added that they had gained valuable experience for their life after college.

Student support – the data analysed shows that the Social Justice Pedagogy employed in this research has provided a warm, friendly atmosphere in which it was okay to make mistakes, and no putdowns. The students felt they were free to take risks by trying things and without the fear of failure in pursuit of the required result. For example, in section 5.2.1 I described how Ayesha supported her classmates by explain the concept of percentage in Arabic. In section 5.3.1, I elaborated on how Warda, who was a very quiet and shy member of the Car Parking group, struggled with her explanation on how to calculate the area of a triangle. During her presentation all her classmates were very supportive of her. Similarly, in section 5.2.5, I described how the Car Parking group made a major error in their calculations because they forgot to take into consideration the gap that should exist between parked cars (both between cars, to allow for occupants to open the doors to enter and exit, as well as the necessary road space for cars to enter and exit between rows). When I drew their attention to the error, they wanted to redo the whole calculation but I supported them by telling them their interpretation was still significant and their involvement in the project was already a success. I also supported the participants with their English, as Muneera wrote on her reflective questionnaire “Goma is good teacher because he understand (sic) our problem with English and he support (sic) all of us to make progress in our study. He said is okay to try not to be afraid of mistake”. Muneera’s testimony is one of many of such testimonials.

Citizenship – the data analysed shows that the Social Justice Pedagogy employed in this research has provided the participants with the opportunity to achieve active citizenship. They have achieved citizenship as all their

chosen project topics led to improvements in their college. As discussed in section 5.4.1, the Car Parking project led to an increase in the students' car parking area at ADWC, the Time of Travel project has resulted in the change in the lessons' starting time for students' from 07:30 to 08:30, and the Career Aspiration project led to career fairs at ADWC featuring information on part-time jobs, not only full-time jobs as was the case before this research.

5.5.2 Challenges Encountered

The challenges encountered in this research are: (1) examination anxiety; (2) Time constraint; (3) Gender issues; (4) Language issues; (5) Doing projects and covering the curriculum; and (6) Students empathy.

Examination Anxiety - Data collected strongly shows that examination anxiety, which I refer to here as "exam fever", was another challenge in the way of teaching mathematics for social justice in this context. Examination anxiety was apparent amongst the participants in this research. They expressed it, both in writing and verbally, at different times during the period of this research. For example, in the presentation by the Time of Travel group, they expressed concerns about the fact that the exam would be made up of numbers that are not theirs, "We think about the exam. Exam is no [not] like project is all question questions with some new number to calculate, not our own number[s]. This is not fun" (TT group presentation, 12th May 2009). Similar anxiety was expressed by the Car Parking group in their report. They stated, "We hope exam will not be too difficult to pass".

I recorded in my journal the number of times that students asked me if the project they were engaged on would be in the exam as at least fifteen times. What was even more interesting was the fact that the questions were always being asked by the students I considered to be academically able. These students, although they were enjoying the projects, it seems always had one eye on the exam. Disappointing? No! Sadly, these students were just unconsciously responding to the kind of pressure society has placed on them: which is, the pressure to study for the sake of exams. I recorded during one of our sessions at the Maths Club, that we were talking about how

everyone was now interested in maths because of the projects going on, and Ayesha, who is one of those able students, asked, “now everyone in our class like maths, but Goma, will this project help the girls in exam to pass?” My answer to her was, “So long as you all remember what you have learned from these projects, it will help you in the exam and beyond the exam.” I believe Ayesha was more concerned about some of her classmates than herself. However, her question was very important and it served as a reminder to me that I needed to curtail the “exam fever” amongst the participants sooner, rather than later. Therefore, during my contact with the group, I went further to assure them that the “Enrich Worksheets” they were working from covered all the concepts required for the end of year examination. They all seemed happy with my explanations, but whether or not deep down they were convinced, I don’t know. One thing that was clear though was after the discussions all the groups continued working enthusiastically and with confidence.

The *exam fever* expressed by the students was also expressed earlier on by a parent who called me after receiving consent forms for her daughter to take part in interviews. This parent was concerned that her daughter might not be taught “enough” content to enable her to do well in the end of year exam. I explained to her that the project would, indeed, cover the entire intended curriculum. Despite my attempt to convince this parent on the merits her daughter stood to gain if she took part in these research projects, in the end she only agreed for her daughter to take part in whole class activities but not interviews.

Time Constraint - Data collected supports my claim that lack of time to develop familiarity and trust with the students was a major challenge to teaching mathematics using Social Justice Pedagogy in this context. For instance, as at the time of this research, it was a policy in the DF Department that no teacher should teach a particular class for 2 consecutive semesters. This policy was intended to ensure that DF students were exposed to different pedagogical approaches to learning by Faculty. This meant that I had only a few months to win the trust of the participants in this research. If I had taught this class for the whole academic year it would have allowed me

more time to become “one with them” which, I believe, would have facilitated more open discussion in the class. My claim is supported by Fatima’s remarks on her reflective questionnaire when she said “He teach us only this semester,..., if he teach me again next time I know him to relax and talk”. Here Fatima is pointing to the fact that she did not feel comfortable talking to me because in her opinion one semester is not enough to establish trust between us.

In addition, because Social Justice Pedagogy is new to the participants they were hesitant to take control of their learning. For example, during the earlier stages of this research work, participants didn’t want to ask their classmates questions during whole class discussions: whenever one of them said something, the others were always reluctant to express opposite views. I was very concerned about this. My “quiet” discussion with one of the participants called Muneera, revealed that if I asked the first questions it would be easier for the students to contribute because then their classmates would not be offended that they started the questioning. She said, “We don’t want to offend our classmate in case we ask question and they don’t know the answer”. I followed up my discussions with Muneera with a chat with a colleague called Helen, who teaches at the Bachelor level in the Education Department. She said they train their student’s right from their first year on about positive criticism: consequently, the students always voice their opinions - even if it contradicts that of their peers. Therefore, it is obvious that time was needed to train DF students about positive criticism.

Gender Issues - Being a male teacher teaching female students was also a major challenge in this context. As I stated in the earlier part of this thesis, a high proportion of these students had never been spoken to by a man, other than members of their family. Therefore, having a male teacher was not the norm for female ADWC students prior to entering tertiary education. As a male teacher, I have taught a class for a whole Semester without ever seeing the faces of some of the students in my class because they wore their veil. This is a common experience for all male teachers across HCT campuses. As a male teacher I am also not allowed to have any one-to-one interviews or

discussions with the participants. This means participants had no opportunity to express personal views in private. Were I a female teacher, this barrier would not have existed and participants might have expressed some different views in private. For instance, during brainstorming sessions on suitable topics, a group of students wanted to use mathematics as a tool to investigate the rate of marriage failures. This topic would have given them the opportunity to interview fellow students from broken families with a view to providing insight into some of the root causes of marriage failures in the UAE. Unfortunately, as a male teacher I could not discuss such politically controversial topics with students because it is not something that is acceptable in the culture and system where this research work was carried out.

Language Barrier - In addition to the above mentioned challenges, using English as the language of instruction presented another challenge in teaching for social justice in this context. As is the case with most UAE Nationals, all the participants in this research have Arabic as their mother tongue. Arabic is the language of instruction throughout their primary and secondary education. Some of the participants in the research find it challenging to express themselves in English and I do not speak Arabic. Since all the class discussions and interviews were conducted in English this meant I was unable to capture the complete views of the participants on some issues. Although I asked the participants to complete their reflective questionnaire in Arabic if they preferred to do so, I believe had the class discussions and interviews been conducted in Arabic they would have been better able to express themselves. For example, during focus group interview with the Career Aspiration group one participant had a lot to say but because she could not express herself as well as she would have liked she sometimes mixed English with Arabic and I had to ask her peers to translate what she said.

Doing Projects and Covering the Curriculum - the final challenge was my inability to provide similar learning experiences in mathematics to all the groups. The conflict between: traditional teachings where all students cover

the same topics and different groups working on their own projects was a source of tension in this study. All the projects were conducted simultaneously; therefore, it was challenging to pass on information or to scaffold the participants as a whole class. If I had had all the groups work on the same project, at the same time, it would have been easier to have whole class discussions amongst all members of each of the groups. For example, when the Career Aspiration group needed help on how to design a questionnaire, I called the attention of the whole class and explained to them all the concepts of a good questionnaire. It was obvious to me that the other groups were not 100% with me, because they were not designing any questionnaires. .In addition, it was challenging to focus attention entirely on the project because of the pressure to cover the expected curriculum in time for the end of year examination. A good quality research into teaching for social justice should have a section in which the researcher reflects on and critiques his or her practice and findings.

Students' Reluctance to Critique - Also, data collected during interviews and my journal entries suggest that students' reluctance to critique each other was another challenge in teaching mathematics for social justice in this context. As stated earlier, during the earlier stages of this research work, my students were reluctant to ask their classmates questions during whole class discussions: whenever one of them said something, the others were always reluctant to express opposite views. I had a "quiet" discussion Muneera, one of the participants, and she said if I asked the first questions it would be easier for the students to contribute because then their classmates would not be offended that they started the questioning. From that day on, throughout the presentations, I asked the "ice breaker" question, after which meaningful discussions usually followed. I followed up my discussions with Muneera with a chat with one of my critical friends, Peter, who is from New Zealand, but originally from an Arabic speaking nation, about this challenge. He told me that empathy (fellow feeling) is highly valued in the Arab culture, and people instinctively apply it to every aspect of their lives. He went on to say our students expect us to show empathy to them at all times and they get offended when they sense lack of empathy from anyone. I also had a chat

with another colleague, Julie, who teaches Bachelor students in the Health Department. She said their students rarely question their peers during group presentations. She said they are reluctant to challenge their peers because they see us, their teachers, as outsiders: hence they always show solidarity to their fellow students.

In section 5.5.3 below I present a reflection on my practices based 7 elements of the Productive Pedagogy as explained earlier in section 5.5.1. For clarity, some issues are repeated here.

5.5.3 Reflection on My Practices

A good quality research paper into teaching for social justice should have a section in which the researcher reflects on and critiques his or her practice and findings. As started earlier, I found some of the elements of Productive Pedagogy useful as a means for reflecting on my practice in this research. These elements are: *higher order thinking; engagement; substantive conversation; connectedness; student control; student support; and citizenship.*

Higher Order Thinking – as discussed earlier in section 5.5.1, this requires the learners to carry out tasks in which they are required to analyse as well as to synthesise their findings. Data analysed shows that for all the projects in this research thesis, participants carried out calculations, synthesised and analysed their results and reflected on them (for example, Shaikha's, Salama's and Mouza's calculations on the Time of Travel project). They also made recommendations to the college authority based on the findings of their project work. In addition, the participants in this research manipulated information and ideas in ways that transformed their meaning and implications and they solved problems and discovered new meaning and understanding (for example, Ayesha's and Zainab's calculations on analysing Graphs, as presented earlier in section 5.2.3). Additionally, a profoundly significant observation was that students were prepared to set aside *their own preconceptions and prejudices* in the light of their own research – they were willing to allow new, trusted information to overturn their own ideas,

beliefs, perceptions or certainties about the “realities” of their world. For example, the Car Parking project group thought the parking allocation between teachers and students at ADWC was unfair, but they accepted the result of their findings even though it contradicted their initial perception. In their letter to the college Director (see Appendix 9) they wrote,

We initially thought that the parking space allocation at ADWC was not fairly done. We are happy to report to you that, contrary to our initial perception, the parking space allocation at ADWC 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.

In this respect, it became almost a serendipitous exercise in the “Scientific Method” – where *hypothesis; experiment; data analysis; and conclusion* were the exemplars of rationality and *Higher Order Thinking*.

However, these are the same students who were described earlier in this thesis as having weak Common Educational Proficiency Assessment (CEPA) scores and were, therefore, perceived as mathematically weak. This begged the question:., how could students who were described as mathematically weak be able to develop *higher order thinking* skills within the six weeks of their project?

There are 2 possible answers here: (1) the participants have not actually developed *higher order thinking* skills, but, because of my expectation for them to do so, I perceived the small but significant problem-solving skills demonstrated by the participants as *higher order thinking* skills; or (2) the students were already familiar with the concepts (percentages, time calculations and graphs) required for their project from their secondary school mathematics, therefore, their projects only provided them with the opportunity to develop relational understanding of such concepts and as a result they were able to demonstrate some *higher order thinking* skills within the period of my research. In my opinion, the latter is probably the case, because after my initial interview with the participants, during which I asked them to tell me about their experiences with mathematics during their

secondary school education, which they all said was not an enjoyable experience, I had a discussion with some Engineering students at ADWC (those perceived as mathematically able students) and they told me that the topics of percentages, time calculations and graphs are covered in secondary mathematics.

Another question begging an answer is: how could a total of 54% of contact periods (*thirty periods out of fifty-five*) be sufficient and effective enough for the teacher to cover the concepts required in the curriculum and still provide opportunity for students to demonstrate significant *higher order thinking* skills? This might be one of the reasons why some parents were reluctant to give permission for their daughters to take part in the projects. It might be that participants were rushed and not given enough time to consolidate the concepts learned because they had to be ready for their end of year examination. If this was the case then they could not have developed the kind of significant *higher order thinking* skills professed in this thesis, and whatever successes were recorded in this research might not be the true representation of the students' successes in their projects. Clearly, a single research study such as mine is not sufficient to provide a satisfactory answer to this question. Nevertheless, I contend that the fact that the participants were able to demonstrate some degree of critical thinking skills, regardless of how little it was, suggests that, in this context, the participants have demonstrated significant *higher order thinking* skills especially in light of relative entry – exit abilities.

In general, I found Social Justice Pedagogy inadequate in promoting *higher order thinking*, probably because the topics involved in this research were elementary level mathematics.

Substantive Conversation – as discussed earlier in section 5.5.1, there should be substantial dialogue between students and also between teacher and students as a result of whole class discussions. This occurs when there is a considerable interaction which is reciprocal and which promotes coherent shared understanding. Throughout the students' project substantive conversation occurred. For example, my discussions with the Car Parking

project group as presented in Section (5.2.6) led to another substantive conversation. In that section, I asked the Car Parking project group how they arrived at the ratio of car parking area to number of students as 1:2. The team leader's reply was "the ratio of 214 to 300, is the ratio 1:2". I asked why and she replied, "It is actually 1:1.4 but we rounded up to make sure there will be no student without space to park her car". Similarly, during our focus group interviews, I asked the group why they rounded down their answer to the calculation $1611 \div 7.52 = 214$ ". Ayesha said, "Because rounding up will lead to more cars than there is space for. Is better to have free space than have car with no where to park". I then asked if the answer was, say 214.72, would they still round down? She said, "Yes". I did not ask further question because I was aware that when asking questions - followed by another question student may lapse into "a relativist position that nothing is knowable" (Gutstein, 2006a, p. 64).

As stated earlier, the participants in this research were shy and generally lacked the confidence to voice an opinion. In addition, only a total of 6 weeks was used for the students' projects. The 6 weeks might not be enough to establish the kind of trust necessary for teaching for social justice, that is, for the participants to see me as one of them, or at least, "on their side", and express themselves without fear of any retribution. Therefore, one may ask, how come the participants in this research seemed to be very open minded in their discussion with me in class and during focus group interviews.

In addition, the topics targeted in this research, namely, percentage, graphs and time calculations took a total of eleven weeks to complete, but only a total of 6 weeks was used for the students' projects and from my supervisor's perspective the projects were supposed to have covered the entire expected curriculum so that students are well prepared for the end of year examination. This implies that there might have been pressure on both myself and the students to complete the projects in a set time; consequently, such pressure might have obstructed the atmosphere needed for *substantive conversation* to flourish.

It is pertinent to mention here that although a single research like mine is not enough to provide a definitive answer to this question, data analysed suggests the participants were comfortable and they happily discussed issues with me because they saw me as someone who was there to help them in their attempt to solve their problem.

Connectedness to the World – as discussed earlier in section 5.5.1, this required the task to have real life connections to the learners' world. One of the best ways to achieve this is to ensure that the tasks are student-initiated, with scaffolding if need be. Students will almost always come up with tasks that have meaning in their lives.

All the project topics in this research were decided by the participants themselves after brainstorming sessions. All topics were of primary importance to the participants pursuing them directly or indirectly. Therefore, it is obvious that the topics had real life connections to the participants' world.

The importance of giving students work that is connected to their lives can never be overemphasised. As stated earlier, all the projects pursued in this research had real life connections to the participants' world. However, the projects could have been strengthened by choosing topics that would benefit both the students and the out of college community in general, for example, "dangers of smoking", "immigration" etc. On the other hand, such projects would have required students to collect data from outside of the college by interviewing non-college authorities. Unfortunately, given the Islamic and cultural rules laid down on all HCT colleges, it will be impossible to obtain permission for such data collection for the foreseeable future.

Engagement – as discussed earlier in section 5.5.1, because some students can do school work and others cannot, it is important from the outset that students are clear on what is expected of them and to provide scaffolding, when necessary, to ensure students don't lose interest because they were stuck and not making any progress. All the groups in this research work chose the areas they were investigating. They also knew what the expectations from me and from their classmates were. They received adequate scaffolding when needed. For example, at the early stages of the

research, some groups received help on questionnaire design, some received help on designing their data collection sheet and some received help on reading a measuring tape. I documented the level of engagement on the tasks, which included attentiveness, completing the work and showing enthusiasm for it by taking the initiative to raise questions, answering questions in details, contributing to group discussions and helping others (for example, in section 5.5.1, I discussed what Noura, Yasmeen, Bedour and Afra thought about their engagement in this research work).

However, on reflection, many of the participants might not have been aware of the expectations on them at the beginning of the projects because I did not explicitly tell them, as the projects were supposed to be “student controlled”. Therefore, many of them were engaged because they simply saw the project as an opportunity to voice their opinion on the issue they were investigating. However, as the projects progressed they soon realised (1) its potential benefit to their lives at campus, (2) its connectedness to their lives, and (3) its potential as a platform for a democratic process. Such realisations were documented as the principal reasons behind the participants’ significant engagement.

Student Control – as discussed earlier in section 5.5.1, this required the tasks to be student centered; they need to see it as their own project not one imposed by the teacher. Participants should be part of the decision making in the process of curriculum design.

To ensure the participants in this research saw the work as theirs, I encouraged all the project groups to have team leaders who coordinated group discussions, a recorder to record work completed, and every group member played their part during class presentations. I assumed the role of an adviser and a facilitator. Participants were fully in charge of the way their project work unfolded. I documented how the participants assumed responsibility for the activities with which they engaged.

On reflection, however, the projects in this research might not have been fully under *students’ control* because some students were not allowed to pursue the topics they wanted to investigate. As I mentioned earlier, I had to avoid

politically controversial topics because of the nature of my employment contract with the Higher Colleges of Technology (HCT). Therefore, one might argue that some topics were imposed on, or denied to the participants.

Student Support – as discussed earlier in section 5.5.1, it is important to let the students know it is okay to make mistakes, that there would be no put-downs. To achieve this, I particularly stressed to the students the importance of being diplomatic when asking questions, answering questions or making suggestions. I gave them several examples of how people can agree to disagree. Throughout the research work, students abided by my advice on these important issues while still expressing their opinions. I documented how they enjoyed the positive and socially supportive learning environment provided throughout the projects.

However, it is pertinent to mention here that when students realised their actions in the classroom were being *watched* (documented for reporting) they might have tended to behave differently from usual. Throughout my research, participants were at their best in terms of their support for each other: behaviours, attitudes to work and their attendance were close to perfect. The previously reported long-term change in attendance and class-room exit strategies exhibited by these students indicate that a change occurred, but was attitudinal, rather than strategic or short term on their part. If this was not the case in my research then the findings become unreliable. Just as there was no evidence that the participants were acting there was also no definitive evidence that they were not, though I would posit that habituation, over a 6 week period, would make it less likely that the whole class was “putting on an act”. If changing behaviour for the strategic reason of being recorded favourably in a research paper that had no direct bearing on their end-of-year results was the prime initial motivator, I would have expected to see a falling away of “co-operative” behaviours over the duration of the project, given there was no real high-value benefit *for the student* in maintaining a *façade* – ESPECIALLY for those students who had not received parental permission to fully participate, and were therefore unlikely to be recorded in any case.

Citizenship – as discussed earlier in section 5.5.1, it is not just enough to be a clever student; action needs to be taken as well (Mills, SMEC education conversation 2010). For all the projects in this research, participants demonstrated great enthusiasm and they also took action as discussed in Section 5.4.1. In addition, data analysed shows that Social Justice Pedagogy builds positive and active citizenship.

It was stated earlier that, prior to their projects, the students were not used to taking action, therefore, the action taken by them was, indeed, unprecedented and a breakthrough in their journeys toward becoming agents for change. But, one does not easily develop the ability to read and write the world with mathematics, more so within 6 weeks. Therefore, the action taken by the participants in this research might have been instigated by me. Not everything in my research went as planned.

I was naïve to think that every student in my class (DF203) would get permission from their parents to participate in my research. I recall one of my critical friends advising that I remove the word “relationship” from the sentence below, which was initially on the parents’ consent form, because, in his words, “many of the parents may misinterpret it to mean love”;

The decision not to participate will in no way impact on your daughter’s current or future *relationship* with the researcher and/or Abu Dhabi Women’s College.

In other words, some parents may perceive signing the form to mean they had given me permission to have *any* kind of relationship with their daughters. This may be surprising to many people in Western countries, but in the context of this research the probability of such interpretation is high. I removed the word *relationship* from the form but some parents still refused permission for their daughters to take part. This is indeed significant here because if the word *relationship* could be misinterpreted by some parents in the community in which this research was carried out, it is reasonable to assume that the phrase “social justice” may have been equally perceived as revolutionary by some of these parents.

It was daring to have carried out such a project with a class that I was only teaching for one semester. As I mentioned earlier, one semester was not enough to establish the kind of trust necessary for teaching for social justice to flourish. Therefore, if I were to carry out this research again, I would seek permission from the college Director to be allowed to teach the class which would be involved in this research for 2 consecutive semesters. This way I could use the first semester to build trust between me and the students before starting the projects in the second semester.

I was also brave to have run 3 projects simultaneously. Doing so made it challenging for me to effectively monitor the progress made by the different groups. It was also challenging to have whole class discussions during the projects before class presentations. In addition, although each team member was supposed to play a role in their group it was challenging to ensure this was absolutely the case. Therefore, if I was to carry out this research again I would make sure only one project topic was pursued at any one time.

In general, however, it is reasonable to assert that, limited in scope though the research has been; it has, nonetheless, supported the assertions of those who had hitherto engaged in the same field and it has also added to the limited literature available on the teaching of mathematics for social justice.

5.5.4 Summary.

The data collected and analysed strongly suggests that the teaching methodology employed in this research work, that is Social Justice Pedagogy, has recorded successes and challenges similar to most of those recorded in the few, yet significant, research works carried out on teaching mathematics for social justice; for example, see Gutstein (2006a), Tuner (2003), and Gutierrez (2009).

The data shows that teaching Practical Numeracy to DF students using Social Justice Pedagogy has led to significant improvements in the students' ability and self-belief in mathematics. Most of the participants now see themselves as doers of mathematics rather than afraid of mathematics. They now enjoy studying mathematics which was not the case prior to their

participation in this research. In the process of learning significant mathematics, the participants demonstrated significant engagement with the subject.

Data analysed shows that the Social Justice Pedagogy employed in this research has led to the participants demonstrating unprecedented levels of engagement with mathematics and on their projects. Such engagements have led to a rise in the profile of mathematics at ADWC and also a positive change of attitude towards mathematics by many DF students. Many DF students now participate in out of class activities involving mathematics, for instant the Ajiyaluana Day celebrations. In addition to the significant engagement with mathematics and their projects, the participants have developed a sense of “social agency” by their ability to use mathematics as a tool to understand their worlds and effect change in them.

Achieving “social agency” status by the participants in this research was a breakthrough for them. However, whether or not they would at least retain if not improve on their developed sense of social agency as they pursue higher studies in the coming years is a question I cannot answer. However, what is clear from the data collected and analysed is that the teaching for Social Justice Pedagogy utilised in this research has provided the participants with the opportunity to develop a sense of “social agency”. Some challenges were also encountered in using Social Justice Pedagogy in this context.

Data collected shows time was a major challenge to teaching mathematics using Social Justice Pedagogy in this context. It was a policy in the DF Department that no teacher should teach a particular class for 2 consecutive semesters. If I had taught this class for the whole academic year it would have allowed me more time to become “one with them” which, I believe, would have facilitated more open discussion in the class. Also, being a male teacher teaching female students was another challenge in this context. As a male teacher I was not allowed to have any one-to-one interviews or discussions with the participants. This means participants had no opportunity to express personal views in private. In addition, the use of English as a language of instruction presented another challenge in teaching for social

justice in this context. Arabic is the language of instruction throughout their primary and secondary education. I believe had the class discussions and interviews been conducted in Arabic they would have been better able to express themselves. “Exam fever” was another challenge in the way of teaching mathematics for social justice in this context. Examination anxiety was apparent amongst the participants in this research. They expressed it, both in writing and verbally, at different times during the period of this research. The “exam fever” expressed by the students was also expressed by a parent who called me after receiving consent forms for her daughter to take part in interviews. This parent was concerned that her daughter might not be taught ‘enough’ content to enable her to do well in the end of year exam. Despite my attempt to convince this parent on the merits her daughter stood to gain if she took part in these research projects, in the end she refused her daughter permission to participate in interviews. Another challenge was students’ empathy. During the earlier stages of group discussions, participants were reluctant to express opposite views. As started earlier, my discussion with one of the participants revealed that if I asked the first questions, it would be easier for the students to contribute because then their classmates won’t be offended that they started the questioning. The final challenge was my inability to pass on parallel information to the project groups. All the projects were conducted simultaneously; therefore, it was challenging to pass on information or to scaffold the participants as a whole class. Of the above challenges encountered, “Time” (in particular, Diploma Foundation Department’s policy on course allocation), was the most serious constraint, as it did not allow me sufficient time to win the trust of Section DF203 students and their parents, before embarking on this research. However, I consider that, despite these constraints, the principal objectives of my research were achieved.

CHAPTER 6

DISCUSSIONS AND CONCLUSIONS

6.1 Introduction

The research work presented in this thesis developed a pedagogical approach based on incorporation of social justice issues which enhanced the teaching of a Practical Numeracy Course within the Diploma Foundation (DF) year of the Higher Colleges of Technology (HCT). Practical numeracy prepares young Emiratis at the Higher Colleges of Technology for their Diploma Courses. In this sense, I defined practical numeracy as an aggregate of mathematical skills necessary to cope with the demands of the higher levels of Diploma Programs.

This research was carried out at Abu Dhabi Women's College, which is one of the seventeen colleges operating under the auspices of Higher Colleges of Technology in the United Arab Emirates (UAE). There were twenty female participants in this research. Their ages ranged from 16-36 years and all of them were among the body of students whom I taught. The Practical Numeracy course at HCT was taught using 8 modular booklets. The Modules targeted in this research were: percentages; time calculations; and graphs. The length of time taken to cover a module ranges from 3 to 5 weeks, depending on the content to be covered in the booklet. The module relating to percentages is taught over 5 weeks, the module on time calculations is taught over 2 weeks, whilst the module on graphs is taught over 3 weeks. There were 5 contact periods per week of 55 minutes each. My choice to do my research within these topics was a consequence of my experience teaching them using the traditional teaching approach and also because I had observed that students at Abu Dhabi Women's College had continued to find these particular topics especially challenging. Furthermore, these topics lend themselves to student projects and are powerful tools to investigate issues of social justice.

Three projects were completed in this research work, namely, Time of Travel (TT); Career Aspirations (CA); and Car Parking (CP). The topics were chosen based on individual participant's interest after brainstorming sessions in my class, and all dealt with one or more issues that have social justice implications.

This research investigated the results among students after adopting a social justice approach to teaching. The results showed the effects upon:

1. students' learning in mathematics;
2. students' engagement;
3. students' ability to develop agency; and,
4. successes and challenges encountered in using this approach to teaching in this particular context.

This chapter presents discussions on the findings; implications for future research and the successes and limitations encountered during the study; and, suggestions for future research. Section 6.2 presents the discussions of each finding based on the order of the research aims stated above. Section 6.3 discusses the research implications. This is followed by Section 6.4 in which the limitations of the study are discussed whilst Section 6.5 provides suggestions for future research. The final Section 6.6 concludes with a closing comment.

6.2 Discussion of Findings

This section is divided into 4 subsections in accordance with the research aims.

6.2.1 Learning Mathematics

Research Aim 1: What was the resulting students' learning in mathematics as a result of the adoption of a social justice approach to teaching?

The findings strongly suggest that the involvement of students in the projects assured there was no decline in their ability to learn mathematical content - it

further helped them develop significant relational understanding of the topics targeted in this research work, as presented below.

The participants have demonstrated significant understanding of how to sketch draw and how to calculate the area of compound shapes, even though at the Diploma Foundations (DF) level students are not taught how to calculate the area of compound shapes or how to sketch draw. They also demonstrated significant understanding on how to compare and contrast bar graphs and they have also acquired significant analytical skills necessary for understanding the hidden messages in graphs, especially Bar Graphs. This is in line with Johnston and Yasukawa's (2001) definition of numeracy, stated as, a way of negotiating the world through mathematics.

The finding also show there is some evidence that the participants developed understanding of how to carry out calculations involving time, in particular, how to (a) convert time from one unit to another, for example, hours to minutes, (b) add and subtract time and read time. There was also evidence to suggest the participants' have developed significant ability to problem solve and to think critically in many instances during collaborations, in class. For example, in the Car Parking project, after calculating the area of all the car parks, participants decided it was reasonable to use the area of an average (not a small or large car because most students drove small to average cars) to calculate the total number of cars that could park at the parking areas, at any given time. By deciding to use the area of an average car, the group demonstrated significant problem-solving and critical thinking skills. By doing so, the participants have demonstrated significant numeracy skills in accordance with Coben's (2000b) definition of a numerate person, stated as, "someone who is competent, confident, and comfortable with his or her judgements on whether to use mathematics in a particular situation and if so, what mathematics to use, how to do it, what degree of accuracy is appropriate, and what the answer means in relation to the context" (p. 35). They have also demonstrated some of the characteristics of qualitative literacy in accordance with Steen's (2001) criteria - confidence with mathematics; cultural appreciation; logical thinking; making decisions; applying mathematics in context; and, number sense.

In addition, the findings show that participants have developed significant ability to communicate their mathematical ideas. The findings also suggest that participants have developed and demonstrated significant reasoning skills by interpreting their mathematical calculations beyond mathematics. For example, Shaikha's work in Section 5.3.2; 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. Her interpretation reminds us of one of the limitations of mathematics, which is, that mathematics alone does not always provide the right solutions to authentic problems - that is why interpretation based on the individual's needs is so important. There was also some evidence to suggest participants demonstrated significant understanding of meaningful rounding. For instance, they demonstrated such knowledge in deciding on the number of cars that can park in each car park. Also, participants used the concept of meaningful rounding to reach their conclusion that the ratio of: Teacher to Parking area is 1:2, that is, each teacher has got two parking spaces; while , Students to Parking area was 2:1. These are in line with van Groenestijn's (2003) definition of "Numerate Behaviour", stated as "managing a situation or solving a problem in a real context by responding, interpreting and communicating information about mathematical idea that is represented in a range of ways and requires activation of a range of enabling knowledge, behaviours, and processes" (p. 231).

The findings show that mathematics alone does not always provide the right solutions to authentic problems. For example, in Section 5.2.5, 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. Shaikha's work has not only reminded us of one of the limitations of mathematics but also demonstrated reasoning beyond mathematics.

Finally, the findings in this research show the participants also "succeeded in an academic sense" as they all passed their End of Module assessments and the end of year Key Common Assessment (KCA) examination. This is in line with Gutstein's (2006a) mathematical pedagogical goals for teaching mathematics for social justice, which requires the learner to pass the

prescribed examination which would enable him or her to gain admission into his or her desired course. The findings in this research also show participants faced some challenges during their projects; the challenges are presented in the next paragraphs.

As stated before, the Car Parking group initially struggled with how to use a measuring tape to measure the dimensions of the car parks. I provided the groups with the necessary scaffolding without interfering too much with their decision making; as a result the participants gained confidence and took control of their learning. My action was significant because without concrete, yet minimal, support they would probably struggle to read the world with mathematics. Such actions give support to Gutstein's (2006a) dictum that in the absence of concrete direction and guidance, one does not easily become a "reader" of the world using mathematics. My action was also in line with "engagement" in accordance with the principles of Productive Pedagogy (Linguard, et. al., 2001), which encourages scaffolding students when necessary to ensure they don't lose interest because they are stuck and not making any progress. Many participants also initially struggled with some basic mathematical computations.

Some of them struggled with how to calculate percentage change. They were confused on which value to divide the change value with. The commonest mistake was where students simply divided the change by the bigger value of the two given values, and they did not know when a change was an increase or decrease (for example, Afra's work in Section 5.2.2). Similarly, the Car Parking group made one major error in their calculations. They forgot to take into consideration the gap that should exist between parked cars (both between cars, to allow for occupants to open the doors to enter and exit, as well as the necessary road space for cars to enter and exit between rows). But, this error in calculation was consistent throughout, hence, in my opinion, this setback, though significant, does not adversely affect the interpretation they provided for their result.

In addition, the findings also indicate interference from the students' prior knowledge with their ability to make sense of adding and subtracting times

expressed in hours and minutes - previous misconceived ideas of addition and subtraction were hindering their understanding here (for example, Nouf's work in Section 5.2.4). Their projects provided opportunity to them to develop relational understanding of these concepts. This finding supports Richard Winter's dictum (in Frankenstein, 2006, p. 28) that the problems many students encounter in understanding mathematics are not due to the discipline's "difficulty abstractions," but due to the cultural form in which mathematics is presented.

Finally, findings show that students need to be reminded regularly of the importance of reading questions more than one time before attempting to solve them. Many of the errors in the participants' computations were due to lack of reading the question carefully (for example, Sumaya's work in Section 5.1.5).

6.2.2 Students' Engagement in a Mathematics Classroom

Research Aim 2: What was the resultant students' engagement due to the adoption of a social justice approach to teaching?

The findings in this research suggest that the unprecedented level of engagement demonstrated by the participants was as a result of three factors. First, the projects were connected to their lived lives, second, the participants' believed their projects had the potential to better their lives in college and out of college; and, third, the project topics were chosen by them. For these reasons, they developed a keen interest in mathematics, so much that they engaged in discussing mathematics in and out of the classroom. Such keen interest has resulted in students' participation in other mathematics activities, for example, the Remediation Programme and Ajiyaluana Day celebration, as discussed in Sections 5.3.2. In addition, it was interesting throughout that during lessons, those reluctant learners who habitually would have gone to the "rest room" in the past and spend a considerable amount of time there before returning to class, never asked to be excused to go to the "rest room". Lateness for mathematics lessons became a thing of the past - everyone was eager to arrive and reluctant to leave at the end of the lessons.

The opportunity to investigate real issues increased the students' engagement and also pushed them to construct and apply important mathematical concepts (Turner et. al., in Gutstein & Peterson (2005)). Data analysed as in Section 5.2 strongly demonstrate that if students are solving problems which have social implications for their lives they are more likely to engage in them because they see such problems as “theirs”: not ones imposed on them by the teacher. This is in line with Gutstein and Peterson's (2005) suggestion that “engaging students in mathematics within a social justice context increases students' interest in mathematics and also helps them learn important mathematics” (p. 4).

These findings also give support to the suggestion (González, 2005; Valenzuela, 1999, 2002) that education rooted in students' needs, experiences and circumstances has the potential to be transformative. The findings are also in line with Mill's et al., (2009) suggestion that the work given to students should be connected to their world to enable them to experience a learning environment in which they are most likely to demonstrate a high level of intellectual outcome.

Henningsen and Stein (1997), in their investigation of the factors in mathematics classrooms that either hinder or support students' engagement, found that minority students fail to engage in high-level mathematical tasks due to a lack of opportunities to participate in challenging mathematics learning experiences rather than to a lack of potential. Based on their research findings they recommended that teachers provide meaningful mathematics for their students. The findings in this research further highlighted the importance of a meaningful mathematics teaching approach, which is what Social Justice Pedagogy provides.

In addition, the findings in this research are also in line with the National Council of Teachers of Mathematics (2000) recommendation, that as a way of engaging students, a more student-centered mathematics classroom is needed whereby a “relational” approach of teaching is created, as against an “instrumental” method. The findings give support to Peterson's (2005) suggestion that because most curriculums rarely encourage linking

mathematics to other subjects, many students see mathematics as an isolated subject with no relevance to their lives. As a result, they are led to believe that mathematics is not connected to social reality in any substantive way.

As stated earlier, the findings in this research suggest that one of the reasons for the unprecedented level of engagement by the participants was because the project topics were democratically chosen by them. They have experienced a democratic process for the first time in a mathematics classroom. Their project work provided them with opportunities, for the first time in their academic journeys, to have some control of their studying and learning habits. As a result, despite some initial hitches, the participants relished the opportunity and applied themselves beyond the point of “duty”. Such “students’ control” is in line with the principles of Productive Pedagogy (Lingard, et al., 2001), which suggests that if tasks are student centered, and seen by the students as their own tasks, not one imposed by the teacher; they would be most willing to engage in them. Data reveals participants had lots of fun because they chose their project topics based on their interests.

The significance of “fun” cannot be underestimated. Maria Montessori, the founder of the “Montessori Method”, now utilised around the world, observed that one test of the correctness of educational procedure is the happiness of the child. And, the greatest sign of success for a teacher occurs when the students are working as if the teacher did not exist.

Indeed, I have felt the reality of both these phenomena in the classroom, utilising this Social Justice Pedagogy, as the students immersed themselves in the work of their projects – experiencing, what other researchers have labeled, “Flow” (Csikszentmihaly, 1975; Csikszentmihaly & Rathunde, 1993). Csikszentmihaly (1975) postulates that Apathy is created when both challenge and skills are low; Anxiety develops where challenge is high, but skills are low; Boredom results from low challenge, but high skills. The only place where “Flow” arises, permitting contentment, self-fulfilment and sustained concentration and focus, is when skills and challenge are both high and approximately matched.

These examples of educational philosophy and psychology of learning, by Csikszentmihaly (1975), were certainly evident in the conduct of the work and the outcomes of student engagement in this research. Data reveals the participants had fun throughout the research, hence, everyone was happily engaged and enjoying what they were working on because it made sense in their world - in other words, it was connected to their world in accordance with the paradigm of Productive Principles (see, Lingard, et al., 2001).

The findings also reveal that participants expressed positive experience with the way their mathematics lessons were facilitated. Each of the participants enjoyed the mathematics lessons in which their projects were discussed – they gave it significant effort because they saw themselves as trying to solve their own problems. All this happened because it was obvious to the students that they were working on real world problems which were not totally teacher directed and which meant a lot for them. In addition, they felt it might help improve their lives not only on campus but also in the community.

Finally, data analysis reveals there were instances where participants felt frustrated because of their inability to express themselves as persuasively as they would have wished, and by the demand placed upon them to be independent learners. Their frustrations were because: (a) English is their second language; and, (b) the pedagogy employed, that is, Social Justice Pedagogy, is contrary to the instrumental teaching method they were used to during their school days. However, because occasional scaffolding was provided without interfering too much with the participants' decision making, and because students were encouraged to express their mathematical ideas in an environment of no put-downs, they persevered in their engagement with their projects and mathematics, and presented their findings enthusiastically and with confidence. Substantive conversation occurred in accordance with the principles of Productive Pedagogy (Hayes et al., 2001). Such substantive conversation, which led to significant engagement by the participants, is in accordance with Flores's (2006), suggestion, that, the students' level of engagement in a mathematics classroom can be enhanced, by encouraging them to talk about their mathematical ideas. Similarly, the frustrations

expressed by the participants, with regards to Social Justice Pedagogy, are in line with those expressed by Gutstein's students (see Barbosa et al., in Gutstein, 2006a).

6.2.3 *Students' Agency*

Research Aim 3: Did the participants' develop agency as a result of the adoption of a social justice approach to teaching?

This question aimed to explore how the teaching of practical numeracy, using the social justice approach, could develop the ability of students to achieve a sense of agency. Gutstein (2006a) defined social agency as a kind of agency that does not simply mean psychological or motivational factors, for example, students' sense of self efficacy, individual achievement/attainment, or effort optimism, but one which is developed when "the learner sees himself or herself as capable of contributing to historical processes" (p. 27). During the project, the participants in this research realised their work was historical because it was the first time anything like that has been done in ADWC. Pruyne (1999) referred to agency in which students not only see themselves as people whose actions can and do make a difference, but who also take such action based on their awareness of oppressive and unjust conditions with the aim of changing the situation for better, as "critical agency". He defined this enhanced sense of agency as, determined action taken by a student, individually or as a group to facilitate the creation of counter hegemonic pedagogical.

Researchers differ in the way they see the connections between student agency and equity. Some advocate attending to student agency as a way of encouraging mathematical learning by fostering higher levels of engagement (e.g. Allexsant-Snyder & Hart, 2001). Others like to link student agency to broader notions of empowerment and social justice (e.g. Ernest, 2001; Gutstein, 2003, 2007; Valero, 2002, Tuner et al., 2007). The findings in this research support the latter school of thought, that fostering student agency supports equity through both its impact on students' sense of themselves as doers and creators of mathematics, and its encouraging them to see

themselves as capable citizens who have the power to be “key participants in the struggles for equity and justice” (Gutstein, 2003, p. 27).

In addition, the findings show that the participants have developed both a sense of “social agency” (Gutstein 2006a) and “critical agency” (Pruyn, 1999), as their actions have led to: (a) an increase in the students’ car parking area; (b) a change in lesson starting time for students’ from 07:30 to 08:30; and, (c) career fairs at their College featuring information on part-time jobs, not only full-time jobs as was the case before this research. To achieve the milestones mentioned, participants utilised mathematics as a tool to understand their worlds (in this case, their problems with parking space at the college; travel times to and from college; and, career aspirations) and they followed their understanding with action to redress the perceived injustices. The Car Parking project, took action by meeting with the college Director during which they presented their findings to him. Similarly, the Time of Travel project participants took action by sending a letter to the Student Services Coordinator at the time. In the letter they made recommendations on ways to improve the bus services at the college. The Career Aspiration project students took action by writing a letter to ADWC Career Coordinator explaining their findings and making recommendations. In other words, after reading the world with mathematics in accordance with Gutstein (2006a), they also wrote the world with mathematics (Gutstein, 2006a).

The participants in this research utilised mathematics as a tool to better understand the challenges some of them faced with parking space at the college; the challenges they all faced with travelling to and from college; and, the career aspirations of DF students. By doing this, they have read their world with mathematics in accordance with Gutstein’s (2003) suggestion that reading the world with mathematics entails using 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. For instance, if one uses mathematics as a tool to understand how banks make their profit or what information they hide from customers or what is left out, and so on, then he or she has read the world using mathematics. Similarly, if one utilises mathematics as a tool to expose social injustice, then he or she

has also read the world using mathematics. After using mathematics as a tool to read the world, the participants followed it with action: the Car Parking project group met with the college Director, as a result of their project, the student car parking area was increased; the Time of Travel project group took action by sending a letter to the Student Services Coordinator at the time. As a result of their project, the starting time is now 08:30, not 07:30 as in previous academic years; the final group, the Career Aspiration project group took action by writing a letter to the college's Career Coordinator, as a result of their project, Career Fair shows at ADWC now include information on part-time jobs. Prior to their projects, these students were not used to taking action, therefore, the action taken by them was, indeed, unprecedented and a breakthrough in their journeys toward becoming agents for change. This finding is in line with Tate's (1995) belief that if a curriculum is centered on problem-solving connected to real experiences of the learner, there is a high possibility that the learner will use mathematics as a tool to change the society. The findings also give support to critical mathematics educators' (Frankenstein, 1990; Gutstein, 2003, 2006a, 2007; Gutstein, Middleton, & Fey, 2005; Skovsmose, 1994; Tate, 1995) suggestions that mathematics education should aim to both equip students with the skill and understanding to succeed academically, and prepare them to critically investigate, challenge and act upon issues in their lives and communities. In other words, mathematics education should support students' sense of agency, their sense of themselves as people who can make a difference, and their ability to be critical and active participants in the world.

In addition, the findings show that participants have also developed a sense of academic agency by accepting responsibility for their learning, and they showed initiative and perseverance in their quest for knowledge. As a result they achieved self-regulatory status in accordance with (Zimmerman, 1990, 2001). A self-regulated learner accepts responsibility for cultivating knowledge and skills - they demonstrate initiative and perseverance in their quest for learning. They also demonstrate agency in their ability to confidently voice an opinion in class amongst peers and out of class without fear, also by interpreting their mathematical calculations beyond mathematics (see,

Shaikha's work in Section 5.3.2), and demanding equity for all the participants.

The finding also supports Bruner's (1996) and Pruy'n's (1999) suggestion that supporting students' sense of agency is a critical component of schooling as well as an important step towards achieving equity in mathematics education (Ernest, 2002; Gutstein, 2003; Valero, 2002). This research has also provided the opportunity for the participants to develop significant confidence in their study of mathematics.

The findings suggest that participants in this research were initially haunted by the rote-learning experience they went through during their secondary school education. Many of them viewed mathematics knowledge as a collection of unrelated facts and procedures (Brown et al., 1988; Grouws et al., 1996; Schoenfeld, 1992). They believed that mathematics is learned by memorization (Brown et al., 1988; Schoenfeld, 1989). For this reason, even though the topics covered in this research were supposedly taught to them during their secondary school education, they could not recall basic concepts associated with percentages, time calculation and graphs because their prior knowledge on these topics was not well understood. This finding in this research is consistent with Hiebert and Carpenter's (1992) suggestion that prior knowledge that is not well understood has the potential to negatively influence future learning. In other words, if learners simply memorize content without developing cognitive links between components of that content, then it is unlikely that they will be able to transfer much of what has been memorised to related themes. Bransford et. al., (1999) and, Gagne and White (1978) added to Hiebert and Carpenters' (1992) dictum that if the learner established rich, internal cognitive connections between relevant verbal propositions, imagery, skills and memories of episodes, they will be better placed to successfully transfer their prior knowledge on the content. Similarly, Resnick and Ford (1981) added that the practice of teaching mathematical concepts through stand-alone examples and repetitious practice sets does not foster understanding or the transfer of learning to other areas. In addition to the influence of prior knowledge on learning, findings

showed that one's self-belief about mathematics was also a factor influencing the understanding of mathematics.

One's experience of learning mathematics during school days can have a long-lasting effect on the way one subsequently thinks of the subject. Positive experience can lead to the holding of positive self-belief, while negative experience can lead a student to developing negative self-belief about their ability in mathematics. Muis (2004) in his review of multiple studies on student mathematical beliefs revealed that, in general, students hold non-availing beliefs about mathematics and its learning. These non-availing mathematical beliefs are contrary to the idea of mathematics and mathematics learning advocated by the National Council of Teachers of Mathematics (NCTM) principles and standards (2000), which emphasizes relational understanding rather than memorization. Researchers have also found students' desire to learn mathematics to be strongly linked to their perceived competence, ability and achievement. When they perceive themselves as capable of doing well in mathematics, they tend to value mathematics and become more inquisitive about the subject of enquiry. Similarly, those who perceive themselves as unable to do well tend to switch off from the subject (Ames, 1992; Dweck, 1986; Meece, Blumenfeld, & Hoyle, 1988; Middleton & Spanias, 1999; Schiefele & Csikszentmihalyi, 1995). The findings in this research (from data analysed in Section 5.2) are also in line with the latter suggestions. The data analysed shows that participants saw themselves as not capable of learning mathematics, and had developed negative self-belief about the subject and even hatred towards mathematics. However, they told me that their exposure to the teaching for Social Justice Pedagogy has significantly helped them to see how useful mathematics could be to their lives. It is therefore reasonable to assert that, this methodology, has provided the participants with opportunity to overcome their past negative self-belief about mathematics and gained (sometimes, for the first time in their lives) confidence in solving problems involving geometry; percentages, graphs and time calculations. This finding is also in line with Purkeys' (1970) suggestion that students will behave in certain ways due to their beliefs and perceptions about themselves and others. He suggested

that a crucial part of the teacher's job should be to teach content and develop positive self-concept in students. The findings also give support to Banduras' (1986) suggestion that in all areas of life, the behavior of human beings is impacted by their beliefs.

6.2.4 Successes and Challenges of Teaching Mathematics using a Social Justice Approach.

Research Aim 4: What were the successes and challenges encountered in using a social justice approach to teaching in this particular context?

The data analysis as presented in Section 5.4 suggests that the teaching methodology employed in this research work, that is Social Justice Pedagogy, has recorded successes and challenges similar to most of those recorded in the few, yet significant, research works carried out on teaching mathematics for social justice; for example, see Gutstein (2006a), Tuner (2003), and Gutierrez (2009).

As stated in section 5.5.1, a major success was achieved in the implementation of some elements of Productive Pedagogy. The successes are presented below.

The findings show that the participants in this research have developed significant ability to analyse and to synthesise their findings. It was pleasing for me to see the participants thinking out of their comfort zones as this does not happen often at the DF. The examples of Higher Order Thinking skills reported in section 5.5.1 are in accordance with Hayes, et al., (2006) definition of Higher Order Thinking, which is, "to manipulate information and ideas in ways that transformed their meaning and implications" (p. 42).

Data analysis reveals the participants have experienced a democratic process in their mathematics classroom. Many of them told me that this experience was indeed one that they would never forget in their life time, because it was the first ever. It was pleasing for me to have recorded how the participants grew from shy to confident young adults who are no longer afraid to voice an opinion on issues that are important to them. Such

confidence resulted in passionate debates amongst participants on some issues, for example, why the military is perceived as an unsuitable career for women and on the relevance of the UAE Emiratization Program. These passionate debates helped the participants to develop significant ability to communicate their mathematical ideas. In addition, the participants' explanation on sensible rounding (when to round down or round up an answer) as well as their explanation of the meaning of percentage also helped them to develop significant ability to present their mathematical ideas. These examples are all in accordance with Hayes, et al's., (2006) definition of Substantive Conversation, which is "there are considerable teacher-student and student-student exchanges; the interaction is reciprocal; and it promotes coherent shared understanding" (p. 44).

Another success recorded in this research is that it has resulted in an unprecedented level of engagement by the DF students. Data analysis strongly suggests that all the participants in this research relished the opportunity provided to them by engaging enthusiastically on their projects; in the process they demonstrated a high level intellectual outcome. This is in line with Mills et al's (2009) suggestion that "if the work given to students is connected to their worlds, a learning environment will be created in which they are most likely to demonstrate high levels of intellectual outcome" (p. 71). An additional success is that the Social Justice Pedagogy employed in this research provided participants with the opportunity to engage in activities which connected mathematics to their lives beyond the classroom. This is also in line with Hayes et al., (2006) definition of connectedness "the extent to which knowledge is built on students' existing knowledge and connected with the world beyond the classroom", (p. 53).

Additional success of this research is that all the tasks were student centered. All the project topics were decided by the participants themselves. Data analysis reveals the participants have accepted responsibility for cultivating knowledge and they showed initiatives and perseverance in their project. For example, during the period of the research, participants kept coming to the Mathematics Club, during their lunch time, to continue working on their projects. As I reported earlier in section 5.4.1, on one occasion I

asked the participants why they were using their lunch time for the project instead of enjoying the time with their fellow students around the campus. One of them called Haleema said they were doing that because the project meant so much for them. These participants have clearly utilised the opportunity provided to them to develop into self-regulatory learners. This is in line with Zimmerman (1990, 2001) suggestion that self-regulated learner is someone who accepts responsibility for nurturing knowledge and skills; they also show initiative and perseverance in their quest for learning.

This research is also successful for providing support to students. Data analysed show that a warm, friendly atmosphere existed throughout the period of the projects. Students said they felt they were free to take risks by trying things without the fear of failure in pursuit of the required result. An example of this is, when Warda (see section 5.3.1) a very quiet and shy member of the Car Parking group, presented to the class on how to calculate the area of a triangle. Although she struggled to articulate her explanation, all the students supported her. As a result of this kind of support, participants in this research have developed significant self-belief in their ability to do mathematics.

Another success recorded in this project is that it had aided the participants to achieve active citizenship. The findings also show that teaching Practical Numeracy to DF students using Social Justice Pedagogy has led to the students' achieving a sense of agency. (A detailed discussion was presented in 6.2.3). For all the participants in this research this was the first time they were involved in any form of action that might be misinterpreted as revolt against the authorities. As stated in section 5.5.1, the action taken by the Car Parking project led to an increase in the students' car parking area at ADWC, the Time of Travel project has resulted in the change in the lessons' starting time for students' from 07:30 to 08:30, and the Career Aspiration project led to career fairs at ADWC featuring information on part-time jobs, not only full-time jobs as was the case before this research. The results achieved by the participants are in line with Mills's (SMEC Education Conversation, 2010) suggestion that for citizenship to be demonstrated "it is not just enough to be a "clever student" action needs to be taken as well".

In addition to the major successes recorded in this research as a result of the implementation of some elements of the Productive Pedagogy, as outlined above, successes were also recorded as follows.

Exposure to rote learning methodology had led the participants in this research to perceive mathematics as a subject that is very difficult to understand. As a result, they developed dislike and even hatred for the subject; this led them to hold non-availing beliefs (Muis, 2004) about mathematics. The findings in this research show that the methodology employed led the participants to change their initial non-availing beliefs about mathematics to availing beliefs; consequently, they have achieved significant relational understanding of some mathematical concepts. All the participants were successful at their end of course (Key Common Assessment (KCA)) examination. Most important of all, the methodology utilised has rekindled hopes for the participants as doers of mathematics. (A detailed discussion was presented in Section 6.2.1).

The findings show that the methodology employed has led to increased local and global awareness for the participants. As my students posed problems that mattered to them, their desire to understand and affect change increased. Data analysis revealed how little knowledge DF students had with regards to local and global issues. For instance, some students didn't know the total number of Emirates in the UAE; some students didn't know the private sector is obliged to employ Emiratis as part of their Government Emiratization Program; and, almost none of the participants thought their opinion on their immediate community (ADWC), and country in general, was important. This is no longer the case. By teaching the students using Social Justice Pedagogy, the participants are now well informed on the issues stated above and they now see themselves as people who can, and should, make a difference in their communities.

This research was also historical, as this approach to teaching is not common in the Middle East. Teaching mathematics through social justice is "relatively" new in many parts of the world. In the whole of the Middle East, this research is probably the first of its kind. Therefore, another success of

this research was that it has helped define how students in the Middle East (in particular at ADWC) respond to teaching using Social Justice Pedagogy. In turn, it has confirmed some or all of the benefits and challenges that researchers from other parts of the world have discovered with regard to the teaching of mathematics for social justice.

Finally, the findings revealed this methodology was successful because it was focused on college students (adult learners) and was carried out in normal classroom settings. To the best of my knowledge, all the research work to date, in which Gutstein's framework for teaching mathematics for social justice was used, was based on middle and high school students (see Gutstein, 2001; Varley et. al., 2007; Tuner et. al., 2009). This is the first case in which such a framework was employed with college students (adult learners). Significantly, literature on teaching for social justice, at college level, was almost entirely absent. Therefore, teaching mathematics for social justice, in this context, was a success, as it has contributed to the literature in this area.

The findings in this research reveal that there were some challenges encountered with teaching mathematics for social justice in this context. Detailed analysis was presented in Section 5.5.2. However, in order to reduce the cognitive demand on the readers, a snap-shot is presented here.

One single yet most influential factor that stands in the way of many teachers teaching mathematics for understanding is the pressure to prepare students for exams (Jacobsen & Mistele, 2010; Lipman 2004; Lipman & Gutstein, 2001; Radicalmath.org, (2007)). Many teachers are compelled to compromise their quest for working towards student understanding because they need to complete external examination syllabus requirements "on time". As Gutstein (2006a) succinctly puts it, making students think less about their end of year exam is a challenging task and requires time, because such a culture contradicts students' expectations of what teaching "should be" – and students are not always so quick to accept this new way of teaching. Findings in this research give support to this (Lipman 2004; Lipman & Gutstein, 2001, 2006a; Radicalmath.org, (2007)) dictum. "Exam fever" was

apparent amongst the participants in this research. They expressed it, both in writing and verbally, at different times during the period of this research.

Another major challenge was time constraint. It was a policy in the DF Department that no teacher should teach a particular class for 2 consecutive semesters. If I had taught this class for the whole academic year it would have allowed me more time to become “one with them” which, I believe, would have facilitated more open discussion in the class. This finding is consistent with Radicalmath.org (2007) groups’ suggestion that it takes time to write good curriculum based on social justice teaching. In addition, time is needed to allow students to get used to this manner of teaching and learning. There is also the challenge of implementing change in a single subject.

Also, being a male teacher teaching female students was another challenge in this context. As a male teacher I am not allowed to have any one-to-one interviews or discussions with the participants. This means participants had no opportunity to express personal views in private.

In addition, the use of English as the language of instruction presented another challenge in teaching for social justice in this context. Arabic is the language of instruction throughout their primary and secondary education. I believe had the class discussions and interviews been conducted in Arabic they would have been better able to express themselves. This finding is in line with (Clarkson, 2002; Ellerton, 1989; and Ellerton & Clarkson, 1996).

Another challenge was students’ reluctance to critique their each other. During the earlier stages of group discussions, participants were reluctant to express opposing views. My discussion with one of the participants revealed that if I asked the first questions it would be easier for the students to contribute because then their classmates wouldn’t be offended that they started the questioning. The final challenge was my inability to pass on parallel information to the project groups. All the projects were conducted simultaneously; therefore, it was challenging to provide similar learning experiences in mathematics to all the groups.

Finally, another major challenge of my research was that the classroom in which it was carried out did not meet all of Gutstein's (2006a) criteria for a classroom for social justice, because discussions on politically taboo topics were not encouraged in this context. For instance, during brainstorming sessions on suitable topics, a group of students wanted to use mathematics as a tool to investigate the rate of marriage failures. This topic would have given them the opportunity to interview fellow students from broken families with a view to providing insight into some of the root causes of marriage failures in the UAE. Although I was attempting to teach for social justice, I could not allow this topic to be discussed in my class because it may lead into sensible findings seen to be controversial for a male teacher and from a different culture to the students to discuss with students. It is pertinent to mention here that I am contracted not to engage in any discussions that have religious bearing with the students. Issues with direct connections to the Islamic religion, like marriage, are left exclusively for the parents and religious leaders to deal with. However, my guess is that an Emirati female teacher might be able to take a chance and discuss such topics with the students.

Of the above challenges encountered, time, in particular, DF Departmental policy on course allocation, was the most serious constraint, as it did not allow sufficient time to win the trust of Section DF203 students, and their parents, before embarking on this research. However, I consider that, despite these constraints, the principal objectives of my research were achieved.

6.3 Implications of the Study

My research sought to contribute to research studies in teaching mathematics for social justice and its implications for researchers in the field of teaching for social justice as well as mathematics education. The current investigation on teaching practical numeracy through Social Justice Pedagogy to adult learners was prompted by the observation that a noticeable gap exists in the literature on teaching mathematics for social justice.

One of the important implications this study is related to the practice of

teaching mathematics in this context. The findings from this study draw attention to urgent need for a meaningful mathematics curriculum at the Higher Colleges of Technology – one with real life connections to the learner’s world. Such curriculum can support students’ understanding of mathematics because it would allow them to draw upon their familiar experiences in making sense of the mathematics. In addition, such curriculum can support students’ ability to see how the context relates to their own lives and experiences and use this knowledge to support their mathematical analysis and arguments. However, it takes time to write good curriculum (RadicalMath.org, 2007), in addition, the teachers who would deliver the curriculum need to be trained on how to relate mathematics topics with the real life experiences of their students. This call is in line with Jacobsen and Mistele’s (2010) findings that the abilities of some preservice teachers to connect mathematics and social issues improved dramatically as a result of the training they received. This kind of training is best achieved if the teachers are open-minded and have good and relational understanding of mathematics themselves. This is necessary because teachers with such understanding would obviously be believers in such method of teaching, and therefore have reasonable chance of surviving within a system that most often does not support teaching for social justice.

As I was writing this thesis, Higher Colleges of Technology administrators were working excitedly on developing a new Bachelor degree program, which marked the end of the Diploma Foundation Course across all HCT Colleges, starting from the 2010/2011 academic year. Nevertheless, my research work provides empirical evidence in support of some of the changes made, for example, the need for the curriculum to: become more relevant to the learners’ world; provide opportunities for critical thinking; and, provide opportunities for students to become “self- regulators”.

In addition, the findings show that with careful planning and determination on the part of the teacher the obstacles to teaching mathematics for social justice identified in this research can be minimised and eventually overcome, if policymakers are on board the “social justice ship”. Therefore, it is

important that college Directors and teachers feel they are being encouraged to be creative without fear of retribution from Higher College of Technology policy makers.

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 perceived as passive and not visible. The findings in this research show that, like their counterparts in the Western world, these students are also interested in social justice issues. This is particularly significant because of the current ongoing Arab Spring in the Middle East. Therefore, extending the research to this new context of women in traditional societies shows that a focus on social justice is possible and beneficial. In addition, the findings show the new methodology utilised in this research, that is, combining social justice with Productive Pedagogy is advantageous. This provides a springboard for future researchers to conduct further studies using this approach.

This research has made a major 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 the Middle East to college students (adult learners) in normal classroom settings. Findings show that the participants have developed both the social justice goals and Mathematics goal as prescribed by Gutstein (2006a). The study also shows that the application of Gutstein's framework in this context has some limitations. In addition, the research gap in investigating the ability of students to develop agency as a result of Social Justice Pedagogy in the Middle East was also bridged through this research. The findings indicate that students have developed a sense of agency by their ability to read and write the world with mathematics.

Distinctive contribution was also made through this study by supporting the assertions of those who had hitherto engaged in the same field (Gutstein, 2006a, 2007; Gutierrez, 2007; Turner, 2003), and it has also added to the limited literature available on the teaching of mathematics for social justice to

adults. In addition, the study found empathy (reluctance to critique) as an additional challenge in the way of teaching for social justice. This finding adds to the literature on the challenges associated with the teaching of mathematics for social justice.

6.4 Limitations of the Research

One major limitation of this study 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, as I mentioned before, I was probably the first male out of their family to exchange words with them. 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 was that the sample size (focus groups) was small. Over the years, a number of criteria were used regarding the use of focus groups for data collection. Some of such criteria are that group projects should most often have 6 to 10 participants per group, and have a total of three to five groups per project. In this research, I had only 3 focus groups, with only 3 students in one group and 4 students each in the other two. This was because, initially, many of the students agreed to take part in interviews but some parents declined the invitation for their daughters to be recorded on tape, even though the students indicated they wanted to take part.

Another limitation of the study is that, although I used a triangulation method for data collection in accordance with (Cooper 2001), and grounded theory for analysis, in accordance with Strauss and Corbin (1998), and Charmaz (2008), to achieve credibility in the interpretation of results, as a novice researcher, it was challenging to keep my voice hidden behind those of the participants in accordance with the advice from Fine and Weis (1997). In other words, it would be impossible to completely disallow my personal views on issues discussed from influencing those of the participants. Therefore, the findings in this research could be more reliable if it was carried out by an

experienced researcher in the area of teaching for social justice.

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 the many of the challenges these students might have encountered throughout their journey with me in this research. One can only hope that those challenges, if known, are not significant enough to falter the conclusions reached in this research.

A further limitation was it could be that, the experimental conditions created during the research have introduced a change in routine that might have inspired the participants. If this was a routine then it may not be effective in the long run. However, this can be said of any research.

In addition to the above limitations, there was the lack of research with regard to teaching mathematics for social justice in the United Arab Emirates and Middle East in general that could be used as a base line for reference. Consequently, this research had to refer to literature from different cultural contexts.

6.5 Recommendations for Further Research

To the best of my knowledge research on teaching for social justice is almost nonexistent in the Middle East. Therefore, the findings in this research could serve as a springboard for future research in the Middle East. In particular, the following suggestions and directions for future research may help to advance our understanding about teaching for social justice in the Middle East.

1. A research project similar to mine, in any Diploma Foundation department, at any of the Higher Colleges of Technology's Men's Colleges in the UAE. This is important because it may shade some light on whether or not the views expressed by the women in this research are shared by their male counterparts at the men's college.

2. A further project involving 2 HCT colleges; one a Men's college and the other a Women's college, at a higher level, possibly Diploma or Higher Diploma. Students at the Diploma and Higher Diploma levels are generally more able to express themselves orally and in writing. Therefore, it would be interesting to see if views expressed by the Diploma Foundation (DF) students in this research are shared by the students at the higher levels.
3. 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 may show that Social Justice Pedagogy does not disadvantage students academically, instead it provides them with opportunities to be better prepared for their future educational journeys.

It would be interesting to see if the views expressed on mathematics experiences at school; equality in the workplace; career aspirations; and, of course, the teaching methodology employed (Social Justice Pedagogy), by the women in this research are shared by their counterparts at the men's college, and also by students at higher levels of study within the college; and whether results and views changed over time.

The research for 1. & 2. should be conducted over a sufficient period of time, at least one academic year, to allow the researcher(s) and participants to build trust in each other. Trust between the teacher/researcher and the participant is a key factor to success in teaching for social justice. This is because to assure quality the researcher(s) will need to convince the participants to open their world to him or her and this is not possible unless there is trust.

Given the cultural background of the students at HCT and some religious constraints, it is also important that a male researcher takes on the men's college whilst a female researcher takes on the women's college. In other

words, it is important to accept the local “unjust?” practices as inevitable. It would also be advantageous for the researchers to be bilingual in Arabic and English; this would allow the students to express their views more effectively and to give more nuanced information in the qualitative research instruments. It is pertinent to mention here that by this I am not reinforcing gender segregation of education system, but given the context of the country (UAE); I am simply suggesting the most feasible way of carrying out further research on the teaching for social justice in this context.

There should be only one project happening at any given time within any given class group. This is particularly important because it would enable the researcher(s) to provide similar learning experiences in mathematics to all the participants. This was one of the challenges I faced during the projects in this thesis.

6.6 A Final Comment

It is pertinent to mention here that many of the issues considered as social justice issues in this research would not be seen as such in the Western world. Therefore, it is important to understand the context of this research. After all, social justice interpretations are contextual. With that in mind, one of the important lessons from this research is that it has shown that teaching for social justice in a context such as the one in which this research was carried out is a challenging task: it needs courage and commitment on the part of the researcher; and support and even protection by the head of the college or policymakers, because it is risky, especially for a contracted teacher like me. Therefore, if the results of this research are to provide useful insights and possible solutions as to why so many students nowadays dislike mathematics, then there is a need to respond positively to its findings as well as the challenges identified.

In addition, if this study is to be of maximum utility in the promotion of this pedagogy, then it is important to go beyond consideration of the performance of students exposed to this research, to consideration of how this pedagogy would move from being merely another piece of academic research to being an accepted pedagogy rolled out into classrooms as a widely applicable

educational modality. My understanding of the implications of this research, coupled with a literature review of contemporary research by others (none of which was found to discredit the pedagogy), reinforces my belief that this pedagogy should be promoted as a valuable tool for improving educational outcomes for the students, as well as making those students more valuable contributors to their society. As for me, I will continue to work to provide the benefits discovered in this research to my students here in the United Arab Emirates; policy makers; and anywhere in the world where my future teaching journey takes me. In terms of 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 the social and cultural constraints are within the society of which the students are a part.

In proposing the adoption of a novel pedagogy, regardless of the benefits discovered by the research, one must be cognisant of the barriers to adoption inherent within the institutional education environment, as well as potential barriers present in the wider cultural milieu. The pedagogy I have chosen to investigate and pursue could be perceived by some to be a challenge to certain normative cultural values or traditions in a Middle Eastern context. Accordingly, great thought must be given to assessing the value of these findings in the context of implementation. If this is to be widely used it has to be shown that it is in harmony with local culture.

It is not necessarily opinions that are hard to change, but rather, beliefs and misinformation. Recent research confirms that where an individual or group has previously accepted or entrenched *misinformation; beliefs; or a world-view*, that perception of reality will largely trump facts and data that contradict, challenge or disprove these previously held positions. Information that is presumed to be true at encoding but later on turns out to be false (i.e., misinformation) often continues to influence memory and reasoning (Ecker et al., 2011)

This insight is important to this research because if this pedagogy is initially perceived to be antagonistic to the norms of the culture, even if this view is later modified or corrected, it may be very hard to eliminate this view among

decision-makers. So, if this pedagogy is to succeed, it is important to attempt to ensure that no initial negative view takes hold. Analysing or affecting people's predispositions is beyond the scope of this thesis, however, being proactive about preventing a misapprehension about the nature of this pedagogy *is* possible.

Utilising caution in the *naming* of this pedagogy should at least neutralise initial misconceptions based on the use of what could be considered culturally loaded terms. For many, particularly in the currently politically charged atmosphere throughout the Middle East, a term such as "social justice" could have a revolutionary flavor that is a little too potent for comfort. For this reason, I would suggest the adoption of *Peoples' Pedagogy* as an alternate term to that chosen by Gutstein, which is the "Social Justice" Pedagogy. It is my belief that the psychology implied by the "People Pedagogy" term for decision-makers, teachers, parents and students would tend to be one that anticipates a co-operative, positive experience rather than the possibly confrontational one suggested by "social justice". This proactive marketing of the pedagogy is supported by Ever's (2006) work in, "*Crisis in School Management*

If I were to carry out this research again, in this part of the world, one of the things I would do is to replace the phrase "social justice" with something like, *Peoples' Pedagogy*, which may be perceived as less controversial.

For my students, 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, their reference to the answer section at the back of a text book! By applying mathematics to their everyday lives, it suddenly became relevant to them, and they realised the potential which it could have for changing often long-established norms.

It is pertinent to mention again here that it is reasonable to assert that, limited in scope though this research has been, it has, nonetheless, supported the assertions of those who have hitherto engaged in the same field, and it has

also added to the limited literature available on the teaching of mathematics for social justice.

APPENDICES

APPENDIX 1

Reflective Questionnaire

Please answer the following questions. You may write in Arabic if that would make it easier for you to express your point of view.

1. Do you like working on project work? Explain your answer fully.
2. Are the project(s) you have just completed the same or similar in form with the ones you may have done in the past? Explain your answer.
3. What do you like or not like about the mathematics projects you have completed this semester?
4. What would you have done differently if given the chance to repeat these projects?

Some Students' Responses on Reflective Questionnaires

Afra

1. *I didn't like project before because of English. Now Goma make it very easy for me to understand the math because he support all the girls in lesson with spelling and explain difficult words. Before I didn't want project work I just follow my friends but now I want more project in math.*
2. *This is better it makes us understand math and what we are doing to solve our question. Before we just work with numbers from book. This project I important to us not like before only project no meaning to my life. It makes us search information on internet about age of driving in other country. This make me know about things outside my country. It make us more aware of our country and.*
3. *I understand math better and I want to do math all the time. I go to class early after break no late. I don't want any break for double period I stay in class. All the project very important to students. Now we talk to each other more in class before some girls don't talk much but now we all talk. For me it makes me more confidence when I do math or even talk about math with my friends. Also now graph is easy to understand when I see it in newspaper or bank advert. I don't like to leave my math class again because we do fun stuff..., we are busy talking about our work, and arguing about what is right*

or wrong. Goma math make us work very well all the time and because we are solving our problems we enjoy it.

4. This is good project already. I like it.

Ayesha

1. I always like to work in project. I like working in group. This project was special for me because is different, is about car parking and I drive to college. This is my second time to be a leader in class. I was leader in my school during one activity. But this one is different because we are in charge of what we do and how we do. Teacher give advise only to us. Also we choose the topic by ourself not the teacher. This gives us good control of the work and good experience for our future after we finish college. All the students in my team are happy with this way to do project work...
2. No! This one is very important not because of grade but because we try to solve our parking problem. Projects before are about numbers from somewhere that no one know where they come from. But now we use our data from measuring the fields. This is very good fun for all of us.
3. I like many things about the math project we do. 1. Is about our problem we try to solve using math. This makes everyone try to find the answer. 2. It is more fun to do. I measure big area with tape for the first time in our life. I won't forget this project work. 3. I feel important after meeting the college Director to talk about our work. He was very friendly and he like our result. 4. We learn math without fear because is all simple and fun way measuring field for car parking area.
4. Next time I want to ask all the student in college to answer question about who drives to college. Because, I know the number 300 that we got from students service is not correct. This number make the problem okay but I know is not okay, the ratio is more than 1:2.

Muneera

1. I always like to do project but this project is more fun math. Goma is good teacher because he understand our problem with English and he support all of us to make progress in our study. He said is okay to try not to be afraid of mistake. Thank you teacher. I never be a leader before. This project has given me the chance to be leader. To organise my group girls in meeting and presentation to class. I like the project because students are in control not

teacher. We decide and the teacher only advice us. This is good experience for my life and all the girls in my group, never forget it.

- 2. This math projects are all different but I like them all. All of them are about making our future better. The projects are different from any one I do before in college.*
- 3. I like the bus project because we know from it that college bus is good value. Before many girls think college bus is too expensive. I like the career project because we know about jobs in private sector and about government program Emiratization. I like the car parking project because the college knows that we need more parking for student. In all I like all the project because we learn math in fun way. We even forgot is math we are doing. We argue and I like the presentation by all the groups. I think my group is best. It makes us more confidence to speak in public. This project give me power to understand the meaning of things using maths. Before I don't know how to give meaning to any math, like percentage or anything. My knowledge is good now for mathematics I never think it will be like this.*
- 4. Our project was the career project. I will ask all the diploma foundation college girls in college to answer the questionnaire this will make the answer better.*

Zainab

- 1. I don't like project work, too noisy. This project is good because girls did not disturb other students. May be because all girls know what their project want and are busy with the work to complete on time. This is very good to see girls working very serious in project, , without fear of mistake.*
- 2. This project is different. First time we are working to solve our problem in math. Other time is all about number from book without meaning. We al like the project*
- 3. I am from Abu Dhabi. I don't use bus but now I want to use bus. This project makes us know we can also ask for bus for girls from Abu Dhabi. Our parent need break for driving us to college. We also need new friends on the bus. The girls from outside have more friends because they meet in bus every day. Is not fair.*
- 4. I will ask the girls from Abu Dhabi to meet Intesar to ask for our bus. We are all student so we need our bus for college to help our parent not to drive every morning to college.*

Rahma

- 1. I like doing project work, is more fun. But I like the one we finish now because is about my life problem and we want to change the problem for better.*
- 2. No. This project is all about our life and this is different from before. Before they give us the number to use but now we use our number is kind of more fun. Is about our life this make more interested.*
- 3. I like all the three projects. But I only did the Career Aspiration one in my group. This project made all the student know about different jobs in UAE, different company and how they take worker to work for their office. We never get this chance before. This is first time any girl in my class do this project like this. I didn't know about the job of Emiratization but now I know. This project give student power to change the college problems, like with the car parking and bus projects. Many girls now speak with no panic in public. We learn math without fear like we fear before. Now no one want to late to math class.*
- 4. I will ask all the girls in the college should do the project. This is good for them. Also this make the project more better because every student did it. But is still very good we have to start small and become big one day.*

Dalal

- 1. I don't mind but book is better. You can do your work without other girls disturbing you.*
- 2. This one is different. We collected the data in this one. We learn more about our life in this one but before is all number from somewhere I don't know. This is a lot better than the Plan Trip project we did before or the Healthy Food project.*
- 3. It make me important because everyone must listen to my presentation. Also I feel good I am contributing to solve my college problem. We learn math in relax way without fear. I am very good to talk in public now no fear. I don't like the project is too long. We need to study to pass exam and this project take long. I am worry about the exam because is not like the project. I like the project but my parent want me to pass exam, this is why I worry about this project and I want us to work from the book like other sections. But Goma say we will pass, I trust him.*
- 4. Is okay like this but make it two weeks next time.*

Nouf

1. *I don't like project work before. Because many students don't do the work only copy from the friends. This is problem with project sometimes. And also class become too noisy, people talking and me a like to work quiet place.*
2. *I am surprise this project student didn't make too much noise in class, everyone was serious and work together not waiting to copy. I think we all enjoy doing it because is about our college and our life to make it better.*
3. *This project show me that if is about our life every girl will try her best and not to be noisy in class. Also now I know about percentages in easy way and I know the meaning why we use it. Math is fun now I enjoy it more than before the project. But I fear the exam will be difficult to pass before we learn only from project work.*
4. *I don't know. My group works on the bus project. May be we can ask the bus drivers what they think next time so we can hear their view also. Now is all about students may be the driver can answer some of the questions like why they speed, use mobile...*

Bedour

1. *Before no but now I like it is a lot of fun. Before I don't know that private company employ many people in UAE than government. This project give me many knowledge about many things. I am happy to learn more mathematics like this one.*
2. *No. This is about college, before is about number no meaning.*
3. *This project give me more power to speak in group. No shy like before. I now see math as useful in my life. I didn't like math before but now I go to class early no late again. I can calculate percentage in fun way also can add and subtract time. Before is all hard to understand. Now Abu Dhabi girls want to get bus, is good, I support.*
4. *I don't know. Project is very good like this already.*

Tahani

1. *I like project always. But sometime people make too much noise. Is good in this project many students work well without noise.*
2. *This one have more meaning because is about our data we collected. Is our work not given by teacher. Now math is enjoy not like before. We learn better I listen more in class because we enjoy the subject now. Every girl is very*

happy with the project. We try solve our problems with bus, parking and career.

- 3. In my project I use math with percentage to show college student need information about Emiratization programme, to ask for information about part-time job not full time. This is good way to math no boring.*
- 4. I like it all. No change please. This math is good, before this class I don't know Emiratis can work in private, I think is only people from other country. I will apply there after college I want work with people from other country.*

Fatima

- 1. I don't like project. Because many student don't listening is always noisy. But I also try my best anything I do so I try my best here also.*
- 2. All the same, too much arguing no time to think about the work and exam.*
- 3. I don't like to talk to man not my family. This teacher is not my family and I don't know him, He teach us only this semester. But his good teacher may be if he teach me again next time I know him more to relax and talk. But I learn a lot things from his class and the project.*
- 4. I want do the project alone to complete the career project in time if I get chance. I need time to practice for exam.*

APPENDIX 2

Students' Project Presentations

Time of Travel Project (TT)

Below is the work presented by the NA Group:

We are 5 in my group. All of us are from outside Abu Dhabi city. Every girls already finish calculate her answer for the information she collected from the bus travelling time. We decide to use Nahid result for our presentation because no time to show for everybody. This project is important to the girls who use the bus and may be to Abu Dhabi girls also who want to get bus to college. But the mathematics we learn from it is important to all of the girls in my class.

Name	ID	Section	CITY Name	TO COLLEGE	FROM COLLEGE
			Dhabi R	Time I entered the Bus or Car from my City or Home	Time I came out of the Bus or Car to College
			MONDAY	5:30 am	6:35 am
			TUESDAY	5:31 am	6:36 am
			WEDNESDAY	5:32 am	6:37 am
			THURSDAY	5:33 am	6:38 am

We are four in my group. All of us are from fresh calculate her answer for the information she decide to use Nahid result for our presentation because project is important to the girls who use the bus and get bus to college. But the mathematics we learn from it is important to all of the girls in my class.

Our answer is here

1) United Arab Emirates = 19 years to drive car
 South = 16 year
 Victoria = 18 years

Other state in Australia = all 17 year old before drive car. I get the information from <http://www.2pass.co.uk/age3.htm>

The reason why sometime late sometime early is because

2) Traffic is a lot sometime, this become difficult for driver to do speed

3) Speed of the bus also cause delay. If good speed and less traffic on way we arrive early also.

4) Sometime weather very cloudy, driver can not see far, so drive slowly to safe.

5) We have 11 students in my class from 20 outside abu dhabi

TT member explaining their work to the class

Our answer is here.

- 1) United Arab Emirates = 19 years to drive car, but for Australia is
 - South = 16 year
 - Victoria = 18 years
 - Other state in Australia = all 17 year old before drive car. I get the information from <http://www.2pass.co.uk/age3.htm>
- 2) The reason why sometime late sometime early is because
 - a. Traffic is a lot sometime, this become difficult for driver to do speed
 - b. Speed of the bus also cause delay. If good speed and less traffic on way we arrive early also.
 - c. Sometime weather very cloudy, driver can not see far, so drive slowly to safe.
- 3) We have 11 students in my class from 20 outside abu dhabi

4) *I work my answer like this*

I have $9 \div 20 \times 2300 = 1035$ student from abu dhabi

So we have $1035 \div 2300 \times 100 = 45\%$ from abu dhabi city

5) *From outside = $100 - 45 = 55\%$, because total percent is 100%, I minus 45% from 100% to gave me 55%.*

6) *Here is my table. Example for my calculation is, for Sunday I leave home 5:50 am and come college 6:55 am, so I write $6:55 - 5:50$ give answer 1 hours 5minute. This one easy but for Monday hard, like this I leave home 5:55 am come college 7:00am, so I have $7:00 - 5:55$. 00 take 55 can not. I borrow 1 hour from 5hr to get new calculation like, $6:60 - 5:55 = 1 \text{ hr } 5 \text{ min}$*

7)

Name:			
CITY Name :	TO COLLEGE	FROM COLLEGE	
Khalifa B	Time I entered the Bus or Car from my City or Home	Time I came out of the Bus or Car, in College	Time I entered the Bus or Car from College
SUNDAY	5:50 am	6:55 am	2:40 pm
MONDAY	5:55 am	7:00 am	2:40 pm
TUESDAY	5:45 am	6:50 am	2:43 pm
WEDNESDAY	5:55 am	7:00 am	2:43 pm
THURSDAY	6:00 am	7:10 am	2:44 pm

DAY	Time on Bus		TOTAL TIME
	COMING TO CALLEGE	GOING BACK HOME	ON BUS In minutes
SUNDAY	1 hr 5min	45 min	110 min
MONDAY	1hr 45min	45 min	110 min
TUESDAY	1hr 5min	45 min	110 min
WEDNESDAY	1hr 45min	45 min	110 min
THURSDAY	1hr 10min	46 min	111 min
		TOTAL	551 min

From this table, I see coming take long. This because many people drive to Abu Dhabi in morning, but going home fast, no many car people still in office, office finish late my college time finish before office finish.

8) Sunday = 110 min

Thursday = 111 min

Change = 111 - 110 = 1 min

Percentage change = $1 \div 110 \times 100 = 0.91\%$, 2 decimal place

= 1 % in 1 dp, is very small increase not decrease.

9) Total number = 551 min

10) Monday = 110 min

$$= 110 \div 551 \times 100$$

$$= 19.96\%$$

$$= 20\%$$

11)

Dh	Time
15	120
x	551

$X = 15 \times 551 \div 120 = \text{Dh } 68.88$, answer must 2 dp for money.

We have 20 weeks in one semester = $68.88 \times 20 = \text{Dh } 1377.60$, I put 0 here to have 60 pills not same as 6 pills, this is why we give answer 2 decimal in money calculation.

It cost me Dh1377.60 to travel to college with public bus in one semester. I only pay Dh 1900 for college bus.

12) College bus is expensive more. This is not good deal for all the girls. But girls who leave near Abu Dhabi is cheap by college bus. So, is different for every girl.

We like the bus because it is safe for me. My parents don't worry to bring me to college I enter the bus. The bus pick me from front of my house, my parent see me enter the bus is important here in UAE. I am happy and grateful to leader in college who think to help students with the bus.

13) Sometimes the bus is dirty, noisy. The driver speed too much and also use mobile when he drives.

- 14) *We want college to appoint student leader on bus, so that she can report any student who is too noisy or if the driver speed too much. Student should sign contract to behave well on bus.*
- 15) *Is about my problem, so more interesting for me. I collected the data, so is my own work not someone work. we feel close to the work. This is good because we feel important in my society to change the problem with our bus. All the teacher in our college should use this way to teach us. I like math very well now because I see how useful in my life. Before just waste time always.*
- 16) *We worry of the final exam, is not like this project. They only ask about numbers from book. I am confuse, I will fail, but our teacher say we will pass. I hope so.*

What we learn from the project:

1. *The actual meaning of percentage and how to apply it in world problem. Now I know percentages give more meaning than ordinary number.*
2. *We learn how to add and subtract time. Many of us find this very difficult before. But because we did it as part of the project we understand more.*
3. *We learn to remember to write our answer in two decimal place for money questions. This is a big problem for many of us, but with the project I think we will never forget this in the exam, inshAllah [God willing].*
4. *We learn about the different age people drive in Australia, United Kingdom and USA. We compare with UAE age for driving*
5. *We learn to work in group. From this project we now talk to each other more in class. Before some girls don't greet me but now we greet everyday and we talk about college.*
6. *We now know many girls leave home very early in the morning (5:30 am) everyday to catch bus to college. This is not good for their health because no time for eat breakfast. This need to change. College can start 9 am for every girl.*
7. *We also learn from the project every girl have different problem. In our group all girls from outside Abu Dhabi is cheap for them to use college bus, but for some girls who leave near Abu Dhabi is not cheap. But, every girl we ask say the college bus is better because is safe when you travel all students. Also the bus pick the girls from home not bus garage.*
8. *We are all grateful to college for giving the bus. But, some girls think the bus should be free because we are students and we need help from the government to make it free.*
9. *Mathematics is fun when it is teach using something that has meaning like in this project. We want to do more project like this one. We don't feel is math class because everybody is so happy doing the work.*

10. *We feel important because all the girls must listen to us to present our work.*
11. *We feel important because we contribute to our college to solve this bus problem.*
12. *Now we can talk more in public without feel shy of the people. This is good when I look for job in future.*
13. *We think about the exam. Exam is no like project is all question questions with some new number to calculate, not our own number. This is not fun.*

Below is the work presented by the AG Group

We are 5 in my group. All of us from Abu Dhabi but one girl from outside the city. She travel by bus but three of us we don't use college bus but we find this project interesting to make our point and to learn mathematics in fun way. We want to use the result of Hanans' to present what we learn from the project. We use Hanans' result because she is from Abu Dhabi and her house far from college more than us, many in our group from Abu Dhabi too.

My group work is here.

1. *UAE is 19 years for driving*

From this project we know in Australia different for every state. Example, Victoria = 18 years, South Australia is 16 years, Queensland is 17 years, Tasmania is 17 years, Northern is 17 year and Canberra is 17 years.

<http://www.2pass.co.uk/age3.htm>

- 2) *Traffic is a lot in the morning in Abu Dhabi sometimes less. If traffic less we go college in time but when more we go late like 10 minutes late. Layla who come from outside Abu Dhabi say sometime cloud make bus driver slow down because can not see far.*

In our class only 11 girls from 20 outside abu dhabi, we all 20 students.

We calculate $9 \div 20 \times 2300 = 1035$

we get $1035 \div 2300 \times 100 = 45\%$ girls abu dhabi city in our college

Outside = $100 - 45 = 55\%$, you only minus from 100% to get answer.

Here is table with time for journey.

Name:			
CITY Name : Abu Dhabi	TO COLLEGE		FROM COLLEGE
	Time I entered the Car from my Home	Time I came out of the Car, in College	Time I entered the Car from College
SUNDAY	6:50 am	7:15 am	2:30 pm
MONDAY	6:45 am	7:00 am	2:28 pm
TUESDAY	6:50 am	7:20 am	2:32 pm
WEDNESDAY	7:00 am	7:15 am	2:29 pm
THURSDAY	6:55 am	7:10 am	2:40 pm

DAY	Time on Bus		TOTAL TIME
	COMING TO CALLEGE	GOING BACK HOME	ON BUS In minutes
SUNDAY	<i>25 min</i>	<i>20 min</i>	<i>45 min</i>
MONDAY	<i>15min</i>	<i>10 min</i>	<i>25 min</i>
TUESDAY	<i>30 min</i>	<i>18 min</i>	<i>48 min</i>
WEDNESDAY	<i>15 min</i>	<i>22 min</i>	<i>37 min</i>
THURSDAY	<i>15 min</i>	<i>15 min</i>	<i>30 min</i>
		TOTAL	185 min

We see that all the time is very short to come to college.

Sunday = 45 min

Thursday = 30 min

Change = 45 - 30 = 15 min

Percentage change = $15 \div 45 \times 100 = 33.33\%$, 2 decimal place

= 33 % in whole number, is decrease percentage.

Total number = 185 min

Monday = 25 min

= $25 \div 185 \times 100$

$$= 13.51 \%$$

$$= 14\%$$

□

<i>Dh</i>	<i>Time</i>
15	120
x	185

$$X = 15 \times 185 \div 120 = \text{Dh } 23.13, \text{ we round to 2 dp because is money.}$$

For one semester is 20 weeks = $23.13 \times 20 = \text{Dh } 462.60$, we add 0 to get 2dp.

Cost on public bus is Dh462.60.60 to travel to college. But college collect Dh 1900 for college bus. This too expensive to use bus in Abu Dhabi.

- College bus is not good deal for girls from Abu Dhabi, it cost more from our calculation.
- We will like to have bus for Abu Dhabi because Layla say she meet friends on bus. Is safe only students from same college and bus take her from house not station.
- Layla only use bus in my group. She want clean bus and good conditioner to cool the bus. Too much noisy some girls. She want all student should sign contract to be good behavior on bus.
- This work make math interest to learn more. We collect our time travel and use it so is our problem to solve. This make all the girl work well for the project.
- We worry about KCA exam in final. How this project help pass the exam we want to know.

What we learn in project

- a. We learn how to calculate the percentage of numbers and the meaning of percentage in life. Also percentage change and about fractions of a number.
- b. We now know how to calculate using ratio idea.
- c. How to add and subtract time in hour or minute. And also collect our own data for project. This is first time we do this. Very interesting.
- d. To calculate percentage change. Is easy now to remember it.
- e. To write answer in 2 dp for money.
- f. We also learn about age for driving in different college because we didn't know before so we check for the information on internet.

- g. *We learn to work in group and how to talk and argue own point in group.*
- h. *It makes us understand the problem the girls from outside Abu Dhabi face with bus. Layla tell us many many problems with bus. Before this project we think the bus is always good.*
- i. *We also learn to be grateful for our college Director Dr Bradley Cook for giving some girls the bus.*
- j. *We learn math in better fun way not like before. This makes us enjoy the subject of math more. Before we fair the subject but is okay now. We need more project like this one.*
- k. *Class is sometimes too noisy but is okay because we are enjoying the math.*
- l. *It makes us talk more with each other. Before this project we don't talk to some girls in the class but now we talk a lot about things.*
- m. *It give me more confidence to talk in group. No shy again like before.*
- n. *This project gives the girl chance to change college problem with the bus.*
- o. *This project will not be in exam, so if we spend too much time we will not pass exam very well. We need to use book more.*
- p. *We also learn the bus is very expensive for us who are from Abu Dhabi. Is cheap to come by our car or taxi. But we all agree that we want bus also. Why? Because now our parents have to drop us in college and some work in office. Is not fair for us not to have bus, we are students also here. We have to choice to use the bus or not but college should give us the bus. We want to meet other girls also on bus like the other student not from Abu Dhabi city.*

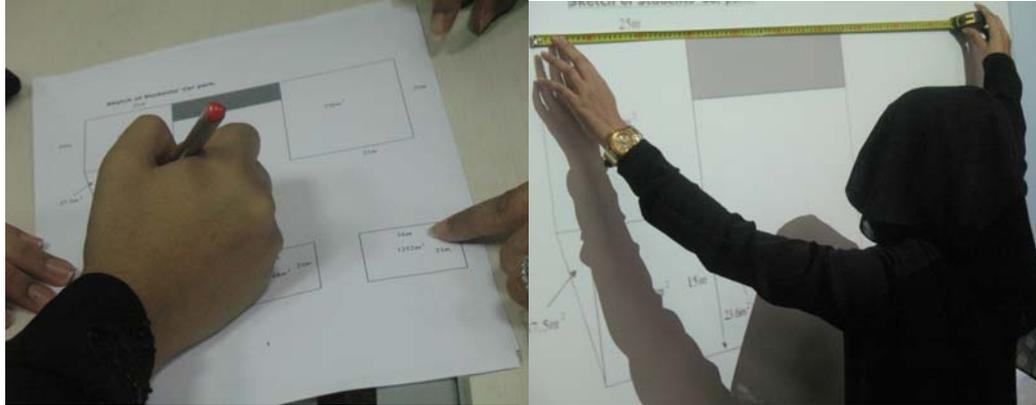
Car Parking Project (CP)

Below is the work presented by the Car Parking Group:

Part 1 is the work presented by the group to their classmates and Part 2 is the presentation they made to the College Director.

Part 1

We are 5 in my group. Three of us drive our cars to college but two girls doesn't drive but they are from Abu Dhabi the parents bring her to college every day. This project is very important for many of us who drive to college. Our car park is small and the gate is narrow. College buses use the same gate as the cars. This is dangerous. This is why we want to work on the project to try and solve this very important problem for ourselves.



CP group members calculating the areas of the car park

CP group member explaining to the class how they measured the dimensions of the car parks.

Now we show you our calculations:

- *We divided the student parking area into rectangles and triangles as in the diagram [above].*

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

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

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

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

1. *The lengths of an average car is 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 ADWC, 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 ADWC.*

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 ADWC 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 ADWC.

What we learn from this project:

7. *How to calculate area of Rectangle, Triangle.*
8. *How to use tape to measure length, and to draw sketch of the car park.*
9. *How to approximate length of car and use ratio to know the number of car in each car park in college.*
10. *Important of unit for area and length. Also about angle like 90 degree[e] and perpendicular[r] line. Also about how to divide a shape into different small one to make easy to solve problem.*
11. *We learn important to work in group. Everybody to help to solve the problem ,make it easy to get the correct answer.*

12. *Some girls drive to college but not register by student service. This make difficult to know the number who drive to college. This make many girls to suffer because no place to park car and is not good for girls to park outside college in case something happen to the car.*
13. *We are happy parking is free not to pay.*
14. *We have understood the topic of percentage in a relaxed way. Doing mathematics without the fear of the subject like before. This is good way to learn mathematics.*
15. *In this project, we have discovered the power of mathematics to resolve potential conflict. We initially thought the space allocation was totally unjustified but now we found that it is not bad. This kind of project makes learning of mathematics fun and interesting not the type of boring stuff we used to do.*
16. *Also, we hope our result will serve as a reminder to the college administrators that when the number of students driving to college increases there will be the need to provide extra parking area for the students.*
17. *Car park allocation at ADWC is okay. However, we would like to suggest exist and entrance be separated or made wider.*
18. *We will share our findings from this project with ADWC students, as there are many out there who are still thinking the parking space for students is not fairly thought about.*
19. *We will write a letter to college Director Dr Bradley Cook to tell him about our findings and also to request a meeting with him for face to face discussions about this very important problem.*

Part 2

The Director of ADWC was given a copy of the below presentation at the end of the presentation by the CP group.

Introduction:

We are here today to share with you, as the Director of our college, our findings from the project on "Car Parking at ADWC". We hope that the results to be presented will play a part in the future planning of our college.

Why is this project important?

This project is important because as students we have noticed that the car parking area allocated to us is small and a lot of students are forced to park outside the college. And as we all know, parking outside has a lot of risks. Also the gate is narrow which may result in accidents if something is not done soon.

What mathematics skills are needed to successfully complete this project?

The skills needed are

- Geometry – measuring lengths, ratio
- Number – multiplication, addition, division, subtraction and rounding

Results:

We found the following:

20. Total students' car park is approximately 1161 square meters.
21. The lengths of an average car is 4.7 meter by 1.6 meter
So, the area is $4.7 \times 1.6 = 7.52$ square meters
22. It means, for the students' car park, we have approximately $1611 \div 7.52 = 214$ car parking spaces.
23. And, since there are 2150 students at ADWC, it means we will have the ratio as

$$214: 2150 = 1:10$$

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

This is clearly not fair!

24. For the teachers, there are three car parking areas and we calculated the approximate total area as 3440 square meters. And, there is 212 staff at ADWC.

Therefore, there are approximately $3440 \div 7.52 = 457$ car parking spaces.

This means:

$$457: 212 = 2: 1$$

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 ADWC 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:

25. Nothing changed.

Students:

26. Car: population

$$214: 300 = 1: 2$$

This means, there is one car parking space for every 2 students at ADWC.

CONCLUSION:

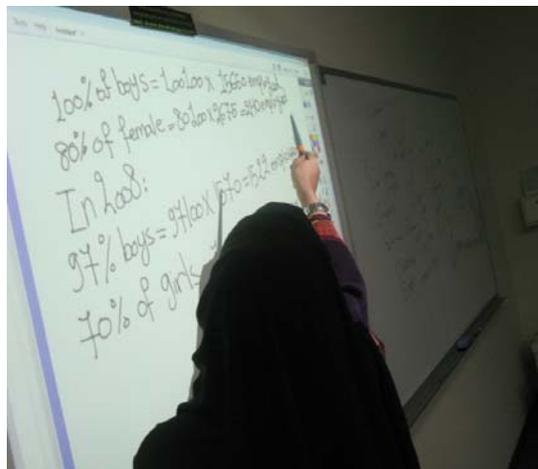
27. *Car park allocation at ADWC is okay. However, we would like to suggest that exist and entrance are separated or at least made wider.*
28. *In this project, we have discovered the power of mathematics to resolve potential conflict. We initially thought the space allocation was totally unjustified but now we found that it is not bad. This kind of project makes learning of mathematics fun and interesting not the type of boring stuff we used to do.*
29. *We hope our findings will help in the future planning of the car park allocations at ADWC.*

Career Aspiration Project (CA)

Below is the work presented by the Career Aspiration Group:

I should remind you here that for the career Aspirations (CA) project team, with prompting and direction from me developed a questionnaire to collect their data. It was piloted within their class and then the final questionnaire was completed by 7 out of 9 sections in DF.

We are 5 girls in this group. Three of us work part time in office the other two girls don't work. We chose this topic because we are working girls and we have some idea about career and some things that we want to see changed in UAE. Our work is presented to you using Power Point Presentation. Here are the main points:



CA team member explaining their work to the class during presentations

In this project we learn about:

We want to use question number one, from our questionnaire to show meaning of percentage and percentage change. Question-1 say:

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

- a. *I always think about it*
- b. *I sometimes think about it*
- c. *I have never thought about it.*

When our class answer these questionnaire, a = 4, b= 9, and c=7. But when all the 7 section answer it, a= 81, b= 60, and c= 4.

You see all the number don't give good meaning. This is why we need percentage to tell people this number is out of 100, they will understand more.

This is how we calculate our percentage:

Now, for our class question 1 answers:

a = $420 \times 100 = 20\%$: b = $920 \times 100 = 45\%$: c = $720 \times 100 = 35\%$

Total number of student who answer question 1 is 145. So, now a = $81145 \times 100 = 55.9 = 56\%$ to whole number; b = $60145 \times 100 = 41.4 = 41\%$, and c = $3145 \times 100 = 2.1 = 2\%$.

Now is more meaning to say 56% students choose answer number [a], and so on. Every one will understand. This why percentage is more meaning and easy to understand than raw number. But we have one problem. Our percentage did not add 100%. The reason is because we round some of our answer so loss accurate of result.

Now, for our class b = 45% is the high answer, mean more student sometime think about what they want do after college. But when we calculate all the section a = 56% is highest. This mean is better to ask many students before we know the true story about something in their life not just few. Is also mean our student always think about what they will do after college. This is good for our country to know student think of future.

Looking at the calculations, we see percentage change for a = $56 - 20 = 36\%$, b = $45 - 41 = 4\%$, and c = $35 - 2 = 33\%$. The percentage change response-a is higher than all the rest.

30. *We have understood the topic of percentage in a relaxed way. Doing mathematics without the fair of the subject like before. This is good way to learn mathematics.*

31. *We have learnt about meaning of percentages and making graphs in a fun way.*
32. *We learn to calculate percent of a quantity and change.*
33. *We have learnt how to construct a good questionnaire for data collection and what is good or no good question.*
34. *Many students don't know about career available in UAE. They need more education here.*
35. *Many students don't know about private company. They think only employ foreign people not Emiratis.*
36. *Many DF girls did not know about Emiratization program. Those who know want more information. So we suggest college to invite people to talk about this topic. We need more Emiratis to work in the office of Emiratization department because they know about our problems more than foreign people.*
37. *We need more information about part time jobs not only full time. Many DF don't like to attend career fair because of this reason. They always talk about full time jobs only.*
38. *All the girls are grateful to our leaders for setting the Emiratization department to help local people.*
39. *They also grateful to our college because the career department is always help students to organise seminar about jobs.*
40. *We are happy to be part of looking for solution to our problem. This is good way to teach mathematics, we understand it more now than before.*
41. *We need more courses for women college, like all the Engineering because women can also do these courses not only men.*
42. *We hope exam will not be too difficult to pass.*

APPENDICE 3

Career Aspiration (CA) Questionnaire

Please answer the following questions.

3) 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

4) Have you ever discussed career opportunities with anyone?

- with my parents with my teacher with my friends

5) 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"/>

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

- Excellent Very good Very little Poor

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

- Yes may be I know enough

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

- Government Private Sector None

9) 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

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

- They are equal there are not equal

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

- a man a women I don't mind

12) Do you live in Abu Dhabi?

- Yes No

13) Who is a civil servant amongst your parents

- my father my mother father and mother none

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

- a male a female I don't mind

15) Select your age range from below

- 17 – 19 20 – 24 more than 24 years

APPENDICE 4

Career Aspiration Mathematical Enriched Worksheet (2)

Tasks:

1. Discuss the results on career suitability for men and women. Give reasons for your thoughts.
2. Calculate the percentage for each response on the summarized questionnaire. Round your answer to the nearest whole number.
3. Does the percentage in each question add up to 100? Why or why not? Explain your answer.

In your group you need to first check that your answers for the calculation on question (2) agree with each other's, and discuss discrepancies if any.

4. As a group, were you surprised by the responses of your classmates to some questions? List the question(s) number(s) and explain why you were surprised.
5. Do you think your classmates are well informed of the career opportunities available to them? Explain the criteria your group used to judge a student as well informed or not.

Now collate all the responses from the other Sections (samples), and as a group, calculate the percentages as you did in question (2).

6. What are the similarities or differences between what you found in question (2) and the response summary questionnaire for all the Sections? Explain your answer.
7. Calculate the percentage change between each response in question (3) of your class questionnaire and that of the summarised questionnaire. Say whether it is a percentage increase or decrease. Explain why the change occurred and what it means.
8. Based on your group findings would you say DF students at ADWC are well informed regarding career opportunities available to them? Explain your answer.
9. Explain what you understand by the Emiratization programme. Is it a good thing? Why or why not? Explain your answer.
10. Suggest ways in which ADWC students could be made more aware of the career opportunities available to them.
11. What do you like or not like about this teaching approach. Explain your answer fully.

APPENDICE 5

Time of Travel Mathematical Enriched Worksheet (1)

1. At what age are people allowed to drive in the UAE? Search for information on the internet (using www.google.com.au) about the ages people are allowed to start driving in countries like Australia, United Kingdom and America.
Explain any differences and similarities in detail.
2. What do you think are some of the reasons why you don't always arrive at college or back home at the same time every day (Sundays to Thursdays)?
Explain your answer.
3. Find out how many students come from outside Abu Dhabi in your class.
Write down your answer here. _____
4. For this academic year (2008-2009), there are approximately 2300 students registered at ADWC. Based on your answer to question (3), calculate the percentage of students you would expect to come from Abu Dhabi city.
5. Using your answer to questions (4), what percentage of students do you expect to come from outside Abu Dhabi city? Explain how you arrive at your answer!
6. Copy your travelling times to and from college on the table below.

Remember your travelling time to college starts when you enter the bus or car from your bus stop or home, and ends when you come out of the bus or car in the college compound. Similarly, travelling time from college starts when you enter the bus or car from the college, and ends when you come out of the bus or car at your bus stop or home.

	TO COLLEGE			FROM COLLEGE		
	Time I entered the bus or car from my bus stop or home	Time I came out of the bus or car, in College compound	TOTAL TIME ON BUS OR CAR	Time I entered the bus or car from College compound	Time I came out of the bus or car, at my bus stop or home	TOTAL TIME ON BUS OR CAR
SUNDAY						
MONDAY						
TUESDAY						
WEDNESDAY						
THURSDAY						

7. From your table in question (6), calculate the percentage change between the total number of hours travelled on Sunday and Thursday. Say whether is an increase or decrease.
8. From your table in question (6), calculate the approximate total number of minutes you spent on the bus in a week.
9. Express the total number of hours spent on the bus on Monday as a percentage of the total number of hours spent for the whole week.
10. A journey on a bus from Abu Dhabi to Dubai will normally last for two hours, and every passenger pays Dh15, for this journey. Use this information to calculate how much it would have cost you to travel to college using public buses.
11. From your answer in question (10), do you think those of you who travel by bus to college are getting a good deal? Explain your answer fully.
12. Now, what do you like about the bus service provided by ADWC? Explain your answer.
13. What do you not like about the bus service provided by ADWC? Explain your answer.
14. What improvement/change would you like to see made to the current transport arrangements at ADWC? Explain your answer.
15. What do you like about this method of teaching mathematics? Explain your answer.
16. What do you not like about this method of teaching mathematics? Explain your answer.

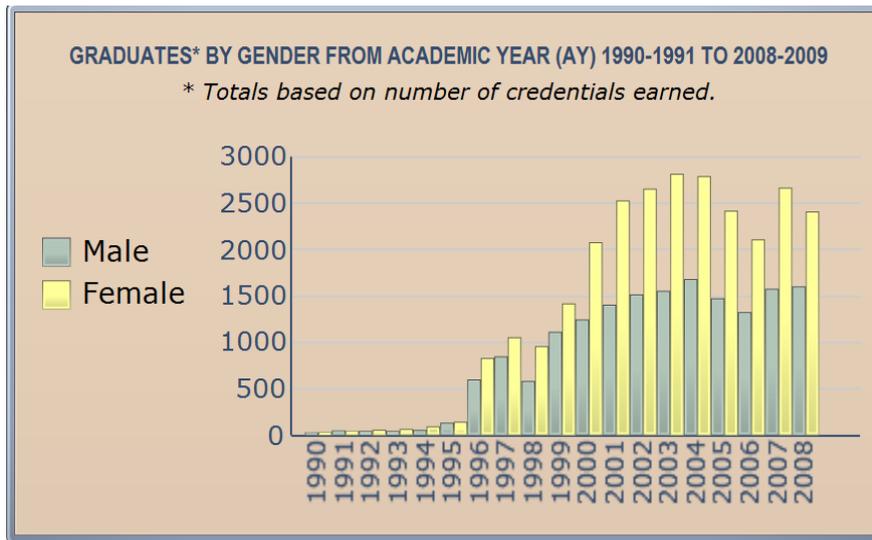
APPENDICE 6

Analysing Graphs Mathematical Enriched Worksheet (3)

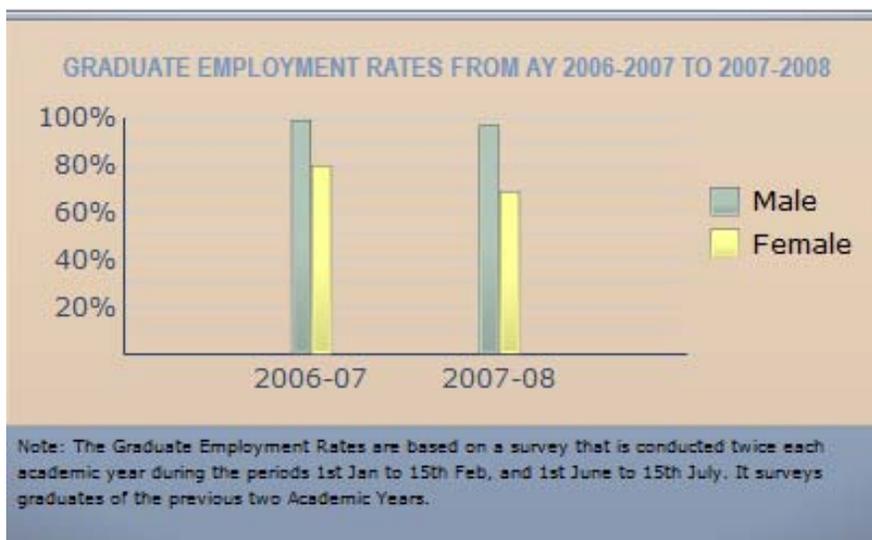
Below are two graphs published by the Higher Colleges of Technology (HCT), as part of its, Focus of the Week, publications.

Your task is to use mathematics as a tool to analyse these two graphs.

Graph (1):



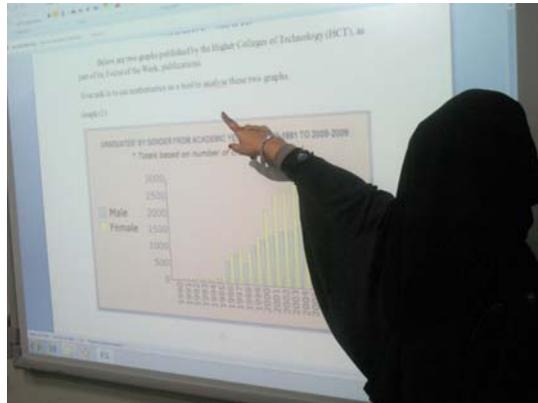
Graph (2):



APPENDIX 7

My Graph Work: By Ayesha

To analyse the graph, I plan to look to see any similar thing in them from looking at the graphs. I will then write about things, then I will calculated using math Mr Goma teach us from the class project work, this semester.



Ayesha explaining her work on graph to her class mates during class discussions

Graph 1:

In 2007 and 2008 the number of male is same but the number of girls is bigger in all the years. 2007 have more than 2500 male and only over 1500 boys. 2008 has over 2000 but less 2500 male and just over 1500 male. My conclusion here is more women have graduate than male in the two year.

Graph 2:

First I see the number of graduate employed for the female decrease more then the decrease for the male. I don't know why but may be not many women finish college in the year, or no many jobs for female or may be some girls is married and husband don't allow them to work. Is difficult to know the true here by looking at the graphs.

But as we look graph 2, many more women finished college than the boys, so why in graph 2 more men have jobs than women? This is not fair! Then, may be no many jobs for women. Why no many job for women? A woman can do like man job also, why not give her the chance to prove to do the job. Anyway, this graph is old, many thing have changed in UAE. More women have right to work not like before in any company she like. She is more independent. We are lucky to have good leader who think to help women like this way. We thank the King of our country for the freedom.

If this graph is do now in 2010, I am sure the result will see more women worker in office and same with man in office.

Now I want use math to prove something in my work.

Percentage change

Graph 1 (2007 to 2008):

Male: Change = 1570-1500=70

Percentage change = $70/1500 \times 100 = 4.67\%$, 2dp. Is increase

Female: Change = 2675 – 2325 = 350

Percentage change = $350/2675 \times 100 = 13.08\%$, 2 dp. Is decrease

The 2 calculation show me that the number of male graduate is increasing at 4.67% rate, but the women is decreasing at 13.08% rate. If this continue like this then more men will graduate than women and we rich time when very small women will go college. But this data is only for two years so we can not use it to say the future will be like this or no, we need more information to say is true or not.

Graph 2 (2007 to 2008):

Male:

Percentage change = 100- 97 = 3%, decrease. This only approximate because I can not read accurately the graph

Female: Percentage change = 80-70 =10%, decrease.

Here I can see the percentage decrease is more for women. This mean less women graduated and instead for them to get jobs, more of them are now will no jobs, why. This is not fair for justice. Since less women finish college, they should get job, so that other women will go to college also. This is encourage more women to go college. For the boys more of them are graduate but only few no jobs. Why? We are all equal. As I say before, our great leaders have change all this injustice, now we are equal in office for jobs.

Now I want to use number to give better meaning to my answer.

In 2007:

$100\% \text{ of boys} = 100100 \times 1560 = 1560 \text{ employed}$

$80\% \text{ of female} = 80100 \times 2675 = 2140 \text{ employed}$

In 2008:

$97\% \text{ of boys} = 97100 \times 1570 = 1522 \text{ employed}$

$70\% \text{ of girls} = 70100 \times 2325 = 1627 \text{ employed}$

Now I see more women are actually employ in jobs than boys in the two years. By calculating the actual number. But is it fair that more girls graduate are employ than men? No. It should be equal for justice in UAE.

Now I want to check the change in the percentage.

2007:

$\text{Change} = 2140 - 1560 = 580$

2008:

$\text{Change} = 1627 - 1522 = 105$

Now I can see the gap is reducing between man and women. This is good to achieve equality in the society. I am happy to see the gap getting smaller and one day it will be zero.

This is the power of mathematics. Before, I think women are less employed, but after using math to calculate the actual number I see is not true, more women are employed than boys. Looking at graph 2, everyone will think women are not favour but will calculations is now all clear to me. The project we did with teacher in my class made me to be able to give meaning to these graphs. Thank you Goma for teaching us this way. Math is very interesting now, with this way of teaching. Is all about our life not like before.

APPENDIX 8

My Work on Graph: By Zainab

Graph(2) is only for 2007 to 2008, so I will only look 2007 and 2008 in graph(1), to get better result.

Graph(1)

The number of male graduate is the same the number of women is not same. It have a decrease in it.

Graph(2)

For female there is a percentage decrease. For men is very small percentage decrease.

Male: % change = $100 - 98 = 2\%$, decrease

Female: % change = $80 - 70 = 10\%$, decrease.

Okay in graph(1), I have

2007:

Female = 2625 and male = 2565

Number of employed:

Female = $80/100 \times 2625 = 2100$, Male = $100/100 \times 2565 = 2565$

This mean more women are employed than men in 2007. But looking at the graph somebody think more men have employ.

2008:

Female = 2320

70 $100 \times 2320 = 2436$,

Male = 2565

Male = $95/100 \times 2565 = 2436$ I change to whole number because is people, can not have decimal.

Again I see more women are employed in 2008.

Change from 2007 to 2008 for people employed is:

$$\text{Male} = 2565 - 2436 = 129$$

$$\text{Female} = 2100 - 1624 = 476$$

Although more women are employed less women and more men are getting jobs now, as in 2008. This is not fair for women. I think graph(2) is not true for graph(1). I will calculate and do my correct graph.

2007:

$$\text{Male} = 2625, \text{ Female} = 2565, \text{ Total} = 5190$$

$$\% \text{ male} = \frac{2625}{5190} \times 100 = 50.6\%$$

$$\% \text{ female} = \frac{2565}{5190} \times 100 = 49.4\%$$

2008:

$$\text{Female} = 2320, \text{ Male} = 2565, \text{ Total} = 4885$$

$$\% \text{ female} = \frac{2320}{4885} \times 100 = 47.5\%$$

$$\% \text{ male} = \frac{2565}{4885} \times 100 = 52.5\%$$

	MALE	FEMALE
2007	50.6	49.4
2008	52.5	47.5

We have to be careful with other people graph. The graph (2) has mistake. I know this because I calculate myself. This is why math is good, it give power to you to agree or no, not just accept graph from other people. I don't accept this graph and I prove my point with math. I will be look newspaper for graph to interpret, may be they have many mistake also.

I want us do more project like the one with my math teacher Goma. Thank you teacher. You make math enjoy for me and my class. Now I always want to see graph in books to read and give meaning, before I don't care because is difficult, no meaning to me.

APPENDICE 9

Car Parking Group's e-mail to College Director

Sent: Monday, May 25, 2009 2:44 PM

To: Dr. Bradley Cook

Cc: Goma Tanko

Subject: Social Justice Mathematics

Dear Dr. Bradley,

Our group with the support of Mr. Goma Tanko was engaged in a Mathematic Project on our campus. The project was about Car Parking Spaces at ADWC. 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 ADWC. We would be grateful if you could spare some time for us to come and present our result.

Regards,

Car Parking Group's Letter to College Director

Sunday, May 31st, 2009

The Director

Dear Sir,

CAR PARKING PROJECT

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

Many of us (students who drive to college) have concerns with the space provide for us to park our cars, so when Mr. Goma Tanko introduced us to "Social Justice Mathematics", we immediately though 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 ADWC.

Student: parking space

2:1

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

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

Suggestions and Conclusions:

1. We initially thought that the parking space allocation at ADWC was not fairly done. We are happy to report to you that, contrary to our initial perception, the parking space allocation at ADWC 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.

APPENDICE 10

Time of Travel Group's Letter to Transport Coordinator

8 June, 2009

The Coordinator

Bus Services

Dear Dalia,

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 ADWC 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.

APPENDICE 11

Career Aspiration Group's Letter to Career Coordinator

8 June, 2009

The Coordinator

Career Services

Dear Intesar,

CAREER ASPIRATION PROJECT

Recently, we completed our study on the topic of percentages using a project called "Career Aspirations at ADWC". 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 ADWC and UAE in general.

These are our findings:

6. All the students agreed that the career department here at ADWC is doing great job in providing them with information regarding career opportunities.
7. Many students have reasonable understanding of the UAE government policy on Emiratization program; however, there are many issues that they would like clarification on.
8. Most students knew very little about the opportunities available in the Private sectors. Some thought private sector only employs foreign workers.
9. ADWC 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 ADWC.
10. Majority of DF students don't like to attend the career fairs.
11. Many students are interested in careers in Engineering.

Recommendations:

6. College should invite guest speakers from the Emiratization department to give talk and answer questions about their programs.
7. There is the need for more awareness campaign here at ADWC on the important role the private sector plays in the UAE economy.

8. 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.
9. Private sectors attending career fairs at ADWC should focus a bit more on part-time jobs for the summer.
10. College should make available more engineering courses to ADWC students.

Conclusion:

The Career Services department here at ADWC 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,

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