Science and Mathematics Education Centre

Application of the Realistic Mathematics Education (RME) Approach with a Focus on Social Justice in Teaching and Learning Mathematics

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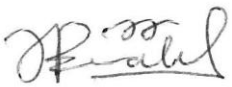
Declaration

This thesis contains no material which has been accepted for any 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 other person except where due acknowledgement has been made.

Signature: 

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ABSTRACT

This study develops an approach to mathematics education focusing on social justice issues through Realistic Mathematics Education (RME). This study was informed by action research and grounded theory as its methodology. The study revealed that there are many areas of teacher development demonstrated i.e: The growth in confidence, the growth in relationship with the students, the growth in ability to incorporate social justice issues in mathematics education, the growth of teacher mathematics knowledge, and the growth in teaching methods. Also, this research investigates the effects of the approach upon some variables in mathematics education, i.e: learning mathematics, engagement, and agency. In particular, the findings show there is some evidence that the socioeconomic background of the school plays an important role in the implementation of this approach.

Dedication

This thesis is dedicated to:

My great parents, who never stop loving and supporting me throughout my life.

My dearest husband, for his love, support, and encouragement.

My beloved sons. May Allah, the Most Gracious, the Most Merciful, keep loving you and protect you.

My country Indonesia, where I was raised to stand guard for a great, independent, and free country.

Lastly, this thesis is dedicated to all mathematics educators and teachers who are committed to their work and who endeavour to work for more and better mathematics education for all students.

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Finally, my deep gratitude to all my family, especially for my parents, who without their love, caring, and prayers, I could not have pursued my dream of completing a PhD. To my beloved husband and my sons: thanks for being patient, supportive, and most of all, loving and caring.

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CHAPTER 1

RATIONALE OF THE STUDY

1. 1 Introduction

Mathematics is often taught to students separated from their real life experiences. As a result, students often cannot apply the methods they have been taught to solving problems in real life (Kohn 2000). In some circumstances, students gain no benefit from learning mathematics.

In the hope that students will perceive the links between problems encountered in school and the real world, there is a need to teach mathematics in context. Considerate of the context of mathematics tasks, Realistic Mathematics Education (RME) is rooted in Freudenthal's interpretation of mathematics as an activity. In this view, *learning* mathematics means *doing* mathematics, of which solving everyday life problems is an essential part (Gravemeijer 1994). In particular, Gravemeijer (1994) goes to argue that RME has to do with situations that are experientially real to the students. These maybe everyday real situations, but they may also be adopted from fantasy worlds in which the students can immerse themselves, and hence become realistic for them. Therefore, RME equips students with problem solving skills through a focus on realistic problems. Students are encouraged to solve problems using their mathematical knowledge, experience, and intuition.

During the past decades, there has been a move away from teaching mathematics as self-contained series of abstract concepts and procedures towards learning mathematics from realistic situations, students' creation or construction of solution procedures, and changes in the role of the teacher and student in the classroom. In particular, the roles of the teacher and students in learning mathematics from this perspective are different from those seen in the traditional lecture style. Instead of working on meaningless context mathematics exercises, students work on realistic problems developed by the teachers. Teachers facilitate discussion of ways to solve problems by sharing ideas and students' constructing solutions. In particular, RME incorporates meaningful learning into the mathematics lesson by using realistic problems as a starting point which provide students with intellectual challenges and help them to be successful problem solvers rather than just focusing on students' gaining knowledge of the procedures of formal mathematics.

Mathematics cannot be considered as a classroom subject that only involves memorizing rules and procedures. The nature of mathematics used in society has changed more rapidly than school curricula (Atweh & Brady 2009). As Peterson (2001) states, if mathematics is taught in isolation to the everyday life, a student's approach to its study is abstract and they are never encouraged to seriously consider the social and ethical consequences of how mathematics is used in society. Also, if students are not given a chance to see how mathematics can be applied in their lives, they are robbed of an important tool of using it to help them fully participate in society.

Much of the more recent research in mathematics education incorporates the contextual approach to learning mathematics. Broomes (1989) states that real world problems in mathematics education provide students with a bridge between the abstract role of mathematics and their role as members of society. In particular, within recent years, there has been a growing interest in the study of mathematics for social justice. According to Bartell (2013), an important goal of teaching mathematics for social justice is to provide students with mathematics instruction that enables them to learn about social justice while simultaneously engaging in study of meaningful mathematics through engagement in social justice issues.

Indeed, the application of mathematics can deal with some problems of economy, politics, society, and others fields in life. As Kuku (1995) states, mathematics is often related to the economic development of a nation. Undoubtedly, the role of learning mathematics leads students to be effective citizens in the increasingly mathematized world of today (Atweh & Brady, 2009). As such, mathematics education can indeed contribute to society's political, ideological and cultural maintenance and development, and also provide individuals with skills which may help them cope with various spheres in which they live (Niss, 1996). Similarly, Ernest (2002, p. 2) states that social empowerment through mathematics concerns the ability to use mathematics to better one's life chances in study and work and to participate more fully in society through critical mathematical citizenship. Thus, it involves the gaining of power over a broader social domain, including the worlds of work, life and social affairs. Further, Valero (2004) points out that if students are agents and negotiation can help bring their intentions into the educational scene, real empowerment may take place. In order to design the mathematics classroom for active citizenship, teachers must create challenging problems to allow students to develop their ability to develop and use

mathematics, to formulate and to solve problems at the same time as they are considering social aspects of their real world.

Social justice and mathematics are related. On one hand, the use of mathematics in schools as a critical tool for understanding society and issues of social context plays a significant role in increasing students' awareness of their social environment and their knowledge of social justice issues. Moreover, mathematics serves as a valued language that can be used to further the agenda of social change towards a more just society (Gonzalez, 2009). On the other hand, using social justice issues in teaching mathematics provides a real context that allows the development of a better understanding of mathematics. Focusing on a social justice context will enable students to not only learn mathematics content, but also learn about the people's lives in their own environment and in other parts of the world. Moreover, integrating mathematics with social studies is an effective way to make mathematics alive for students. Similarly, Gutstein (2006) points out that providing a social justice context in mathematics lessons potentially increases students' interest in mathematics and also helps them learn the importance of mathematics. In this research, the use of RME aligns neatly with the tenets of teaching mathematics for social justice because a student looking at mathematics within a social justice context is a straightforward extension of the principle of general problem solving in real context.

The combination of the two interests in the RME and social justice issues may provide new insights that allow an improved understanding of mathematics education in the broader social context. Indeed, students may develop their mathematical understanding through working in context that makes sense to them and also it may develop students' awareness of issues within today's society, especially social justice issues, to make mathematics alive for them.

In this study, I worked with the teachers to develop a new approach to teaching mathematics and better understand their teaching practices and their impact on students. The objectives of this research are: 1) to investigate the professional growth of teacher in the practices of the implementation of the approach; 2) to investigate the effects of the approach on students' mathematical learning, engagement, agency, and knowledge about social justice; and 3) to investigate the effects of the schools' socioeconomic background on the implementation of the approach.

In order to understand the context of the schools and the students involved in this study, there is a need to consider the broader education system in Indonesia.

1. 2 Background of the Study

Figure 1.1: Map of Indonesia
Source: www.freeworldmaps.net, (02-11-2013)

Indonesia is part of South East Asia. It is the largest archipelago in the world. It comprises the world's most expansive group of islands with more than 17000 islands stretching along sea lanes from the Indian to the Pacific oceans. Indonesia consists of some of the world's largest islands such as Sumatra, Java, Kalimantan (Borneo), Sulawesi (Celebes), Halmahera, and the west half of New Guinea (Papua), and numerous smaller islands, one of which is Bali (just east of Java). The country's wealth resides also in its 235 million Indonesian citizens, belonging to more than 300 ethnic groups and speaking some 200 different language (UNESCO, 2009).

This study was conducted in Makassar (pointed to by a pin on the map above) which is the provincial capital of South Sulawesi. It is the largest city on Sulawesi and indeed in Eastern Indonesia with numerous domestic and international shipping connections. It is nationally famous as an important port of call for phinisi boats and sailing ships.

Unity in diversity is the national identity of Indonesia. Meanwhile, Pancasila is the state ideology, spelled out in the five basic principles of the Republic of Indonesia as the core values of the national cultural identity. The five principles are: 1) Belief in the Supreme God; 2) Just and civilized humanity; 3) The unity of Indonesia; 4) Democracy guided by the inner wisdom in the unanimity arising out of deliberations among representatives; and 5) Social justice for the whole people of Indonesia. The cultural identity of Pancasila should be implemented and institutionalized in the daily life and

socio-political and economic development of the nation. Indeed, the values of Pancasila are integrated in the Indonesian philosophy of education.

In particular, the preamble of the 1945 Constitution (Indonesia, 1968) sets forth the humanitarian principles as contained in Pancasila, stating that independence is the natural right of every nation and that colonialism must be abolished in this world because it is not in conformity with the values of humanity and justice. Following this, role of the Government of the state of Indonesia must protect all the people of Indonesia, their independence and the land that has been struggled for, and aim to improve public welfare, to educate the people and to participate toward the establishment of a world-order based on freedom, perpetual peace and social justice.

The Indonesian Government also has consistently endeavoured to adhere to the humanitarian precepts and human rights and freedoms embodied in Pancasila, the 1945 constitution, and national laws and regulations. The 1945 Constitution of the Republic of Indonesia which is based upon Pancasila has been incorporated into a number of national laws and regulations that serve to protect and promote the wellbeing of the Indonesian people.

1. 3 The Indonesian Education System

The national education system of Indonesia is based on the 1945 constitution of the Republic and the Pancasila. The Indonesian education system is divided into basic, secondary and higher education. Basic education in Indonesia provides nine years' learning experience in both formal and non-formal education for children aged 7-15. The 6 years in primary school and 3 years in junior high school are compulsory of all Indonesian young people. The goal of basic education is to develop learners' basic intelligence, knowledge, personality, and noble character, as well as the skills to live independently and to continue their education. Basic education is conducted in elementary and junior high schools, both public and religious. Secondary education for children aged 16-18 is the continuation of basic education and comprises general secondary education and vocational secondary education namely, Sekolah Menengah Atas (SMA) and Madrasah Aliyah (MA); senior vocation secondary schools, namely, Sekolah Menegah Kejuruan (SMK), as well as Madrasah Aliyah Kejuruan (MAK), or other schools at the same level. Lastly, higher education consists of diploma, bachelor (sarjana), masters and specialized postgraduate programmes, and doctorate programmes imparted by higher education institutions.

The structure of the educational system of Indonesia is summarised as follows:

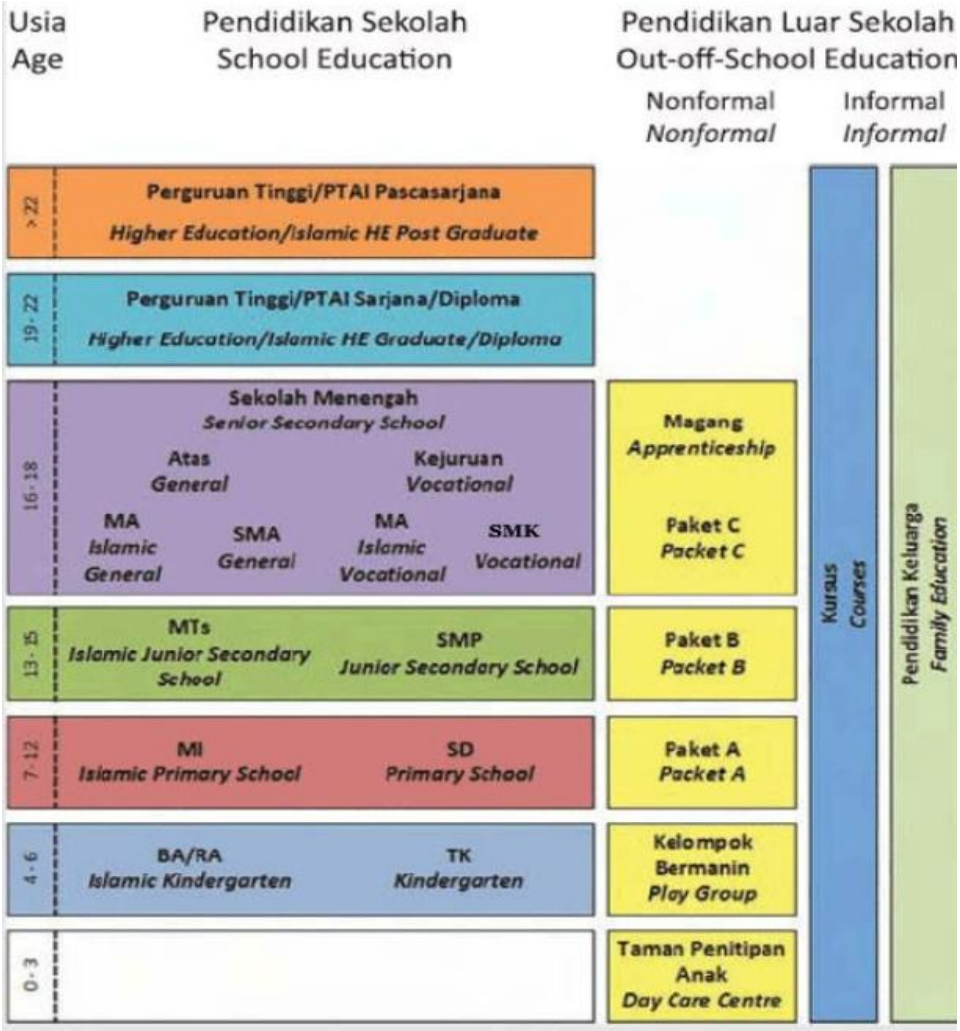


Figure 1.2: Structure of the Education System of Indonesia. (UNESCO-IBE, 2011, p. 7)

Within each levels of education in Indonesia, both private and public institutions are available. There exist two types of private education in Indonesia, namely private secular and private religious institutions. There are few private schools in Indonesia which can be considered as elite schools. The majority of private schools cater for the excess demand by providing school places for students who do not score high enough in national examinations to compete for the limited public school places (Patrinos, 2009). Therefore, most private schools attract lower performing students.

In addition, the public schools have two types of teachers: government employees (civil servants) and contract teachers. The civil servant teachers get a government pension, while the contract teachers are usually employed for a contract period and with lower salaries.

1. 4 Indonesia Mathematics Education Curriculum

Based on Law No.2 of 1989, the role of the national education system is to attempt to form citizens who follow the spirit of the Pancasila as development agents of high quality with the ability to be independent and provide support for the development of the Indonesian society. According to Act of the Republic of Indonesia No. 20 on National Education System (2003), Act Number 2 year 1989 needs to be adjusted in order to implement the principles of the democratisation of education. On this, the new Act of article 3 states that the national education of Indonesia functions to develop the capability, character, and civilization of citizen to enhance its intellectual capacity, and is aimed at developing learners' potential so that they become persons imbued with human values who are faithful and pious to one and only God; who possess morals and noble character; who are healthy, knowledgeable, competent, creative, independent; and as citizens, are democratic and responsible.

In order to achieve the aims of national education, the curriculum plays a vital role, as it is here that the dominant culture can either be supported or challenged. The Act of the Republic of Indonesia on National Education System 2003, defines the curriculum as a set of plans and regulations about the aims, content of lessons and the teaching methods used when the learning activities are implemented to achieve given educational outcomes.

In fact, the curriculum for mathematics education in Indonesia has changed many times. In 1975, curriculum reform emphasised the significance of science and technology development. This reform resulted in the 1975 curriculum, but this curriculum is considered no longer compatible with the needs of the community and the demands of science and technology. The curriculum reform of the 1994 incorporates technology through problem-solving, critical thinking, and inquiry skills into classroom practice. In this reform, nine years compulsory basic education being implemented and the importance of human resource development as an economic factor are emphasized. The extension from six years to nine years of basic education is also intended to alleviate the problem of child labour and to keep children in school until they reach the level of education at which they are able to keep up with the changing demands of their society, especially for those who cannot afford to pursue the higher level of education (Yeom, Acedo et al. 2002).

A decade after the introduction of the 1994 curriculum, a new curriculum was introduced known as the competence-based curriculum (Kurikulum Berbasis Kompetensi, KBK). According to the Depdiknas (2003) the objective of the mathematics discipline for junior high schools in this KBK consist of an understanding of mathematical concepts, mathematical reasoning, problem solving, mathematical communication, and procedures in which students are able to perform correct calculation processes.

In 2006, in accordance with the Act of the Republic of Indonesia Number 20, Year 2003, Educational Unit Level Curriculum (KTSP) was developed. Furthermore, developing the skills to master competence is the main focus of KTSP. The aim of this curriculum is to enable to gain a competence and values which can be used throughout their life which. In this curriculum, schools are given autonomy to plan and develop aspects of the curriculum which include the development of syllabus for each learning area and appropriate lessons plans. Although the KBK and the KTSP are both competency oriented, the autonomy which is given to schools varies. Under the KBK, the government sets the expected competency standards, basic competencies, sets of achievement indicators in relation to each learning outcomes and main learning materials to be covered (Depdiknas, 2003). In contrast, in the KTSP, the government mandates the expected competency standards and basic competencies but teachers control other components of the syllabus such as: mathematical topics, learning activities, indicators, assessment, time allocation, and source material (Peraturan Menteri Pendidikan Nasional No. 23 SKL, 2006).

There are four key concepts that can be taken from the KTSP in relation to this study, namely active learning, the role of the teachers as facilitator, teacher-student interaction, and intertwining or interweaving of the courses or lines of instruction. One concept in the KTSP which to be informed by constructivist perspectives of learning is active learning. The Curriculum Guidelines, translated from the Compilation of Government Policy (2008) suggest “the KTSP should be designed and delivered through a learning process which is active, creative, effective and joyful where the focus is on the students (p. 5)”. Another key concept in the KTSP is to promote the role of a teacher as a facilitator, according to the National Standard of Education in Indonesia “The educational reform involves a paradigm shift in an educational process, from teaching to learning. A teaching paradigm focusing on the role of teachers as transmitter of knowledge to students should shift to a paradigm which gives more roles to the students

to develop their potential and creativity (p. 30)". Additionally, The Curriculum Guideline states that the KTSP should be designed to provide students with learning experiences that involve both cognitive and physical processes. These should encourage interaction among students, between the students and the teachers that will lead to students jointly constructing their knowledge through higher order thinking activities (BSNP, 2006). Furthermore, as BSNP (2006) emphasises the need to provide a thematic approach in order to integrate two or more subjects in order to provide a meaningful learning experience for students. This is known as intertwining.

Susanto (2013) reports that the curriculum 2013 was launched officially on 15 July 2013 by the Education and Culture Minister of Indonesia, to be implemented gradually from the beginning of the 2013/2014 academic year. The aims of the curriculum 2013 is to enable the Indonesian generations to live as citizens who are religious, productive, creative, innovative, and affective and be able to contribute to the life of society, the nation and world civilization (Peraturan Menteri Pendidikan dan Kebudayaan no. 68, 2013).

However, Jeremy (2009) states that we need to understand that curriculum change is not a technical matter. Instead, it is personal journey for teachers. Indeed, no matter how good the curriculum, it will simply remain a plan on paper if it is not implemented properly. To change the curriculum means the government has to train teachers and to provide appropriate resources. There is a need to improve the education system as a whole in harmony with the curriculum change, including the improvement of teachers' competence. Otherwise, the change will result only in a massive waste of money and effort.

1. 5 Research Questions

The primary objective of this study is to investigate the application of the RME approach with a focus on social justice issues in teaching and learning mathematics.

The research questions that will be examined by this study are:

1. How did the teachers demonstrate growth to implement the RME approach?
2. How effective was the approach on students' mathematical learning, engagement, agency, and knowledge about social justice issues?
3. What were the effects of the socioeconomic background of the students on the implementation of the approach and on its effects?

1. 6 Significance of the Study

It is hoped that this study will have theoretical, methodological, and practical implications for the fields of mathematics education. First, the theoretical contribution of this study will contribute to RME literature by employing a social justice context of problems. In particular, teaching mathematics by using the RME approach with a focus on social justice issues uses realistic and real problems as the starting point for teaching and learning mathematics. Also, this study contributes to social justice literature by demonstrating one approach by which it can be implemented in schools. This research may help teachers define how to integrate RME with a focus on social justice within the Indonesian curriculum and also how students respond to this approach. Indeed, it may also contribute to social justice issues around them.

Second, the methodological contribution of this study is informed by action research and grounded theory which are still rarely used in mathematics education research in Indonesia. It may provide a bridge between research and practice in the teaching and learning of mathematics. As Atweh (2004, p. 189) states, action research is a valid and powerful methodology of researching the social context in mathematics education. Furthermore, he goes on to state that action research is a methodology for working towards the improvement of practice through and for developing a deeper understanding of mathematics that might contribute to the emancipatory needs of participants. Indeed, action research is commonly used for improving conditions and practices by involving action, evaluation, and critical reflection. Furthermore, based on the evidence gathered from a study through a grounded theory approach, changes in practice are then implemented. That is useful for mathematics teachers in their everyday lessons to improve the quality of mathematics education which may in turn lead to professional development.

Third, the practical significance of this research is to involve social justice issues which have the potential implications to improve the quality of mathematics education by empowering students to use mathematics to solve real-life problems. This study also provides opportunities for teachers and students to acquire the mathematics skills, knowledge and sense of agency necessary for the effective understanding of important issues in their communities across the world. Additionally, this study will generate a collection of activities and projects that teachers can use to enhance their skills in applying RME and social justice issues. Furthermore, this approach in relatively new in Indonesia as it uses realistic and real contexts in mathematics lessons as well as

introducing the concept of social justice in teaching and learning mathematics.

1. 7 Summary

This chapter has been presented the rationale and background of this study, the research question, and the significance of the study. Chapter 2 presents the literature review which was related to 1) the development of the mathematics curriculum in Indonesia, 2) social justice theories in mathematics education, 3) Realistic Mathematics Education (RME), and 4) variables in mathematics education. Chapter 3 discuss the approaches that were used for data collection and research design, the research quality standards and ethical considerations in this study. Chapter 4 presents the data analysis and discusses the findings. Chapter 5 presents a discussion and summary of the findings by addressing each of the research questions outlined above. This chapter also provides implication of the study, its limitations, and recommendations for further research.

CHAPTER 2

LITERATURE REVIEW

2. 1 Introduction

The previous chapter described the rationale and background of this research. In this study, I am interested in the application of RME with a focus on social justice in teaching and learning mathematics. There is little existing research regarding this study, especially in Indonesia. Therefore, the literature selected for review and discussed in depth covers research work on RME, integration of social justice in mathematics curriculum, and some variables of students learning in mathematics education. Each of these aspects of the literature provides the grounds for addressing the research aims in this study.

This chapter presents the literature review by addressing four sections and one of them is a summary. Section 2.1 explores social justice theories in mathematics education. Section 2.2 discusses the Realistic Mathematics Education (RME). Section 2.3 discusses some variables in mathematics education. A summary of the chapter is presented in Section 2.4.

2. 2 Issues of Social Justice in Mathematics Education

2. 2. 1 What is Social Justice? Why Is It Important in Mathematics Education?

According to Bigelow and Peterson (2002), schools have crucial obligations not only to individual students and families, but to our society as a whole. We live in a world marked by social and economic injustice. Hence, there is a call for transformative intellectuals to speak about unfair conditions in order to address social injustices.

There are widely differing views of social justice because of the different perspectives that people have as a social and ideological agents. Gates and Jorgensen (2009) state that social justice is a relative concept, each person or group having a different view of whether or not something is unjust, socially unjust or relationally unjust. Similarly, Young (in Atweh, 2007, p. 6) states that the principles of social justice are not theorems but they are claims that some people make over others. Even though there are many definitions of the social justice concept, Young (1990) formulated the meaning of social

justice as, “the elimination of institutionalized domination and oppression (p. 15)”. As Chapman and Hobbel (2010) state social justice is a philosophy, an approach, and action that embody treating all people with fairness, respect, dignity, and generosity.

Giroux (in Ayer, 1998) argues that social justice has always had a profound connection to education which has been inspired by theorists of John Dewey, Paulo Freire, and Raymond Williams. Some would argue that learning must be rooted in eliminating social injustices as well as in creating pedagogical practices that help students to imagine a different and better world. In particular, Gutstein (2006) asserts that goals of including social justice in mathematics education are that students develop: socio-political consciousness of the conditions of their lives, communities, and broader society/world (*reading the world*); a sense of *social agency* - or a belief that they are capable of acting on the world to effect change toward social justice (*writing the world*); and positive cultural/ social identities - that is, to be strongly rooted in their language(s), culture(s), and community and have the confidence to stand up for, and act on, what they believe.

2. 2. 2 Mathematics Education and Social Justice

When schools become obsessed with test scores, they limit their ability to serve the broader needs of children and their communities (Karp, 2003). The goals of schools should include that students learn both mathematics and about the world. They should develop a deep socio-political consciousness of their immediate/broader contexts and a sense of social agency (Chapman & Hobbel, 2010). Furthermore, in the process, they should develop strong cultural and social identities, be rooted in who they are as a people, and develop the confidence to stand up for their beliefs. They should learn important mathematics so that they have opportunities to study, pursue meaningful lives, and support their families and communities, but even more, so that they can use mathematics to act against injustice and improve society (Gutstein, 2004).

In particular, learning mathematics is not just about gaining doorway into higher level classes, but about opportunities to draw upon the discipline as a tool for describing, critiquing, and acting transformative upon the world. Indeed, according to Giroux (in Ayer, 1998) if social justice is to become a part of educational work, we need to address some important issues. First, the issue of struggling to create a viable substantive democracy must be located at the centre of any pedagogy of social justice. Second, we need a new language to make youth in all its diversity a central focus for addressing

how we take up the relationship between social justice and democracy.

Furthermore, according to Alrø and Skovsmose (2004) the role of mathematics education is seen to parallel the Freire-pedagogy of developing a competence in making a critical reading of social and cultural contexts in an era of globalisation. An important part of a person's understanding of global issues is the recognition of the dramatic inequalities between nations and social classes within countries.

Indeed, students need to be involved as much as possible in explicit discussions about the purposes and processes of their own education. The classrooms also must provoke students to develop their democratic capacities: to question, to challenge, to make real decisions, to solve problems collectively (Bigelow, 2001). Without social justice teaching inside classrooms, even much needed reforms in funding equity or school governance, will have limited impact (Bigelow, 2001). Furthermore, Bigelow suggests that teachers need to get students to begin to look critically at the many unequal power relations in our society.

A commitment to social justice in education involves developing a curriculum which addresses the real lives of our students, encouraging young people to examine issues of race, class, and gender as they build academic competence, or organizing activities that promote cooperative skills and spirit enables classroom teachers to find ways to promote social justice despite the institutional agenda and bureaucratic practices imposed upon us (Karp, 2003).

2. 2. 3 What Are the Implications of Social Justice in Mathematics Education for Curriculum and Teaching?

According to Osler (2007), in attempting to integrating social justice issues into mathematics, teachers need to create lessons around issues and questions that students have raised and are interested in learning about; create projects that challenge students to suggest just, mathematically sound solutions to the problems that they identified; provide opportunity to the students to present and share their work; scaffold students' understanding of both the mathematics concepts and the issues they are studying; and allow the assessment to determine what students have learned about the mathematics concepts and about social justice issues that were in the lesson or the projects. However, the social justice issues do not have to be the focus of every lesson; sometimes teachers need to spend time focusing on students computations and routine exercises required for

many standardised national tests.

Expanding the curriculum which engages mathematically with issues of social justice such as gender or racial inequality, unequal distribution of income, sexuality or disability may lead to resentment or reveal oppressive beliefs and values (Boylan, 2009). Teaching for social justice can entail conflict, both between students and between students' beliefs and those of the teacher (Boylan, 2009). Teachers also require the confidence to facilitate and support the emotions that can arise when curriculum content is introduced that uses mathematics as a tool to understand more about emotionally charged issues such as poverty, racism and power relationships in society (Adams, 2007).

In particular, social justice in mathematics moves beyond putting mathematics into a social, real world context; it asks students to make use of the mathematics they are studying to make social change (Sriraman, 2008). In this case, students begin to view mathematics as empowering. As Atweh (2009) points out, school mathematics should support students' responsibilities. Furthermore, according to Atweh and Brady (2009) from this ethical perspective, in order for mathematics to contribute to the responsibility of the student as citizen, it should attempt to engage the student in meaningful and authentic real world problems and activities that not only develop their mathematical capability but also help develop the student's understanding of the social world and contribute to its transformation whenever possible.

The philosophy of teaching and learning mathematics for social justice is that mathematics should be learned meaningfully and related to real life struggles against injustice (Gutstein, 2012). Empowering students to critique to change society to make sense of their world and in turn become better able to engage in problem solving and decision-making and to engage in peace making are the important principles of this approach. As Hannaford (1998) suggests, students should have room for the independence that enables them to question, doubt, or disagree in learning mathematics.

Mathematics has functioned as a gatekeeper of many other opportunities, therefore, to teach for social justice must include students developing mathematical power (Bartell, 2013). Furthermore, according to Hannaford (1998, p. 186) "if children are taught mathematics well, it will teach them much of the freedom, skills, and of course the disciplines of expression, dissent and tolerance, that democracy needs to succeed". Indeed, an ideal education in which students have democratic access to powerful

mathematical ideas can result in students having the mathematical skills, knowledge, and understanding to become educated citizens who use their political rights to shape their government and their personal futures (Malloy, 2002, p. 17). Furthermore, Malloy (2002) claims that there is potential of mathematics to enable students to understand that they can use mathematical power to address ills in our society.

A central tenet of mathematics education for social justice is its emphasis on praxis: the process of critically reflecting and acting upon the world in order to transform it (Freire, 1970, p. 6). Praxis corresponds to the knowledge acquired through the process of doing. It is a central ethical dimension; it is reasoned and right action with human good for its object (Ernest, 2007). Through praxis people combine the theoretical interest in wellness with our practical concern for action.

However, Engaging students in social justice issues, many people would say that children at this age are too young to deal with these serious issues. Students can compare and contrast the experiences of people and think about what it means. They can, that is, if they are given the opportunity. The equity and justice must come to live in the classroom. It is in the classroom that students will experience the world, a world that opens possibilities for their developing hearts and minds (Swope, 2006).

2. 3 Realistic Mathematics Education (RME)

2. 3. 1 What is Realistic Mathematics Education (RME)?

Realistic Mathematics Education (RME) is a teaching and learning theory in mathematics education that is rooted in Hans Freudenthal's interpretation of mathematics as a human activity (Freudenthal, 1973). In particular, according to Gravemeijer (1994), the label "realistic" in RME refers to the approach of mathematics education that is taken from the four approaches in mathematics education classified by Treffers (1986): mechanistic, structuralistic, empiristic, and realistic. In realistic mathematics education both horizontal and vertical mathematizing are used to shape the long term learning process. Freudenthal, beginning in the 1960s, had established the idea of mathematisation with two components: horizontal and vertical. Horizontal mathematisation leads from the world of *life* to the world of *symbols*. In the world of *life* one lives, acts (and suffers); in the other one *symbols* are shaped, reshaped, and manipulated, mechanically, comprehendingly, reflectively; this is known as vertical mathematisation. Identifying or describing the specific mathematics in a general

context, schematising, formulating and visualising a problem in different ways, discovering relations, discovering regularities, recognising isomorphic aspects in different problems, transferring a real world problem to a mathematical problem, and transferring a real world problem to a known mathematical problem are examples of horizontal mathematising (Treffers, 1987). Meanwhile, the following activities are the examples of vertical mathematisation: representing a relation in a formula, proving regularities, refining and adjusting ideas in symbols representation (model), using different models, combining and integrating models, formulating a mathematical model, and generalising.

Gravemeijer (1994) argues that the mechanistic approach is the opposite of the realistic approach, it is characterised by the weakness of both the horizontal and the vertical component. The structuralistic and empiristic approaches are somewhere in between; with at one hand the structuralistic approach emphasizing vertical mathematisation, and the one hand the empiristic approach stressing horizontal mathematisation.

The development of RME started around 1970 in the Netherlands. The Dutch reform of mathematics education was called 'realistic' is not just because of its connection with the real world, but also because it offers students problem situations which they can imagine as authentic. As Van den Heuvel Panhuizen (1998) states The Dutch translation of 'to imagine' is 'zich REALISEren'. It is this emphasis on making something real in mind that gave RME its name. The problems to be presented to the students mean that the context can be a real world context but this is not always necessary. Fictitious and even formal mathematics can be providing suitable contexts, as long as they are real in the student's mind (Dickinson, 2012). According to Gravemeijer (2000), in traditional mathematics education, the result of the mathematical activities of others was taken as a starting point for instruction rather than by teaching the activity itself.

> Freudenthal stressed that not all students are future mathematicians: for the majority, all the mathematics they will ever use will be to solve problems in everyday-life situations. Therefore, familiarizing students with a mathematical approach to this type of problem-solving deserved to be a highest priority in mathematics education. This goal could be combined with the objective of having students mathematize problem situations that would be experientially real to them. (p. 782)

Indeed, the basic idea behind the RME is that mathematics must be connected to reality and mathematics be seen as a human activity. Mathematics must be close to children, and be relevant to everyday life situations. As Freudenthal (1971) acknowledges,

mathematics as a human endeavour is an activity of solving problems, of looking for problems, but it is also an activity of organizing subject matter. This subject matter has to be organized according to mathematical patterns if problems from real life situation are to be solved.

2. 3. 2 Key Principles of RME

There are three basic RME heuristics for instructional design which are known as the key principles of RME (Gravemeijer, 1994), namely, *guided reinvention* and *progressive mathematising*, *didactical phenomenology*, and *self-developed models*. According to the reinvention principle, the mathematics lesson needs to provide opportunities for students to experience a process similar to the way in which mathematics was invented (Gravemeijer, 1994). The concept of guided reinvention is influenced by Freudenthal's concept of mathematics as a human activity. He believed that people should give shape to education in such a way that the students have the opportunity to essentially reinvent the discoveries of our forefathers. Because the teacher plays an essential, guiding role, this process is referred to as guided reinvention. In addition, Freudenthal (1971) argues that mathematics should never be presented to students as ready-made product. Furthermore, Gravemeijer (1994) points out that based on a didactical phenomenology, the goal of the phenomenological investigation is to find meaningful problem situations which can be generalised and taken as the basis for vertical mathematisation. Whereas, self developed models play a role in bridging the gap between informal knowledge and formal knowledge by transition from a *model of* to a *model for*. In simple explanation, a *model of* informal mathematical activity becomes a *model for* more formal mathematical reasoning (Gravemeijer, 1994).

This initial distinction led to the development of design heuristics including "guided reinvention" and "didactical phenomenology", both of which provided a genetic aspect to the instructional approaches and worked to capture the need of students to strengthen their understanding of abstract ideas while linking them to practices involving the application of quantifiable knowledge. The starting point of many teachers is to build on what students bring into the classroom, and to connect curriculum to students' lives. Even though, the real world of one child may differ considerably from the real world of another.

Mathematics has arisen and arises through mathematising. This phenomenological fact is didactically accounted for by the principle of guided reinvention. Mathematising is

mathematising something, something non-mathematical or something not yet mathematical enough, which needs more, better, more refined, and more perspicuous mathematising.

Furthermore, Gravemeijer (1994) characterize five types of activity which is known as characteristics of RME in the following way.

2. 3. 3 Characteristics of RME

Gravemeijer (1994) stressed the five characteristics for the Realistic Mathematics Education (RME) as the domain specific instruction theory of Treffers'. Some of the concepts have been elaborated in the key principles of RME subsection.

1. Phenomenological exploration: in line with the basis ideas of Freudenthal's didactical phenomenology, emphasis is on a phenomenological exploration (Freudenthal, 1983, p. 32). The teachers should encourage student to engage with the real world context that make sense to them in learning mathematics.
2. Bridging by vertical instruments: In solving problems, rather than being offered the solution to the students right away there is a need for the students to develop and use their own representation of the situations problem that can help to bridge the gap between the intuitive level and the level of subject matter systematic (Gravemeijer, 1994). In this characteristic, the students demand to move from their own strategies to more sophisticated ways in mathematics.
3. Student contribution: The constructive element is visible in the large contribution to the course coming from the student's own constructions and productions. By engaging students through real life connection with mathematics and maintaining group discussion, students can build the confidence necessary to become active participants in the mathematics lessons.
4. Interactivity: Explicit negotiation, intervention, discussion, cooperation, and evaluation are essential elements in a constructive learning process in which the student's informal methods are used as a lever to attain the formal ones (Gravemeijer, 1994). Indeed, through interactivity students improve their mathematical skills and confidence.
5. Intertwining: The holistic approach, which incorporates applications, implies that learning cannot be dealt with as the integration among different subjects; instead, an intertwining of learning strands is exploited in problem solving. Additionally,

teachers should offer students opportunities to solve problems by using various mathematical tools and knowledge.

These concepts can be used as guidelines to design the implementation of this approach by integrating with social justice issues, including the learning stage in the classroom and the design of student activity sheets.

2. 3. 4 RME Alignment with the Social Justice Focus

Numerous research studies have emphasized the use of problems situated in the real world in mathematics education. The mathematician Hans Freudenthal stressed the connection between mathematics and reality. In particular, there is also a need to promote greater awareness or a social consciousness appropriate for initiating major shift in thinking (Sriraman, 2009). As Freire (1998) suggest, pedagogical practices should support education for freedom and highlighted problems in investing education into the praxis. Indeed, there are many similarities of several key terms and themes between Freudenthal theories and Freire theories. The following table presents these similarities.

Table 2.1:

Similarity between Freudenthal and Freire theories of Education

H. Freudenthal	P. Freire
Mathematics is a human activity	Education as the practice of freedom
Against deductive approach to teaching mathematics	Against banking education
Use of real life problems	Use of generative themes
Mathematics as an activity	Problem posing education
Mathematical discussions	Dialogue
Teacher as a facilitator	Teacher as a facilitator
Students have an active role in their learning process	Students are not docile listeners

The explanation of the theories of Freudenthal in the table is mentioned in the previous section. The following explains similarity between Freire's theories and Freudenthal's theories.

Education should be the Practice of Freedom

Both Freire and Freudenthal argued that education should develop human agency. They emphasised freedom of the learner in constructing their own knowledge through democracy and reinvention. According to Freire (1970) education as a practice for freedom must attempt to expand the capacities necessary for human agency and, hence, the possibilities for democracy itself. Furthermore, education provides possibility and hope for the future of society, for example, from the dialogues or discussion within the class, students start to learn about democratic society. Thus, education should not be test oriented system. Relevantly, instead of seeing mathematics as a ready product to be transmitted, Freudenthal emphasized that mathematics is a human activity that sees students as the re-inventors of knowledge through mathematisation of reality. The process involves student engagement in problem solving through individual or a collective activity.

Against Banking Education

Freire contends that people cannot learn through banking, expert teachers depositing knowledge in the presumably blank minds of their students, who memorize the required rules in order to get future dividends (Frankenstein, 1987). In particular, Freire (1970) states that education can be seem like the banking concept metaphor in which the student is a depository and the teacher becomes depositor. Indeed, the teacher explains and deposits while the student is recipient, memorized person, and repeater. The student's position is no more than a recipient. Unfortunately, current studies show that the student as a recipient will inhibit creativity reduces knowledge transformation. As a consequence, education is far from both inquiry and praxis and results in individuals whose lack of humanity in regrettable.

Implicit in the banking concept is the assumption of a dichotomy between human beings and the world: a person is merely *in* the world, not *with* the world or with others; the individual is spectator, not re-creator (Freire, 1970). However, Freire goes on argue that knowledge emerges only through invention and re-invention, through the restless, impatient, continuing, hopeful inquiry human beings pursue in the world, with the world, and with each other.

Relevantly, in RME theory, the students are treated as active participants in the educational process, in which they develop all sorts of mathematical tools and insights by themselves as an anti-didactic inversion of the traditional (deductive) approach (Van den Heuvel-Panhuizen, 2000). Freudenthal (1991) was concerned that mathematics was

not seen as a ready-made product. Furthermore, Freudenthal (1991, p. 48) criticized anti-didactic inversion. He asserted that learning was not to be understood as duplicating but as guided reinvention.

Generative Themes

Both Freudenthal and Freire encouraged the use of real world problems. RME does not necessary focus on real problems, but on realistic. Similarly, generative themes by Freire focused on authentic problems. According to Freire (in Turner, 2009), generative themes emerge as students and teachers ask questions and pose problems about the experiences which give meaning to their lives. These problems did not have the clear-cut answers of typical textbook exercises, but were intended to challenge students and teachers to respond through and collective action (Frankenstein, 1987). Students need their interest to be stimulated through classroom activities and projects connecting to their lives. Teachers can ask students about the issues that concern them at work, about the non-work activities that interest them, about topics they would like to know in more depth, and so forth (Frankenstein, 1987).

From the Freudenthal perspective, mathematics must be connected to real life problems. Teaching mathematics is not a ready-made system, there is concern to find contextual problems and situations that allow generalisations and provide a basis for linking situations to concepts or ideas in mathematics (Gravemeijer, 1994).

Problem Posing Education

According to Connolly (1981), Freire and Freudenthal encouraged the increase of the agency of the students through the teaching and learning process. In contrast to banking education, Freire suggests that a problem posing education encourages students to become active in thinking and acting upon the world. Freirean problem-posing is intended to reveal the interconnections and complexities of real life situations where often, problems are not solved, only a better understanding of their nature may be possible. Furthermore, Freire (1970) points out that "in problem posing education, human develop their power to perceive critically the way they exist in the world with which and in which they find themselves; they come to see the world not as a static reality, but as a reality in process, in transformation" (p. 70). This process of 'problem-posing' helps people to come to consciousness, viewing as *problems* those inequities and authorities repressing their lives that they have come to take for granted as natural and inevitable, and viewing themselves as actors that have helped sustain but also can resist repressive forces. These theories align with mathematics as an activity of

Freudenthal's theory. Mathematics can be seen as an activity involving meanings to provide student opportunity to explore mathematical concepts and skills. As Freudenthal (1973) states mathematics can be best be learned by doing through using or applying mathematical concepts or procedures.

Dialogue

According to Freire (1970) dialogue is a key component of problem posing education. Commitment to dialogical rather than banking education is important. Freire (1970) states that through dialogue the student is more of an active participant in the teaching learning process. Furthermore, he states that achieving human dignity can be achieved through a collaborative, albeit revolutionary process, and that only dialogue requires and enables generating critical thinking.

One of the characteristics of RME is interactivity, including discussion. According to Van den Heuvel-Panhuizen (2001) the learning of mathematics is a social activity. Based on this idea, the mathematics classroom should offer the opportunity for students to interact with each other and to share their strategies to enable them improve their understanding of mathematics concepts. Discussion enables communication and interaction among participants is connected to the students' realities. Thus, discussion can strengthen students understanding of mathematics concepts and enhance their social skills.

Teacher as a Facilitator

Kincheloe (2000) states "Teachers are not simply curriculum dispensers, but rather are cultural workers committed to addressing the contextual issues facing our students, our schools, and our communities (p. 5)." The teacher's role is one of facilitating learning, rather than transmitting knowledge. According to Treffers (1987), in realistic mathematics education teachers should use pupils' constructions to help them build new constructions and solve problems.

Students are not Docile Listeners

According to Freire (2005) the students are no longer docile listeners but are critical co-investigators in dialogue with the teacher. The teacher presents the material to the students for their consideration, and reconsiders his earlier considerations as the students express their own.

This is relevant to the contribution characteristic of RME: students play an active role in their learning process through their contributions to mathematics lessons.

2. 3. 5 How can the RME Approach with a Focus on Social Justice be Implemented in the Classroom?

Realistic mathematics education places the student in quite a different position from that of traditional educational approaches. Students have to be more self-reliant. In realistic mathematics, like in inquiry mathematics, they have other obligations, such as explaining and justifying their solutions, trying to understand the solutions of others, and asking for explanations or justifications if necessary (Gravemeijer, 1994).

Critical mathematics educators ask why students, in general, do not see mathematics as helping them to interpret events in their lives, or gain control over human experience (Appelbaum, 2007). They search for ways to help students appreciate the marvellous qualities of mathematics in human experience.

RME neatly aligns with social justice issues whereby an RME problem can be modified to become a problem with a social justice theme. The purpose of the problem is stated, then expanded enter the student consciousness, and then the dialogue in the classroom focuses on the topic of discussion.

Based on the characteristics and principles of RME and the theories of Freire with a focus on social justice, the learning steps undertaken in this approach consisted of:

a. Understanding Contextual Problems Focussing on Social Justice

In this step, teachers go over the objectives of the lesson, and engage students with social justice issues. At the same time, they ask students to express their own values and desired action about the social justice issues either individually or in discussion with their peers. Teachers will give scaffolding to lead their students' understanding the problem.

Didactical phenomenology as a principle of RME is achieved when teachers provide students with the real or realistic context problem including social justice issues. The characteristic of RME that might emerge in this step is *the use of context* and *interactivity* in which students develop mathematical tools and insights as active participants in the teaching and learning process through the particular context. The use of context through the presentation of social justice issues is seen as the starting point for student learning activities and their students' interactions.

b. Solving the Problems Individually or in Groups

During the lesson effort should be made to engage students with the application of mathematics to real life and social justice issues by simplifying the social justice problem into their own words or to present a model of the problem based on their understanding and then devising a solution. In this process, students work individually or in groups to elaborate the solution of the problem. In addition, the teacher provides scaffolding to the student in order to construct knowledge or understand a concept enabling the solving of the mathematical problem that focused on social justice.

In this step, the principle of *guided reinvention and progressive mathematizing* is achieved when teachers try to give directions. Teachers tend to build on students' mathematical reasoning and to guide their reinvention of mathematics by locating instructional starting points that are experientially realistic to students. The process of progressive mathematization might be facilitated when students try to describe the problems using their own language or model. They then develop certain mathematics concept and procedures to solve the problems by themselves or within the context of social interaction among teachers and students. In addition, *interactivity* as a characteristic of RME emerges in this step. Instead of working on a given task individually, students work collaboratively in mathematical inquiry. They share their strategies and ideas with each other.

c. Comparing and Discussing Answers

Teachers assist students to share their work with others. These interactions will be devised by the teachers as students engage with the mathematical activities in the classroom through comparing and discussion. During the discussion, teachers should encourage students to express their answers to experience taking responsibility for their own statement or answer about social justice issues by using mathematics knowledge as a tool.

The characteristics of RME which are probably demonstrated in this stage are *interactivity* and *the use of students' own creations and contributions*. Interactions can occur between students and teachers as well as among students.

d. Concluding

At a later meeting, teachers help students to reflect on their investigations. Furthermore, teacher and students discuss their conclusions including concept, definition, and procedures of mathematics which are related to the social justice issues.

At this stage, the characteristics of RME that will emerge are the use of students' own creations and contributions as well as interactivity. Indeed, the intertwining of various mathematics strands or unit might be involved through the whole teaching and learning process.

2. 3. 6 Pendidikan Matematika Realistik Indonesia (PMRI)

PMRI was established from an adaptation of RME theories. In particularly, RME has a long tradition in Indonesia which is known as PMRI, the term that refers to the Indonesian version of the Dutch Realistic Mathematics Education. The key ideas of RME and PMRI are similar. However, RME had to be adapted to the context of local circumstances and culture in Indonesia. We could not adopt RME directly. For example, a teacher can talk about windmill in Netherland, but children in Indonesia can not talk about it, especially children from Indonesian village have never seen windmill. As what other country who adopted RME materials, they should draft the initial materials. Furthermore, Dickinson (2012) reports that after revision of initial materials of RME, it was trialed and re-trialed over a period for effectiveness and examination of student strategies and teacher needs, beliefs and expectations. Additionally, PMRI is not exactly the same as RME since there are cultural differences in education between the Netherlands and Indonesia (de Haan, 2010, p. 134). The Netherlands is an individualist country with a small power distance while Indonesia is a collectivist country with a large power distance. According to Kolman, Noorderhaven et al. (2003), power distance can be defined as the extent to which the less powerful members of institutions and organisations within a country expect and accept power to be distributed unequally. An important aspect of the dissemination of PMRI is to provide professional development for teachers, principals, and teacher educators through local workshops (Sembiring, Hoogland, and Dolk, 2010). The objective of the workshops is to ensure that participants are empowered to implement PMRI in their classrooms. Indeed, Marpaung (in Gijse, 2010) sees a role for Makassar to become a PMRI centre for East Indonesia. Makassar is a far more strategic location for implementation of this approach than Surabaya, because here there are educators ready and capable to coach teachers. Relevantly, this research will be conducted in Makassar.

Indeed, many research studies about RME have been conducted in Indonesia aiming to contribute to solving the problems of mathematics education in Indonesia (Fauzan, 2002; Hadi, 2002; and Zulkardi, 2002). The studies found that the RME approach is

effective in the teaching and learning of mathematics. Also, through the RME approach students' achievement are better than those of students taught through the conventional approach. However, according to Fauzan (2002) the application of RME approach could not be fully applied in Indonesia for two reasons. Firstly, the schools in Indonesia have to finish the curriculum on time because the pupils are required to sit local and/or national examinations. Secondly, it is not possible for a school to withdraw from the local and/or national examination system.

2. 4 Variables in Mathematics Education

Mathematics education reform must be driven by a far broader vision than has been the case in recent years. There is a growth of interest to make rich connections between the various branches of mathematics, between mathematics and other disciplines, and between mathematics and social reality. The call for social justice issues to be incorporated into mathematics education is consistent with the aim of achieving such connections. Indeed, there is a need for learning having a robust and empowering identity in relation to mathematics as Boaler (2003) defines as the dance of agency. Furthermore, the mathematics classroom can be a place of hope, where students and teachers learn about the application of mathematics to society, including injustice issues which is serve to improving awareness and developing citizenship. In particular, engagement should be promoted through teaching and learning mathematics which involves mathematical enrichment tasks. As OECD (2003) states, students with greater engagement in mathematics tend to achieve better results. This is in accordance with one of the aims of this study which is investigating the effects of the RME approach with a focus on social justice on students in term of mathematical learning, engagement, and knowledge about social justice issues. These variables will be discussed in turn in the following section.

2. 4. 1 Learning Mathematics

Learning mathematics is not simply to know definitions and theorems in order to recognize when to use and apply them. Boaler (2000) states that learning mathematics like doing mathematics in at least one important respect. At any stage of learning mathematics, learners have some concepts and methods that they already know and understand. Their learning extends what they already know. People can think of a learning episode, then, as one that includes bridging and transcribing, and possibly

filling, so that some new topic is included in, and integrated with, some of their previous mathematical knowledge (Boaler, 2000. p. 195).

Furthermore, an individual who is to make effective use of his or her mathematical knowledge within a variety of contexts needs to possess a number of mathematical competencies. OECD (2003) has decided to make use of eight mathematical competencies that are relevant and meaningful across all education levels mathematical thinking and reasoning, mathematical argumentation, modelling, problem posing and solving, representation, and communication. For example, for students to become numerate, they must be given opportunities to practise and apply the mathematics they have learned.

Relevantly, National Council of Teachers of Mathematics (NCTM) provides principles and standards for school mathematics: (1) problem solving by applying a variety of appropriate strategies. Monitoring and reflecting on the process of mathematical problem solving; (2) reasoning and proof by making and investigating mathematical conjectures; (3) communicating through organizing mathematical thinking coherently and clearly to peers, teachers and others. Use the language of mathematics to express mathematical ideas precisely; (4) representing by creating and using representations to organize, record, and communicate mathematical ideas. Using models and interpreting mathematical phenomena; and (5) connecting by recognizing and using connections among mathematics ideas through understanding how these ideas interconnect and build on one another to produce a coherent whole.

In particular, Schoenfeld (1988) argues that the nature of mathematics perceived by students is a result of an intricate interaction of cognitive and social factors existing in the context of schooling. If students are to learn and apply mathematics, they must come to see mathematics as having worth in social settings.

2. 4. 2 Engagement

Engagement in learning promotes metacognition and self-esteem, and enables mathematics learning to become meaningful and enjoyable (Fullarton, 1998). It can be regarded as one of the driving forces of learning (OECD, 2004) and increases the academic achievement of learners (Park, 2005).

What is Engagement?

Engagement has been defined as "students' psychological investment in an effort directed toward learning, understanding, or mastering the knowledge, skills, or crafts that academic work is intended to promote" (Newmann, Wehlage, and Lamborn, 1992, p. 12). Furthermore, Newmann (1992) categorise the factors that affect student engagement in authentic work students perform in the classroom, work that "entails extrinsic rewards, meets intrinsic interests, offers students a sense of ownership, is connected to the real world (i.e., the world beyond school), and involves some fun is more authentic and more likely to engage students (p. 23)."

According to Chapman (2003), learning task engagement refers to cognitive criteria, behavioural criteria, and affective criteria. There are several items relating to cognitive and affective engagement according to Chapman (2003, p. 3). Cognitive aspects of engagement often ask students to report on factors such as attention versus distraction, mental effort expended, task persistence in the face of initial failure, and response levels during class time. Affective engagement questions typically ask students to rate their interest in and emotional reactions to learning tasks on indices such as choice of activities, the desire to know more about particular topics, and feelings of stimulation or excitement in beginning new projects. Behavioural engagement has a tendency to be observable and is conceptualized in terms of active responses to instructions.

The degree of student engagement in mathematics classroom was investigated in this study in accordance with Chapman's criteria to assess student levels of cognitive, behavioural, and affective engagement.

How to Achieve Engagement in the Mathematics Classroom

Learner engagement is the extent to which all learners (1) are motivated and committed to learning, (2) have a sense of belonging and accomplishment, and (3) have relationships with adults, peers, and parents that support learning. Indicators include attendance rate and participation rates in extracurricular activities. Furthermore, according to Richard (2009) students will learn most effectively when the teacher makes sense and meaning of the curriculum material being taught. This can only happen if the teacher has created a safe learning environment that encourages students to meet challenges and apply high rigor skills to real-world, unpredictable situations inside and outside of school.

Students might be engaged in a mathematical activity when the students hypothesise, try things out, execute mathematical procedures, communicate and defend results in and reflect on the methods selected and result generated (Davis, 1990). In particular, students' engagement with mathematics and school is related both to their own interest and enjoyment and to external incentives (PISA, 2004). Furthermore, student engagement is enhanced when students are interested, challenged and feel that the work is important.

According to Seeley (2004), when students are actively motivated and busy reaching learning goals, they are also actively constructing knowledge and moving toward successful mastery of key concepts. She goes on to acknowledge that when students are actively involved in writing, modelling, exploring, and discussing mathematics rather than simply watching the teacher do these things, students are more likely to be successful.

Moreover, Seeley (2004) states that although there is no single model for all classrooms or for all learning styles, many teachers now structure their teaching to present their students with a challenging problem or task, either from a real-world context or a compelling mathematical context. After some large-group discussion of the problem, students may work in pairs or in small groups on the task. This element of small-group discussion is an important aspect of engaging students, since they benefit from talking about the mathematics they are doing, sometimes making conjectures, discussing, justifying, and even arguing about methods, approaches, or answers (Seeley, 2004).

There needs to be a personal engagement with mathematics so that it becomes an integral part of the learner's personal identity. As Ernest (2002) states, the learners need to: (1) be confident in their mathematical knowledge and skills; (2) be confident in their ability to apply these capabilities both in routine and non-routine mathematics tasks, and in applied social contexts; (3) be confident in their ability to understand mathematical ideas and concepts including new ones; (4) have a sense of mathematical self-efficacy, namely, a confident self-image of themselves as being successful in mathematics; and (5) have a sense of personal ownership of mathematics including a sense that they can be creative in mathematics.

2. 4. 3 Agency

Critical theories have arisen from a belief that all facts are socially constructed and insomuch are determined by those that define and control their construction. As Maori (2004) states, "a focus within critical theory is therefore one of human agency, of people being actively involved in the construction of knowledge and the concepts through which we see the world (p. 39)."

In particular, Valero (2004) argues that "new notions of power, agency and practice have entered the discourse of mathematics education and have offered alternatives for its understanding (p. 63). Valero contends that the debate is encapsulated in a reflection on the significance of postmodern ideas in the field of mathematics education research and a fundamental change in the conceptions of practice and knowledge.

According to Fuchs (2007), agency is a fundamental and foundational category and puzzle in virtually all social sciences and humanities. In addition, agency is contested because it connects to core questions in metaphysics, philosophy, and ethics, such as free will, moral responsibility, personhood, and subjective rights. Agency is tied to the legacy of liberal humanism that is part of the core of democratic citizenship. Moreover, Klein (2000, p. 76) describes "agency as the positioning of oneself so that one has a voice within and beyond discourses." In addition, an individual's agency refers to the way in which he or she acts, or refrains from acting, and the way in which her or his action contributes to the joint action of the group in which he or she is participating (Gresalfi, Martin, Hand and Greeno. 2009).

There are a considerable number of research articles on students' agency in mathematics education (e.g., Boaler and Greeno, 2000; Cobb, Gresalfi and Hodge, 2009; Wagner, 2007) which draw on Pickering's (1995, p. 21) metaphor of the "dance of agency". As Pickering (1995, p. 22) asserts, the dance of agency, seen asymmetrically from the human end, takes the form of dialectic of resistance and accommodation, where resistance denotes the failure to achieve and intended capture of agency in practice, and accommodation an active human strategy of response to resistance, which can include revisions to goals and intentions. This dance is a metaphor for the tension between individuals' initiatives and structures or conventions in relation to mathematics per se.

Pickering (1995) distinguished between different forms of agency. Conceptual agency involves choosing methods and developing meanings and relations between concepts

and principles. For example, to know algebra is to recognize a set of characteristic symbols and how to use them. As Wittgenstein (1953) put it "Every sign by itself seems dead. What gives it life? In use it is alive" (quoted in Pickering, 1995, p. 115). Meanwhile, disciplinary agency refers to the use of established solution methods and thus turns the concept of agency to the discipline of mathematics itself rather than being seen as the sole responsibility of the person.

Moreover, in mathematics education research, agency can be understood as initiating ideas, agreeing with others, to elaborate and critique, question or disagree with others (Gresalfi, Martin, Hand and Greeno, 2009). In particular, Martin (in Empson, 2002) defines agency in terms of individual perceptions and beliefs, and his primary evidence is found in students' statements about who they are and where they see themselves headed. Similarly, Empson (2002) emphasizes that mathematical agency consists of the power to use mathematics to effect personal and social transformation, the identification of oneself as a mathematical thinker, and the capacity to use and to critique the uses of mathematics in the contexts that matter to oneself and one's communities. Indeed, according to Valero (2004), "If students are agents and negotiation can help bring their intentions into the educational scene, real empowerment may take place (p. 49)."

In the situation in which students are recognized as agents of the educational process, empowerment does not emerge from the "possession" of mathematics, but from the position that students adopt to influence the social practices where mathematics is taught and learned. Empowerment is the manifestation of a relation in which people position themselves in order to influence the outcomes of a situation using diverse tools (Foucault, 1972). In addition, a necessary step toward social justice is to help children to recognize that their voice matters. Real and lasting social change cannot come about until individuals realise the power that they possess.

In particular, mathematical agency is some combination of Ernest's social and epistemological empowerment (Stemhagen, 2009, p. 341). Social empowerment involves in using mathematics to better one's life chances (Ernest, 2002). Epistemological empowerment refers to the degree to which children recognize that they can construct new knowledge and have the power to determine the value of their constructions. Indeed, Stemhagen (2009) states:

> For mathematical agency to be addressed in mathematics classrooms, teachers must commit to helping students learn how to deal with their already mathematized existences and also to recognize that they are agents capable of

> altering such mathematizations and also to create new ones when they see fit. (p. 341)

A core component of achieving equity through mathematics education may be an increase in focusing on students' sense of *agency* – their sense of themselves as "agents whose actions count in, and account for, the world" (Holland, Lachiotte, Skinner & Cain, 1998, p. 285).

Furthermore, Gutstein (2003) points out that "fostering student agency can support equity not only through its impact on students' sense of themselves as doers and creators of mathematics, but also as it encourages students to see themselves as capable citizens who have the power to be key participants in the struggles for equity and justice (p. 27)."

Relevantly, at the heart of Freire's critical pedagogical approach is that students develop a socio-political consciousness that supports them in action aimed at self and social transformation, or in other words, that they develop and enact a sense of *critical agency* (Freire, 1970). In the classrooms, following Paulo Freire's path can help students unveil the world of oppression by encouraging them to think critically, engage in critical dialogue, and problematizing the reality they see (Cipolle, 2010, p. 50).

Moreover, focusing on real situations that concern student' lives allows students to interrogate their own reality, and to see larger societal issues reflected in their experiences (Gellert, Jablonka, and Keitel, 2001). Such reflective discussion can foster a critical mind set among students, thereby contributing to their sense of agency. Additionally, students' desire to understand and address the inequities they experience in low income, urban schools and communities can motivate their use of mathematics (Tate, 1995).

2. 5 Summary

This chapter presented the literature review which integrating social justice in teaching mathematics by using the RME approach. The discussion began by identifying the importance of social justice issues in mathematics education. The next section explained the RME approach in teaching and learning mathematics. This section described briefly the history, the key principles and the characteristics of RME. This approach states that Freudenthal theory of mathematics must be connected to reality and mathematics be seen as human activity. The next section described the alignment between RME and

social justice issues in mathematics education. It began by comparing between Freudenthal and Freire as the most influential people in RME and social justice in education. The next section described an alternative way to incorporate the approach. The implementation of RME with a focus on social justice approach is still new in Indonesia. In relation to this, some variables in mathematics education were also discussed including learning mathematics, engagement, and agency. The review of literature relevant to this thesis has reinforced the need for more research by integrating issues of social justice into mathematics education through RME. The next chapter describes the details of the research methodology.

CHAPTER 3

RESEARCH METHODOLOGY

3. 1 Introduction

The are three research questions of this study: 1) How did the teachers demonstrate growth to implement the RME approach?; 2) How effective was the approach on students' mathematical learning, engagement, agency, and knowledge about social justice issues?; and 3) What were the effects of the socioeconomic background of the students on the implementation of the approach and on its effects? Qualitative research methods were used to conduct the investigation where I used elements of grounded theory and action research as the research approaches. Furthermore, grounded theory and action research are particularly appropriate to my study because my research purpose is to bring about development of teacher practice and the student learning in mathematics classrooms. A variety of the instruments was used for data collection. I will elaborate on these aspects of the research in this chapter.

This chapter on methodology is divided into six parts. Section 3.1 addresses the theoretical framework of research methodology. Section 3.2 explores details of the research design. Section 3.3 describes the procedures used for data analysis. Description of the research quality standards are discussed in section 3.4. Section 3.5 presents the ethical considerations of this study, while Section 3.6 summarizes the chapter.

3. 2 The Theoretical Framework of Research Methodology

This research is a qualitative research by using action research and grounded theory as the methodology. According to Patton (1985 in Merriam, 1998), qualitative research is an effort to understand situations in their uniqueness as part of a particular context and the interactions within them. Patton claims that this understanding is an end in itself, so that it is not necessarily attempting to predict what may happen in the future, but to understand the nature of that setting, what it means for participants to be in that setting, what their lives are like, what's going on for them, what the world looks like in that particular setting, and in the analysis to be able to communicate that faithfully to others who are interested in that setting. Similarly, Denzin and Lincoln (1994, p. 4) argues that

qualitative researchers stress the socially constructed nature of reality, the intimate relationship between the researcher and what is studied, and the situational constraints that shape inquiry. Such researchers emphasize the value-laden nature of inquiry. They seek answers to questions that stress how social experience is created and given meaning

In particular, the use of grounded theory and action research as the research methodology in this study is relevant since the application of the approach is a new line of research in Indonesia, and hence grounded research is appropriate as a means of exploration of the phenomenon. Additionally, the use of action research is relevant in order to developing teaching methods and student learning by integrating social justice with mathematics education.

3. 2. 1 Grounded Theory

Grounded theory is a particular approach to qualitative research (Creswell, 2002). The research question in a grounded theory study is a statement that identifies the phenomenon to be studied and tends to be oriented toward action and process (Strauss, 1990). Indeed, rather than testing the relationships among variables, grounded theory aims to discover relevant categories and the relationships among them, to put together categories in new relevance context that shows a relationship among them, rather according to predetermined theoretical constructs (Strauss & Corbin, 1990). The carrying out of procedures of data collection and analysis systematically and reiteratively enables the research process to capture all potentially relevant aspect of the topic as soon as they are perceived.

Charmaz (2000) maintains that grounded theory through a constructivist approach allows the researcher to achieve a wider realm of interpretation by assuming that people create and maintain meaningful worlds through conferring meaning on their realities and acting within them. In grounded theory the researcher looks beyond surface meaning to illuminate values and beliefs. Interviewing participants over time allows people to share their thoughts and feelings fully. By piecing together the data, the researcher can start to make sense of their research aims. Furthermore, coding and categorising sharpen the researcher's ability to ask questions about the data and allows for viewing it afresh as new ideas are developed. Strauss and Corbin (1990) recommend that based on the coding paradigm the researcher looks for context, conditions, action/interactional strategies, intervening conditions and consequences as a guide to

establishing these relationships.

3. 2. 2 Action Research

Atweh (2004) points out that action research is an international movement that is slowly but steadily gaining a significant place in mathematics education. Theoretical contributions to the development of critical action research have come mainly from the writings of Freire and Fals Borda in South America, and from the Frankfurt School of critical theory and its more recent development by Habermas. Indeed, critical "action research, one of the most promising recent developments in critical theory of education, has been guided by a similar recognition of the potentially valuable role of teachers and learners in the processes of organisational change" (Young, 1990, p. 149).

Kemmis and McTaggart (2000, p. 596) define action research as a learning process, the fruits of which are the real and material changes in: a) what people do; b) how they interact with the world and others; c) what they mean and what they value; and d) the discourses in which they understand and interpret their world.

Similarly, action research is a self-conscious or reflective process of rationally guided experimentation. As McNiff (1997) states that by consciously engaging in their own educational development, teachers gain both professionally and personally; and it is this personal commitment that counts in the process of human enquiry.

Action research is appropriate to this research project related to the improvement of teaching and learning in mathematics. As Carr and Kemmis (1986) argue, action research is done by people on their own work, following an essentially critical approach to schooling, and with the explicit aim of improvement. Moreover, Atweh (2004) points out that through action research teachers can develop a sense of agency in generating knowledge about their practice and in reforming their own practice. Furthermore, Lewin (1946) claims that the best way to move people forward is to engage them in their own enquiries into their own lives. As the basis of his ideas he stresses the importance of democratic collaboration and participation (McNiff, 1997).

Moreover, what gives action research the power for cultural transformation is the structure that keeps the conversation in existence: the spiral nature of action research including plan, act, observe, and reflect (Holly, 2009). It is a form of self-reflective enquiry that is now being used in school-based curriculum development, professional development, and school improvement schemes; it actively involves teachers as

participants in their own educational process (McNiff, 1997).

Through action research, teachers are encouraged to become continuous, lifelong learners in their classrooms with respect to their practice. This notion is central to the very nature of education. Action research encourages teachers to examine the dynamics of their classrooms, critically think about the action and interactions of students (Mills, 2003).

3. 2. 3 The Relationship between Grounded Theory and Action Research

Action research can be defined as a family of research methodologies which pursue action (or change) and research (or understanding) at the same time" (Dick, 1999). In general it does so by alternating action and critical reflection. Theory and practice are integrated.

Grounded theory and action research methods are distinct approaches to qualitative inquiry. In this study, the researcher applied both approaches to address the aims of the research. Integrating these approaches can empower the researcher and participants to investigate professional practice. They can complement each other as an effective tool for amplifying the voices of the participants.

The aim of action research is to integrate action and reflection. Like action research, grounded theory focuses on understanding the research situation rather than on testing a theory. Grounded theory and action research enabled the variables of this research to be realised whilst providing a systematic evidenced based research foundation to develop school practice.

Creswell (2005) states "Grounded theory design is a systematic, qualitative procedure used to generate a theory that explains, at a broad conceptual level, a process, an action or interaction about a substantive topic" (p. 439). Meanwhile, Ebbutt (1985) argues that action research is a systematic study that combines action and reflection with the intention of improving practice. Thus, in this study, action research and grounded theory might fit well together.

It has been recommended in the work of Dick (2003) that in some ways action research and grounded theory are complementary. The author goes on to claim that elements of action research can be embedded in a grounded theory study. Grounded theory can capitalise on its cyclic process by importing ideas from action research, especially in

ways of increasing efficiency and protecting the researcher against preconceptions (Dick, 2001). A process for theory building in action research may be supported by the grounded theory processes of coding and memoing.

According to Dick (2010) both grounded theory and action research are capable of being used flexibly and responsively; their differences suggest ways in which each might be enhanced. He goes on to state that much of grounded theory is about how to convert information and experience into theory. It is common for action researchers to involve participants extensively in a study so that the planned actions have the commitment of their participants. Thus, there some virtue in the combination of grounded theory and action research. The action researcher might make wider use of purposeful sampling to be able to generalize more confidently, also the grounded theorist will be more explicit in understanding the action of participants, and in interpreting information more efficiently. In short, in essence grounded theory is an approach to analysing the data that has been obtained throughout the study whereas action research is about a process of action where one aspect produces data that is amenable to a grounded theory approach for analysis.

3. 3 The Research Design

In this section I discuss the research participants who were involved, the instruments that were used, and the procedures that were followed in this research.

3. 3. 1 Research Participants

In order to address the research question about the effect of the approach on students' performance based on their socioeconomic background, the school selected purposively in this study represented the wide range of school choice based on socioeconomic status of the school community. In this study, SMPN Mutiara is the public school. It was the first choice of some parents to send their child to their designated public school from the same area even though they have a standard admission test. The admission to any public school is very competitive. The students who do not get admitted into a public school will attend a poor private school. However, some parents from higher socioeconomic status choose to send their children to religious international private schools. There were two types of private school participating in this study. One is a private religious international school (SMP Al-Khawarizmi) and one is a standard private school (SMP

Pelita). Most students who attend SMP Al-Khawarizmi are from families with good financial standing and so able to pay the tuition fees to have their child attend. Parents of low SES could not pay for these tuition fees. SMP Al-Khawarizmi has very good learning resources. Meanwhile, SMPN Mutiara is a public school with good reputation in academic emphasis. Compared to the other schools participating, SMP Pelita has inadequate resources and facilities. The students come from low socioeconomic background; several students were orphans.

Prior to conducting the research, I approached one teacher of grade 7, Sulaeman, in the international school (SMP Al-Khawarizmi) to be part of the study. Unfortunately, he rejected because he was pursuing his own Ph.D. program. Sulaeman recommended another teacher, Rahmah, who teaches grade 7 mathematics in the same school. Therefore, I contacted Rahmah and invited her to consider taking part in this study by explaining the aims of this study and the conditions for her involvement. Fortunately, she agreed to participate in this study. Based on information from Rahmah, I invited a state teacher who is a civil servant under the Ministry of Education in Indonesia, Melati, to participate in this study. She is a mathematics teacher in SMPN Mutiara and also teaches in SMP Al-Khawarizmi in grade 8 as a relief teacher. This school was selected to investigate effect the middle schools students' socioeconomic background. Fortunately, Melati has agreed to participate in this study as well. Furthermore, Iriana who teaches in a private school with poor resources (SMP Pelita) was approached as well. She was my schoolmate in our bachelor degree course. And she agreed to participate in this study. Rahmah and Melati chose one class under their supervision as the classroom teacher to be the class participant, whilst in the Iriana's school there is only one class for each grade.

The participants' classes in SMP Pelita were 51 students in one year 7 class consisting of 19 male students and 32 female students. Rahmah, a teacher participant from SMP Al-Khawarizmi selected one class purposively with average achievement from five classes of grade 7. This class has 31 students with 14 male students and 17 female students. Melati, a teacher participant from SMPN Mutiara selected one class purposively from ten classes of grade 7. This class has 40 students, with 14 male students and 26 female students. There is only one class of grade 7 in SMP Pelita and it became the class participating in this study. I turn now to discuss the profile of the teacher participants.

The teacher participant from SMP Pelita is Iriana. She is a permanent mathematics teacher and the school administrator. She is 30 years old and has been teaching since 2006. However, since she was a student at in university in 2001, she has taught in that school as a relief teacher. When Iriana joined the research study, she said she thought that the ability of her students might be different from those of the other two participant schools. Being a lower socioeconomic school, Iriana often mentioned that her class has many behavioural problems. She thinks her students are immature and they just have a little knowledge about social justice issues, especially regarding to their language. Nevertheless, Iriana explained that she has considered implementing a contextual teaching and learning (CTL) approach as her bachelor degree thesis topic.

Rahmah is the mathematics teacher in SMP Al-Khawarizmi to participating in this study. She is 32 years old and has been teaching for around 4 years. She graduated from the Mathematics Department not from the Education Department. However, regarding the requirements for teaching in school, she has completed a graduate diploma of education as well. She is particularly interested in improving her English skills in teaching mathematics. She said to me that she has to work hard on what the school has prescribed, such as following the syllabus and the school schedule, and the assignment period because she works in an international private school.

The teacher participant from SMPN Mutiara is Melati. She is a permanent teacher and is 36 years old. She has been teaching since 2008. Melati is also a mathematics relief teacher in SMP Al-Khawarizmi. It is common in Indonesia that several civil servant (permanent) teachers work in private school as a relief teacher. She also works as a private mathematics tutor for student who wants to enter the university in one college in Makassar. She has currently finished her educational training and has her certified teacher's certification, wherein, the teacher needs to write a portfolio or conduct research which is submitted to the local technical agency. In this case, she was very excited to join this research to enable her to conduct action research as one of the requirements of her professional training.

Table 3.1:

Summary of the names of schools, their type, names of teachers, and name of several students in the years 7's which their voices or works were to be presented in the next chapter.

Names of Schools	Type of School	Names of Teachers	Names of Students
SMP Mutiara	Middle socioeconomic background school	Melati	Vigna, Febi, Jason, Israq, Thasa, Haekal, Danatul, Andi, Padilla, Sandy, Ayu, Fatur, Fiqry, Hadrian, Isnayanti, Nur Hikmah
SMP Al-Khawarizmi	High socioeconomic background school	Rahmah	Reza, Dhafa, Aldy, Aji Kumolomuuti, Gayatri, Gilang, Endah, Calista, Taufiqurrahman, Fahri, Khaerunnisa
SMP Pelita	Low socioeconomic background school	Iriana	Akbar, Marselina, Ayu, Dea Oktora, Zarah, Nurhaedah, Musdalifa, Herawati, Miftahul Janna, Murni, Mirna, Linda, Isnayanti, Umra, Rini, Sri Wahyu, Sriwahyuningsih

3. 3. 2 Instruments

This section will discuss the methods of obtaining data, namely field notes, observation, students' work, focus group discussion, and informal interview. The following table indicates which research aims were to be informed by each instrument.

Table 3.2:

Summary of Research Methods with Data Collection Strategies

Research Objectives	Data Collection Strategy
To investigate the professional growth of teachers in the implementation of the RME approach with a focus on social justice.	Observation Focus group discussion Informal interviews Field Notes
To investigate the effects of the approach on student learning.	Field Notes Observation Students' work Focus group discussion Informal interviews
To investigate the effects of the school socio-economic background on the implementation of the approach and on its effects.	Field Notes Observation Students' work Focus group discussion Informal interviews

Field notes

The advantages of field notes are ongoing as a personal aide memoire (McNiff, 1997). Indeed, field notes can come in many forms, but at the least they include descriptions, direct quotations, and observer comments (Merriam, S. 1998).

It is easy to forget material, thoughts, and impressions of a lesson if the observer does not directly down write his/her observations and actions. Every observer will have their own preferred strategies for recording the data from observations. In this study, I kept notes on my I Pad 2 in Microsoft word format and I noted as closely as possible to the time when lessons were observed. Throughout this project, I maintained field notes on observations and also made notes on conversations which took place during discussions in the class and in the interviews. A sample of field notes from observations in SMP Pelita follows:

Field Notes
SMP Pelita

1st September 2012
Penjumlahan dan pengurangan integer
Handout of the students? They don't have handout: it's not quite good.

The teacher present problem that enable students to examine the inequality resource for example the differences among Papua and Java regarding to the numbers of the population.
They try to read and write the world through math.
Appreciation of the student's knowledge.
The teacher used "learning media" (kancing/collar) to introduce the concept of additions and subtraction of the integer.

Sometimes students just write down what the teacher write on the blackboard without understand what the meaning of their work is.
The math concept that teacher delivered is not to accept fully by the students.
Most of the students just do what they want, although it's not relevant to the learning process.
Note: I think teacher need to consider about that.
Teacher need to activate all the students not only the clever one.
Good Point: Iriana speak as their mother to make student convenient.
Note: they have to effort hard but they got a few salary.

Figure 3.1: Example of Field Notes of SMP Pelita

Observation

In naturalistic settings, teaching and learning processes are often audio taped or videotaped. Taping and video recording have the advantage of recording accounts that are both detailed and accurate (Stringer, 1999). In this research, every single mathematics lessons of each participating teacher was observed for 12 weeks that audio or video recording were made.

The purpose of these observations was to get information about the teachers and the students that enabled me to discuss the research questions. In particular, the teachers were observed in term of their professional growth in implementing the RME approach with a focus on social justice to answer the research question, "How did the teachers demonstrate the growth in implementing the approach?" Meanwhile, the students' behaviour to be observed was related to their mathematical learning, engagement, agency, and knowledge about social justice that enabled me to discuss the research question, "How effective is the RME approach on students' mathematical learning, engagement, agency, and knowledge about social justice issues?" Besides, the observations were also intended to find out about the condition of the school facilities, and also the attitudes of the students to find out about the effect of socio economic background on implementation of this study that enabled me to answer the research question, "What are the effects of the socio economic background on the implementation of the RME approach and on its effects?" All the digital files of the audio and video recorder were saved on an external hard disk. Later, they were sent to the source folder of the NVivo program for analysis purposes.

Students' Work

The analysis of students' work, including students' worksheets, their participation, and project work was to be assessed in terms of what their responses revealed about their mathematical knowledge in relation to the mathematical problem and to social justice issues.

In this research, I found the use of the students' work was particularly important for all the mathematics classrooms. They had their chance to express their views or voice on the project, especially for the project about their own data.

Focus Group Discussion

Marshall and Rossman (1999) points out that the advantages of the focus group discussion method are socially oriented, studying participants in an atmosphere more natural than artificial experimental circumstances and more relaxed than the exposure of a one-to-one interview. It is a technique involving the interviewing of participants in a group ranging from as small as 4 to as large as 12 to share thoughts on a given topic. In particularly, Ebrahim (1995) states:

> Unlike group interviews, the topics to be discussed are decided beforehand, and the facilitator uses a list of open-ended questions arranged in a logical sequence.

> The objective is to obtain information on participants' beliefs and perceptions on a topic of interest. Instead of the researcher asking each person to respond to a question in turn, subjects are encouraged to talk to one another. They ask questions, exchange anecdotes and comments on each other's experiences and points of view. (p. 203)

In this research, I had 3 student focus groups discussions for each school. I had 4 students in each group, consisting of the more able students and those of moderate and low achievement. They were selected purposely by their teachers according to their examination result. Most of the focus group meetings with the students were held in the canteen during the school break and for around 20 minutes. Students were more comfortable when they discussed mathematics in a relaxed environment. The conversations were recorded, and then transcribed.

There were 5 focus groups discussion with the teachers within this study. The teacher focus groups meeting held in the meeting room or in the coffee shop on the weekends which were every two weeks. The focus group discussions were conducted to allow teachers to share their experiences during the implementation of the RME approach in this study. Sometimes in the focus group, teachers got an idea about the project or task that they should provide to their students for the next lesson. As a source of data, focus group discussions were recorded by using a voice recorder after gaining permission from each the research participant.

The discussion in the focus group provided information about a range of ideas and feelings about teachers' and students' experiences in the implementation of the RME approach with a focus on social justice issues in teaching and learning mathematics as well as illuminating the differences in perspective between them. Several themes and key questions were used to encourage participants to express their opinion. Examples of interview questions for the students are: tell me about your experiences on learning mathematics. What is the advantage of the mathematics topic that you learnt in your life? Tell me your perception about the new approach that the teacher conducted. Explain to me about your progress in learning mathematics. Examples of interview questions for the teachers were: What are the restrictions in the implementation of the approach? Tell me your perceptions about the change in the classroom during this study.

Informal Interviews

Interviewing is one of the most common and most powerful ways that we use to understand our fellow human beings. An interview can be one-time, a brief exchange, say five minutes over the telephone, or it can take place over multiple, lengthy sessions, sometimes spanning days, as in life-history interviewing (Denzin, 1994, p. 361). However, a major challenge in constructing any interview is to phrase questions in such a way that they elicit the information which is needed (Mills, 2000).

In this research, the informal interviews with teachers and students were conducted in addition to focus group discussions. The informal interview with the teachers was a reflective interview which is a casual conversation between the researcher and the teacher at the end of the lesson was used to retrieve the teachers' experiences from the classroom, in order to lead them to reflect on their own experiences and to plan for the next lesson. The interview held for at least 15 minutes. Sometimes we spoke whilst we were walking into the office from the classroom. These informal interviews with teachers were ongoing through to the end of the projects.

3. 3. 3 Procedures

This section contains the following subsections: The official curriculum that the teachers followed during this study; the professional development workshop for teachers, and implementation of the RME approach in the classroom.

The Official Mathematics Curriculum

It is difficult to interfere with the mathematical content covered by the teachers as they have to follow the materials based on the syllabus of the official mathematics curriculum. In the mathematics curriculum at each level in Indonesia, the government has determined the official syllabus and the basic competencies. Meanwhile, the indicators are developed by the teachers. See the examples of the indicators below. This subsection contains the mathematics content during this study that was followed by all school participants at the same time. Sample syllabus is attached (see Appendix A).

Integers and Fractions

Basic of Competence:

1. To determine estimation of operation in integers and fractions to the nearest place value.

Indicators:

- To know the rules of rounding off integers and fractions.
- To determine rounding off of integers and fractions.

2. To do the operations of integers and fractions

Indicators:

- To give some example of integers.
- To classify the kind of integers.
- Mention quantities in daily life that use integers.
- To determine the location of integers on a number line.
- To solve the operation of integers (addition, subtraction, multiplication, division, powers and roots)
- To apply the operation of integers in problems solving.
- To calculate the value of the exponents and radicals of integers.
- To give examples of the many forms and kind of fractions (proper, improper, mixed fraction, decimal, percent and per mile)
- To change a fraction form to another fraction form.
- To solve operations of fractions (addition, subtraction, multiplication, division, powers and roots)

3. To apply the properties of integers and fractions in problem solving.

Indicators:

- To inquire the properties of addition, subtraction, multiplication, division, powers and roots.
- To apply the operations of integers in problems solving (Repeated).
- To apply the properties of addition, subtraction, multiplication, division, powers and roots in fractions and applying in daily life.

Algebraic form topic

Basic of Competence:

1. To know the algebraic forms and their elements.

Indicators:

- To explain the definition of algebraic form, variable, constant, factor, term and like/unlike term.

2. To do the operations of algebraic form.

Indicators:

- To do the operations (addition, subtraction, multiplication, division, powers) of algebraic form.
- To explain about Greatest Common Factor (GCF) and Least Common Multiple (LCM) of algebraic form.
- To apply the operations of algebraic form in problems solving

Topic

Linear Equations WITH One Variable (LEOV)

Basic of Competence:

1. To solve linear equations with one variable (LEOV).

Indicators:

- To know linear equations with one variable (LEOV) in many kind form and variable.
- To determine the equal form of linear equations with one variable (LEOV) by both of sides add, subtract, multiply or divide to the same number.
- To determine the solution of linear equations with one variable (LEOV)

Professional Development Workshop for Teachers

After negotiating and developing commitment for this project with the teacher participants, the next stage of this research was providing teacher participants and the headmaster with an information sheet containing the purpose of the research, my role as the researcher, the teachers' and students' role, consent to participate, confidentiality, issues, and further information (see the Appendix B). Then, the headmasters were introduced to the research aim to enable them to better understand the project. I told

them that this was a good opportunity for the schools to improve the quality of teaching practice, student achievement, and a platform to help students learn mathematics through social justice issues and learn social justice issues through mathematics. All the principals were very supportive of the project.

A two day workshop was conducted to provide an orientation to the project and to skill the teachers in appropriate strategies to explore and improve their own teaching skill in designing some activities related to the RME approach with a focus on social justice issues. Actually, according to the interview with the teacher participants in the survey stage before the study began, they had learnt the theory of RME in the university where they gained their diploma or bachelor degree. Additionally, the teaching styles that their school supervisors recommend is consistent with RME approach. During the survey stage, I started to introduce RME approach with a focus on social justice issues. Thus, the two days workshop was just an introduction on how to integrate social justice issues into teaching and learning mathematics with RME approach.

All the teacher participants were provided with an example of a student activity sheet in the workshop session. The materials focussed on the application of RME to social justice issues. The two day workshop was held at the microteaching room in Makassar State University on Monday 2nd Tuesday 3rd July, 2012. This workshop served as a platform for the exchange and sharing of ideas and experiences related to this research. In particularly, a variety of approaches was designed in the training such as presentations, discussions, watching a video related to the RME approach and social justice video.

The introduction, the sessions on the theory of RME and how to conduct RME were presented on power point slides to the teacher participants. The introduction consisted of the aims of the workshop and the research study, the basic principle of the approach, and the research schedule at the school. The theory of RME session included a discussion on the characteristics of RME, the change paradigm from teacher centred to student centred teaching, and several examples of students' activities in line with RME approach. Afterwards, participants were showed a video of an RME lesson. The video drew from the work of the Dutch mathematician Hans Freudenthal which was developed by Marteen Dolk and Catherine Twomey Fosnot (2001) and provided a sample for the teacher participants to design rich context for problem solving, to interpret students' thinking, and to develop a mathematical community in the classroom.

In addition, working with the context to consider in teaching mathematics inspired the teachers to push students in terms of understanding and thinking of different strategies and different ways of representation of the context through the RME approach.

Table 3.3:

Workshop Schedule Day 1: Monday 2nd July, 2012

Time	Topic	Duration
08.00-08.30	Introduction	30 min
08.30-09.30	Explanation about the project	60 min
09.30-09.45	Morning break	15 min
09.45-10.15	What is RME (Theories of RME)	30 min
10.15-11.00	How to conduct RME	45 min
11.00-12.00	Watching video of RME	60 min
12.00-13.30	Lunch	90 min
13.30-15.00	Teaching integer through RME approach	90 min
15.00-16.30	Simulation	90 min
16.30-17.00	Reflection and discussion	30 min

In the next session, there was a simulation of the RME approach in which the teacher participants were asked to develop student activity sheets and lesson plans based on the simulation session. The next activity allowed the teachers to give some feedback for each student activity sheet and lesson plan.

The last session of the first day of the workshop allowed the participants to reflect and discuss other ways of the teacher participants understanding the RME approach. In this section, the teacher participants also shared their teaching experiences, their students' performance, the curriculum, and the possibility of implementing RME in their classroom.

The following table is the schedule of the workshop day 2.

Table 3.4:

Workshop Schedule Day 2: Tuesday3rd July, 2012

Time	Topic	Duration
08.00-08.30	Introduction of social justice	30 min
08.30-09.30	Rethinking the nature & purposes of school: watching video	60 min
09.30-09.45	Morning break	15 min
09.45-10.15	Which way social justice in mathematics education	30 min
10.15-11.00	Recognition of social justice model in mathematics education	45 min
11.00-12.00	Watch video about teaching mathematics through social justice issues	60 min
12.00-13.30	Lunch	90 min
13.30-15.00	Discussion	90 min
15.00-16.30	Preparation for the implementation	90 min
16.30-17.00	Reflection and questions	30 min

When considering rethinking the nature and purposes of school, the participants viewed the video RSA Animate- Changing Education Paradigms. This video was retrieved on June 25, 2012, from http://www.youtube.com/watch?v=zDZFcDGpL4U. According to this video, every country on earth, at the moment, is reforming public education. There are two reasons for it, namely, economic and cultural reasons. Teachers need to educate their students to take their place in the economies and build up their cultural identity. Also, teachers should stimulate creativity and divergent thinking of the students.

In a later session the video "Teaching Mathematics through a Social Justice Lens" (Retrieved from http://www.curriculum.org/secretariat/justice/justice.html) centred on teaching mathematics through social justice issues. This video consisted of an overview in which one school's approach to improving students learning in mathematics used the social justice mathematics approach; integrating social justice issues into mathematics lesson by incorporating the approach to engage children with real number and authentic scenarios that present problems relevant to students' lives; building a collaborative culture of learning; and insights into intense learning in which students discuss the ideas about learning mathematics through a social justice lens. In particular, this video aimed to develop the mathematical concepts and skills of the students in the context of problem solving issues that exist in real life. Students talk about social, economic, and political conditions that people are struggling with in different parts of the world as well

as their responsibilities as global citizens. Thus, this video provided an example of the teaching of mathematics through social justice issues.

Implementation of the RME Approach with a Focus on Social Justice Issues in the Classroom

Two weeks after the workshop, as the result of the discussion about the schedule of data collection that were enhanced through initial survey and the workshop with the teacher participants, they started to conduct their normal lessons in line with the syllabus as shown the schedule in the following table. Meanwhile, I observed the teachers practices in their mathematics classroom.

Table 3.5:

Outline of the Research Schedule

July, 2012

Week	**Topic/ indicators of learning**	**Duration**
Week 2 (Monday 2nd – Thursday 3rd, 2012)	Workshop (Day 1) : Introduction of PMRI	540 min
	Workshop (Day 2) : Introduction of Social Justice in mathematics education	540 min
Week 3	Observing the teacher practice in classroom	(2 x 45 min) each
Week 4	Observing the teacher practice in classroom	(2 x 45 min) each

August, 2012

Week	**Topic/ indicators of learning**	**Duration**
Week 1	**Observing the teacher practice in classroom** *Indicators of learning activities:* ✓ To give some example of integers; ✓ To classify the kind of integers; ✓ Mention quantities in daily life that use integers	(2 x 45 min) each
Week 2	**Observing the teacher practice in classroom** *Indicators of learning activities:* ✓ To determine the location of integers on a number line; ✓ To solve the operation of integers (addition, subtraction, multiplication, division, powers and roots)	(2 x 45 min) each

Due to the school holidays of the fasting month of Ramadhan and Eid Al Fitr 2012 in Indonesia, the research was only conducted for two weeks in August.

September, 2012

Week	**Topic/ indicators of learning**	**Duration**
Week 1	**Observing the teacher practice in classroom** *Indicators of learning activities:* ✓ To apply the operations of integers in problems solving	(2 x 45 min) each
Week 2	**Observing the teacher practice in classroom** *Indicators of learning activities:* ✓ To calculate the value of the exponents and radicals of integers	(2 x 45 min) each
Week 3	**Observing the teacher practice in classroom** *Indicators of learning activities:* ✓ To give examples of the many form and kinds of fractions (proper, improper, mixed fraction, decimal, percent and per mile) ✓ To change a fraction form to another fraction form	(2 x 45 min) each

Week 4	**Observing the teacher practice in classroom** *Indicators of learning activities:* ✓ To solve operations of fractions (addition, subtraction, multiplication, division, powers and roots) ✓ To inquire the properties of addition, subtraction, multiplication, division, powers and roots. ✓ To apply the operations of integers in problem solving (Repeated).	(2 x 45 min) each

October, 2012		
Week	**Topic/ indicators of learning**	**Duration**
Week 1	**Observing the teacher practice in classroom** *Indicators of learning activities:* ✓ To apply the properties of addition, subtraction, multiplication, division, powers and roots in fractions and applying in daily life.	(2 x 45 min) each
Week 2	**Observing the teacher practice in classroom** *Indicators of learning activities:* ✓ To explain the definition of algebraic form, variable, constant, factor, term and like/unlike term. ✓ To do the operations (addition, subtraction, multiplication, division, powers) of algebraic form.	(2 x 45 min) each
Week 3	**Observing the teacher practice in classroom** *Indicators of learning activities:* ✓ To explain about Greatest Common Factor (GCF) and Least Common Multiple (LCM) of algebraic form.	(2 x 45 min) each
Week 4	**Observing the teacher practice in classroom** *Indicators of learning activities:* ✓ To know linear equations with one variable (LEOV) in many kind form and variable. ✓ To determine the equal form of linear equations with one variable (LEOV) by both of sides add, subtract, multiply or divide to the same number. ✓ To determine the solution of linear equations with one variable (LEOV)	(2 x 45 min) each

During this study, the teachers tried to implement the RME approach which focused on social justice issues. They created their own activities and tasks for the students. By doing this, sometimes their lesson plan and student activity sheet was discussed with me by phone or email, so that they could implement those during the next lesson.

The teaching and learning process in the classroom were observed, while I kept field notes. Observations were recorded by using a video recorder after getting permission from all the participants involved in this study. In addition, a voice recorder was activated when I was conducting interviews with the students and the teachers. After the lesson ended, I conducted an informal meeting with the teacher in their office that allowed them to get feedback and to reflect on the lesson that has just taken place.

3. 4 Data Analysis

In keeping with the recommendation of qualitative researchers (Creswell, 1998; Strauss and Corbin, 1990), data analysis took place during the data collection process and not

only at the end of the study. The data analysis process took place intermittently during my data collection. I had developed initial ideas about the teachers' journey, students' performance and the effect of this approach on students while collecting data; three research questions were used as my guide lines to figure out what was happening during the lesson i.e.: How did the teachers demonstrate growth to implement the RME approach?; How effective was the approach on students' mathematical learning, engagement, agency, and knowledge about social justice issues?; What were the effects of the socioeconomic background of the students on the implementation of the approach and on its effects?

The analysis of qualitative data according to Creswell (2008) consists of preparing and organizing data for analysis, exploring the general sense of the data, and coding and representing themes. These steps are in alignment with the analysis of data collection in this research referred to in grounded theory as *'coding'* by using NVivo 9 software.

Preparing and organizing data for analysis in this study including transcribing audio and video recording as soon as possible after the interview and observation. Indeed, all interviews were conducted in Indonesian language and the findings are presented in English. Indonesian language is the researcher's and participants' first language; English is the researcher's second language. The data transcription and translation were guided by the following steps.

- All reflection, interviews and focus group were transcribed in Indonesian language.
- The researcher analysed all data in Indonesian language.
- Themes and selected quotations were translated into English.

Meanwhile, the students' works were captured by digital photos to be saved on a file of students' work to enable the researcher to access them whenever needed. Afterward, this students' work was translated into English. The field notes from each observation were sent directly to my email to keep them safe. Later, the notes were collected within one document labelled 'field notes'.

Exploring the General Sense of the Data:

After organising all the data, I explored the general sense of the data. In doing so, I transcribed the data then reread the data using focused coding in order to group codes and infer connections among them. From this iterative process, I induced key analytic and explanatory themes that were to guide my subsequent readings and interpretations of the data. Furthermore, I looked for patterns and relationships that emerged, and these

were to guide me to search for other connections and interrelationships. In addition, the notes taken during the research allowed me to keep a record of specific segments of the conversation, which might otherwise be lost when viewing the videotapes. Then, I identified the specific quotes for inclusion in the context of the report.

The Process for Coding and Representing Themes:

The NVivo software uses the term nodes for theme or categories. After categorising the data, I went further with cases and concepts to address the research questions. In particularly, data are coded differently depending on the purpose of the data and the stage of the project. There is open coding, axial coding and selective coding. The features and uses of these coding are explained by Borgatti (2005) as the following.

Open Coding: Open coding is the part of the analysis concerned about identifying, naming, categorizing and describing phenomena found in the text. In this study, analysis begins before data collection until the first stage of data analysis. Raw field notes and transcripts reflect the undigested complexity of reality (Patton, 2002, p. 463), needing classification to make sense of them, and to bring order out of chaos (Bazeley, 2007). In particularly, according to Borgatti (2005) the process of naming or labelling in this coding can be done very formally and systematically or quite informally. He goes on to argue that in grounded theory, data are normally coded informally in case some new categories are invented after coding process is completed.

In this study, the researcher classified the data transcription using NVivo by labelling it in order to facilitate later retrieval. Patterns of coding in this study related to some variables described in the previous chapter: characteristics of RME, variables of mathematics education, socio economic background, and professional growth of teachers. An example of a code in this study is presented below:

Text fragment

> Thasa asked Melati: "should I add (-6) and (-1), Mam?"
> Haekal: "I think we have to do subtraction between -6 and -1, the result is -5. Am I right?"
> Danatul: "if I put the number on the number line: I can see that the change of the degree is 5."
> Melati: "How do you know it is 5 not -5, Danatul?"
> Danatul: "because the shift from -6 to -1 tend to the right side means positive, Mam."
> Sandy raised his hand and said: "I agree with Danatul, Mam. (-1) – (-6) = 5."

One thing discussed in the text is learning mathematics. Implied in the text is that Thasa, Haekal, and Danatul tried to solve a mathematical problem. Thus, this text coded as learning mathematics.

Axial Coding: Axial Coding is the process of relating codes (categories and properties) to each other, via a combination of inductive and deductive thinking. To simplify this process, rather than look for any and all kinds of relations, grounded theorists emphasize causal relationships, and fit things into a basic frame of generic relationships.

An example of the axial coding from the text fragment of open coding above is difficulties with the operation of integers of word problem. Another example of the axial coding of this study follows: according to Melati, some of her students get used to thinking and calculating quickly when solving regular mathematics exercises without giving a detail explanation. Also, the lack of mathematics literacy in her students continues to concern her consideration. As a weakness of her students was dealing with word problems, Iriana then designed the learning process to explore more word problems during this study. In particular, Melati tried to vary her teaching methods. Melati explained that she tended to engage students to present various ways of solving problems and tried to engage students with realistic problems including issues of social justice. From the observation data, one of benefits derived from this way was that students worked on word problems intensively. Through practice in using the word problems, the students knew what mathematics strategy was to be applied. Also, they gave full effort in solving the mathematics problem because they saw its connections to their own world. Indeed, some students presented solutions for the problems confidently.

Selective Coding: Selective coding is the process of choosing one category to be the core category, and relating all other categories to that category. The essential idea is to develop a single storyline around which everything else is draped. Coding focus group data, interviews, and field notes aims to find patterns and meaning in data collected. In addition, selective codes are applied to several lines or paragraphs in a transcript and led me to choose the most telling codes to represent the interviewee's voice. By using open codes as a starting point, the process of selective coding helps to verify the adequacy of the initial concepts developed. Selective coding was applied and tested on further interview transcripts.

I compared the data from observation, students' work, and field notes to relate them with one core coding. For example, in order to address the research question about the effects of socioeconomic background on the application of the RME approach with a focus on social justice, I focused on the similarities and differences of the student work of the lower, middle, and high socioeconomic background based on their school. Furthermore, the common themes of the interviews and other data collection were investigated and categorised as the codes. Table 3.6 presents the list of preliminary themes and codes of the data analysis.

Table 3.6:

The List of Themes and Categories

Research Question	Themes	Codes
1. How did the teachers demonstrate the growth to implement the approach?	Professional growth of teachers	The growth in confidence The increase in relationship with the students The growth in their knowledge about social justice The growth in their mathematical knowledge Growth in teaching methods
2. How effective is the RME approach on students' mathematical learning, engagement, agency, and knowledge about social justice issues?	Effectiveness	Mathematical learning Engagement Agency Knowledge about social justice issues
2.1 Mathematical learning:	Learning mathematics topics	The operation of integers Different representations of fractions Greatest Common Factor (GCF) and Least Common Multiple (LCM) of algebraic form
2.2 Engagement:	Students' cognitive engagement	The use of cognitive and metacognitive strategies Integrating new material with previous knowledge
	Students' behaviour engagement	Students are making active responses to the learning tasks presented
	Students' affective engagement	Emotions related to how useful students think the content they are learning would be to them in the future school, school, schoolwork, student-teacher relationship and values.
2.3 agency:	agency	Power to use mathematics to effect personal and social transformation identification of oneself as a mathematical thinker Capacity to use and to critique the uses of mathematics in the context that matter to oneself and one's communities.
2.4 Knowledge about social justice issues	Social justice	Reading the world with mathematics Writing the world with mathematics Developing positive social and cultural identities
3. What are the effects of the socio economic background on the implementation of the approach and on its effects?	Socio-economic background	School facilities The attitude of the students Prior knowledge of the students The quality of the teacher

3. 5 Research Quality Standards

All research must respond to the quality criteria. In particularly, when collecting data for action research studies, it is important for the researchers to ensure the quality of their data (Mertler, C. 2009). Metler states that the extent to which the data reaches a standard of quality is directly related to the usefulness of the research findings for its intended audience. These criteria are described by Lincoln and Guba (1985 in Hendricks, 2006), who explain that the quality of qualitative study can be increased by (1) establishing the verisimilitude of the research findings for the context that was studied (*truth value credibility*); (2) determining the degree to which the results of a research study can be generalized or transferred to other contexts or settings (*transferability*); (3) establishing whether we would obtain the same results if we could observe the same thing twice (*dependability*); and (4) showing that results are an accurate representation of what occurred rather than the result of the researcher's bias, motivation, or interest (*confirmability*). The criteria of standard of quality in this study are discussed in the following sections.

Credibility

The inquiry must be "credible to the constructors of the original multiple realities" (Lincoln and Guba, 1989, p. 296). The strength of a qualitative study that aims to explore a problem or describe a setting, a process, a social group, or a pattern of interaction will rest with its validity (Marshall, 2006). Furthermore, Lincoln and Guba suggest that good qualitative research is dependable. In short, credible reports are those that readers feel trustworthy enough to act on and make decisions in line (Tracy, 2010). Credibility can be established by prolonged engagement with participants, through persistent observation and practice triangulation (Mills, 2000). In terms of prolonged engagement and persistent observation, this study took place over one semester. During the study, I was involved in observing every single mathematics lesson of each of the teacher participants for 12 weeks, with twice a week meeting with each teacher. In addition, I conducted focus group discussions with the teachers and the students.

Transferability

In adherence to Guba and Lincoln's recommendations, in which the researcher must argue that the findings will be useful to others in similar situations, with similar research question or questions of practice, transferability can be established by collecting detailed descriptive data, and developing a detailed description of the context of the

study (Mills, 2000).

To allow transferability in this study, I provided sufficient information about description of the setting, the participants, the mathematics topics, and the context of the study.

Dependability

According to Guba (1981), dependability refers to the stability of the data. Guba recommended the following steps: overlap methods, establish an audit trail.

To enhance dependability of this study, the research process will be reported in detail. In addition, overlapping methods, such as individual interview and focus group discussion have been conducted.

Confirmability

Confirmability refers to the ability of others to confirm or corroborate the findings (Lincoln and Guba, 1989). Guba (1981) argues that practice triangulation and practice reflexivity can be taken to address this. Practice triangulation whereby a variety of data sources and different methods are compared with one another to cross check data. Practice reflexivity can reveal underlying assumptions or biases that cause the researcher to formulate a set of questions in a particular way and to present findings in a particular way.

In this research the reported data have been assured through recording sources and interpretation process in order to enable the integrity of research results to be scrutinized. Multiple sources of data (teachers, students and headmaster) and different forms of data including interpretative data (observations, focus group, interviews, and curriculum materials and students responses) contributed to the quality of the research to reduce effect of investigator bias.

3. 6 Ethical Considerations

An important consideration in this section is informed concern (see in Appendix B). Prior to conducting this research, the researcher was required to gain ethical project approval. The ethical platform on which this study is designed consists of three components: access and acceptance, confidentiality, and client benefit.

The project was approved by the Human Research Ethics Committee (HREC) of Curtin University. The approval of this project was twelve months 18th October 2011 to 17th October 2012 (approval number is SMEC-93-11). However, in order to improve the

quality of reporting, the annual report for the research must be submitted to HREC for the completion of data collection and the ongoing process of this study. The ethical issues addressed in this study were the informed consent as invitation from principals, teachers, students, and parent/guardian to consider taking part in this study, consideration, confidentiality, anonymity, and acknowledgement.

Access and Acceptance

In conducting observer protocol, it is important to gain access to a site through what might be called the site's "gatekeeper" (Wiersma, 2000, p. 418). Whenever research is conducted in an educational setting, it is necessary to obtain permission from the approving body of the agency (Wiersma, 2000, p. 418). Therefore, I needed to get the permission from the headmaster.

At the beginning of the data collection, I invited participants to consider taking part in this study by providing information about the purpose and the procedures of the research, their role in this study, concern to participate, and confidentiality. I made it clear to all participants that their involvement in this study was voluntary and they could withdraw at any time without any problem, I guaranteed participant's anonymity would give information about the updates on the progress of this study and there was a space for the participants to questions about this study at any time. I also assured them that my research would not threaten school policy.

Confidentiality

Not everyone will want to be directly involved in such a study. As Kelly (in Cohen et al., 2000) argues, action research can produce several ethical problems. It may seem like a betrayal of trust if the teachers or the activities of students are recorded and used as evidence. This is particularly the case where the evidence is negative (Cohen et al., 2000). However, I accepted responsibility for maintaining confidentiality. It is not enough to get permission from the participants. They need to know what they were being asked to participate in so they can make an informed decision. Thus, I provided informed consent and anonymity protection.

Benefit for Participants

On the other hand, Strike (1990) (in Cohen et al., 2000), in discussing the ethics of educational evaluation, offers the principle of benefit maximization. The principle of benefit maximization holds that the best decision is the one that results in the greatest benefit for most people. It is pragmatic in the sense that it judges the rightness of our

actions by their consequences or, as Strike argues, the best action is the one with the best results. As the aim of this research to improve the professional growth of the teacher participants and students' learning mathematics by involved social justice issues in the RME approach, it is hoped that the principle of benefit maximization be upheld.

3. 7 Summary of the Chapter

This chapter has outlined the qualitative research methodology informed by action research and grounded theory used in this study. The research design presents the research participants who were involved, the instruments that were used, and the procedures that were conducted. The school selected for this study represent the high, the middle, and the low socioeconomic status in order to address the research question about the effect of the RME approach with a focus on social justice issues on students' performance based on socio economic background. A variety of research instruments was used, including field notes, observation, students' work, focus group discussions, and informal interviews. Furthermore, this chapter also briefly described the mathematics content area of this research which includes integer and fraction, algebraic form and linear equations with one variable, and the use of the algebraic form, linear equation with one variable in problem solving; professional workshop attended by the teachers participants. The different ways of data analysis are also discussed. The chapter also explored the maintenance of research quality standards to enhance trustworthiness. Finally, ethical considerations taken during this study are described. The next chapter provides the data analysis.

CHAPTER 4

DATA ANALYSIS

4. 1 Introduction

This study centres on the application of the RME approach with a focus on social justice in teaching and learning mathematics. There are three main aims of this study: 1) to investigate the professional growth of teacher in the practices of the implementation of the approach; 2) to investigate the effects of the approach on students' mathematical learning, engagement, agency, and knowledge about social justice; and 3) to investigate the effects of the schools' socioeconomic background on the implementation of the approach.

The previous chapter discussed the methodology and data analysis used in the study. This study was a qualitative research informed by action research and grounded theory as the methodology. The instruments used for collecting data were field notes, observations, students' work, focus group discussions, and informal interviews. Grade 7 classes in three schools from different socioeconomic background participated in this study.

This chapter provides details of the data analysis as follows: Section 4.1 describes the professional growth of the teachers' in making changes to their pedagogy. Section 4.2 presents the effects of the RME approach upon students' learning mathematics, engagement, agency, and knowledge about social justice issues. Section 4.3 describes the effect of the schools' socioeconomic background on the implementation of the RME approach with a focus on social justice. Section 4.4 summarises the chapter.

4. 2 Professional Growth of the Teachers

Effective professional development enables teachers to develop the knowledge and skills they need to address challenges and problems in students' learning. Schon (1996) states, effective professional development must be based on the notions of teacher as learner and reflective practitioner. In this study the professional development included a workshop aimed at teachers' developing an understanding of the RME approach with a focus on social justice, understanding the procedures of the study, considering sample activities, and developing a shared commitment to participate and work together. The

workshop involved considerations of how teachers could implement this approach in their teaching. Continual professional development consisted of the teachers engaging in opportunities to reflect on their own practice through informal and reflective meetings and focus group discussion in which they worked collaboratively with each other and with the researcher.

There were many areas of development of the teachers observed in this study: a growth in their confidence, an improvement in relationships with their students, a growth in their knowledge about social justice, a growth in their mathematical knowledge, and growth in teaching methods.

4. 2. 1. The Growth in Confidence

In the early stages of this research, I invited the teachers to consider taking part in this action research on the application of the RME approach with a focus on social justice in teaching and learning mathematics. I outlined the objectives of this research and provided a list of tasks that constituted their role in this research, i.e., attending the workshop; developing some activities for their students dealing with social justice issues; allowing me to observe their teaching when implementing this approach; attending focus group discussions and formal and informal meetings to discuss their experiences and feelings about their implementation of the approach; and allowing me to interview them and their students separately within focus group discussions. At that time, the teacher participants expressed some doubt about their ability to fulfil these tasks. They expressed concern about their skills and ability to participate in such research due to lack of previous knowledge about integrating social justice issues in mathematics lessons. I assured them that we would be working together and that I would support them in the project.

Likewise, in the early weeks of this study, the teachers lacked confidence in planning mathematical problems for teaching in line with the aims of this study. They just used mathematics exercises adapted from the textbook in their usual manner.

For example, in week 2 of this study, when she was dealing with the topic of fractions, Melati gave her students an exercise from their textbook as follows: “A father has 12 million rupiah. He needs to give the amount of money to his three sons. The first child should get 2/4 of the amount, the second ¼ of the amount, while the third child gets 1/12 of the total. Who gets the least money? How much money will each child get?”

Vigna, a student, said: "I'm bored, Mam. Again and again we have to do such exercises. It is childish." In the mathematics lesson, some students might feel challenged but others might be bored by such routine problems. In Vigna case, she felt bored by a series of routine problems with meaningless unrealistic contexts.

At the end of week 2 of this study, I conducted a reflection meeting with all the teacher participants: Melati, Rahmah, and Iriana. In this meeting, I reminded them about the materials from the workshop, and encouraged them to create new material in line with the aims of this study and to use sample problems and activities given in the workshop.

During the later weeks of this study, the teachers tried to integrate social justice issues in their lessons using more realistic contexts that students can identify with. For example, in week 5 of this study, Melati posed the following question verbally to her students as an additional problem from outside the textbook that illustrated an increase in confidence in her ability to supplement the textbook with teacher-made problems:

Melati: If half of the students in a classroom need remedial help, what percentage of the students need remedial help in the classroom? For example, there are 44 pupils of which 22 pupils require remedial work and the other 22 pass the exam. What percentage of the students is that?
Students: 50%.
Melati: If 50% of the pupils take remedial classes, is the learning achieved successful or not?
Students: no!
Melati: For example, if 34 students do not pass the test and only 10 students pass it, would the learning be successful or not?
Students: would not.
Melati: If the average of results in one class is lower than other classes could the students' result be judged as fair or not?
Students: Fair!
Melati: Why do you say fair?
Febi: It is because the students' achievement depends on their own abilities, Mam.

The conversation above indicates that Melati tried to invite her students to make a judgement on whether a situation is fair or unfair. This case represents an early attempt of the teacher to introduce social justice thinking to her mathematics lesson. However, this discussion is in line with the usual use of mathematics questions where there is only one correct answer. There was no room to discuss different possible judgements on that situation. The teachers were not used to allowing a discussion and to consider different views on the answer. Perhaps the lack of ability of the teacher to pursue the discussion further can be attributed to her lack of understanding about the meaning of social justice. She did not take this opportunity to discuss that a schools' lack of achievement

can be a social justice issue and not a mere reflection of students' ability. Moreover, from the students' statements, they seemed to make intuitive decisions on what was just and fair.

Turning to the focus group discussion in week 4 of this study, the teachers critically reflected on their experiences. Every teacher shared their own experience in teaching mathematics. For instance, Melati said that "Honestly, from integrating social justice issues into my lessons, I noted that this approach led students to think critically and increased their critical consciousness with respect to social issues." Furthermore, both Rahmah and Melati claimed that to improve their teaching practices they still need some literature to RME and social justice issues, in particular sample of activities in the line of RME approach. Interestingly, this demonstrated that the teachers had developed an interest to learn this approach to teaching and were ready to put in additional effort to enhance the use of social justice issues in teaching mathematics.

Another incident came from Iriana. In the middle stages of this study, after finishing teaching in grade 7, Iriana and I were discussing the last lesson I observed in the office as we usually did. Generally, I would ask about her feelings or thinking about how the lesson ran. She said: "I can see some of my students are getting active now". Suddenly, two mathematics pre-service teachers from a local university came into the office and joined us. They were planning to conduct a survey for teachers about teaching practice. One of them asked Iriana about the kind of approach that she used in her mathematics grade 7. Iriana was quick to say that she applied the RME approach, adding that she achieved this by creating some activities which were connected to the real life context of the students. It seems like Iriana felt confident now that her teaching practice was along the lines of the RME as she designed students' activities on her own.

Furthermore, after the two pre-service teachers had left, Iriana told me: "The students seem to have improved in their engagement since I have introduced this approach. They have become more and more active (in the classroom) and brave (in answer questions) and also I myself always try my best in every lesson during this research program." Also, according to Iriana, she is planning to develop a lot more tasks as story problems for her next lessons. She added that she believed that the students would find some benefit from such an approach in their future learning.

Iriana sometimes discussed her instructional materials with me before starting the lesson via email or phone. In the later stage of this study, Iriana told me: "I am happy with this

project, because what I have done within this study is in the line of the expectations of my school supervisor[1] in terms of the approach to teaching mathematics by implementing RME and the design of my student activity sheets. Those things that I have designed will be the materials I can present for my next regular supervision meeting".

4. 2. 2. The Growth in Relationship with the Students

In the reflection meetings during this research, teachers described attempts to understand their students. For example, they took into account the diversity of student interests and experiences; established and maintained a positive rapport with and among students by showing respect to and valuing students' ideas and ways of thinking.

Through this study, the teachers tried to take into account the individual students' background, interests, and emotional strengths. For example, prior to conducting the research, according to Iriana, she used to follow the syllabus to teach at school with little regard of the needs of her students. At the beginning of this study, data observation shows that there were differences among individuals in learning mathematics. Some students coped very well with the material under discussion while others needed intensive explanation from their teacher. A good example of this was Akbar, a student in SMP Pelita, who showed low motivation towards learning mathematics in the classroom. Based on the informal discussions and reflection sessions during this study, Iriana came to realize her responsibility towards some of her students who needed additional attention. Increasingly, she paid attention to individual students, designed and engaged students in mathematics group discussions by mixing high, middle, and low achieving students in one group to enable them to be more focused and engaged within the lesson. Thus, she has become closer to her students. The following are some examples from the data.

In week 4 of this study, at the end of the lesson on exponents and radicals, Iriana and I discussed how well the lesson went. I said, "It is observed that some students need more time and rehearsal with a certain topic before moving on to further topics. In the recent lesson, I found that some of students still did not understand how to deal with roots of integers. However, the lesson moved onto the topic of exponents." Iriana said to me:

[1]A Supervisor is a senior teacher chosen by the Department of Education in the province with the responsibility for monitoring and evaluation. They assess school teacher's preparation; observe how the teachers conduct their lessons and examine all activities of the school teachers. Their evaluation reports are sent to the local Department of Education.

"Sometimes I have to rush to enable me teach in the line of the syllabus to finish all the material on it". I said: "Yes, you can Mam. Nevertheless, you have to be aware of the mathematical competencies that students are expected to achieve as the lesson objectives". She then suggested that it might be helpful to deal with this problem by providing students with cooperative learning opportunities because this may enable students with diverse abilities to discuss their task together. On the next meeting, still in week 4 of this study, Iriana designed a lesson around cooperative learning to allow interactions between high and low achieving students.

Iriana told me that it was a real challenge to motivate some of the students in this class who did not even try to understand. For example, Iriana pointed out that one particular student, Akbar, did not like mathematics. From the data observation and the field notes for several lessons in SMP Pelita School, Akbar did not pay attention in his mathematics lessons. Iriana met many times with Akbar after the class and spoke to him personally about why he would not pay attention in his mathematics classes. As Akbar stated, there was a distressing atmosphere at his home due to his parents' conflict. Akbar added that his parents have not shown any interest in his mathematics achievement nor in his other subjects. He struggled in mathematics and did not enjoy mathematics classes. Iriana stated "I will discuss with his parents their son's problem in mathematics during the parents' forum. I thought he also needed personal attention in school." Hence she not only planned to engage the parents in their son's learning, which is sometimes ignored by the educators in that school, but also planned to give him individual help in the classroom.

Another example comes from Rahmah in week 2 of this study. Talking about one particular student in her class, she stated: "Actually Reza is clever, however sometimes he just lacks a focus on his classroom studies. Some students have the ability to perform the mathematical tasks. However, sometimes they need help, such as scaffolding, to enable them to go beyond what the tasks requires. Unfortunately, without some personal attention, they do not focus on solving the task and engage in something that is irrelevant to the lesson."

The same case happened to Dhafa (one of SMP Al-Khawarizmi's students) when I asked him about his perceptions about mathematics. He said:

> Mathematics is bad, Mam. It makes me tired. If I learn it, sometimes I can understand. But, if I have to face a lot of counting, I always feel lazy. I want to be a businessman, Mam. I do not need mathematics then. Indonesian language is not a hard subject, Mam. I enjoy studying it.

After discussing such cases with all the teachers in the focus group meeting of week 6 of this study, they suggested that one way of approaching this problem was the occasional use of cooperative group discussions within the lesson to allow students to share their knowledge and solutions to mathematics problem and keep them engaged with the tasks. It was a tool for fostering integration among diverse students, specifically between the high and low achieving students. The teachers also suggested using teaching strategies that would make students more involved and motivated through connecting their mathematical tasks with real life problems. In this focus group discussion, the teachers offered some examples of activities which were introduced at the workshop as a consideration for the next mathematics lesson.

Moving on to the focus group meeting in week 8 of this study, another example came from Rahmah. Prior to the meeting, Rahmah attended a seminar on mathematics literacy, which was informed by the RME approach, at Makassar State University. According to Rahmah, this seminar reinforced her understanding of RME and increased her interest in implementing this approach. Indeed, during the seminar, a regional mathematics competition for junior high schools was held in the same place and on the same theme. Rahmah's three students joined this competition, but they did not win. According to the students, the main reason behind their loss was that they faced challenges in how to transform information from the word problem to the mathematical symbols or representations. In the following planning meeting, the teacher participants designed more word problems, especially with regard to issues of social justice, to be used in next classes.

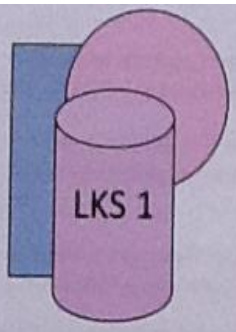
Turning to week 2 of this study in SMPN Mutiara, Melati recognized that some students had difficulties in operations on negative number. After analysing her students' work on the mathematics test on integers, Melati noted that some students did not understand how to perform the multiplication of negative numbers; some did not complete all the questions on the test; some lacked understanding of the story problems; other students had difficulties to understand the requirements of the questions; and others were inaccurate in solving the problem. Thus, in week 3 of this study, Melati provided her students with applications of the use of integers in problem solving such as the weekly expenditure project and health and nutrition task (as will be discussed in the next section).

4. 2. 3. The Growth in the Ability to Incorporate Social Justice Issues in Mathematics Education

Dealing with social justice issues in mathematics education is still new in Indonesia. Hence, the teacher participants did not confident at the beginning of the study in raising social justice problems as they relate to the mathematics studied in school. This section will discuss how the teacher participants grew in their abilities to integrate social justice issues within their mathematics lessons during this study.

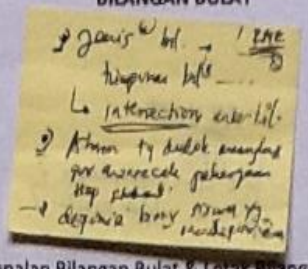
At the beginning of this study, I conducted workshop a two day for participating teachers' workshop. During the workshop I tried to get an initial understanding of the teachers about incorporating social justice issues in mathematics lessons. For example, the teachers, Iriana and Melati, admitted that they had not heard about teaching mathematics for social justice. The teachers shared their own understanding of this approach. According to Iriana, the approach is involved in bringing real life situations and contexts into the classroom by incorporating social justice issues in mathematics problem solving. Specifically, Iriana was worried about whether raising social justice issues with her students would make the focus of the lesson social justice at the expense of doing mathematics. According to Melati, teaching mathematics for social justice means incorporating justice issues into the mathematics lessons. Meanwhile, Rahmah perceived that teaching mathematics for social justice means teaching mathematics while the students are getting an opportunity to consider some social justice issues.

At the beginning of this study, the teachers made up mathematics problems which included social justice issues by looking for the social justice issues which were connected to the particular mathematics topic. However, sometimes they did not engage students in a deep discussion of the issues or they just focused on the mathematics content of the issues. The teachers faced some difficulties in combining mathematics and social justice. In particularly, the data revealed that tensions arose early around balancing social justice issues and mathematics knowledge in implementing this approach. The following examples illustrate the efforts of teachers in attempting to implement the approach. For example, in week 2 of this study Iriana created a student activity sheet about global warming issues to be discussed in group work.



BAB 1

BILANGAN BULAT



Materi Pembelajaran : Pengenalan Bilangan Bulat & Letak Bilangan Bulat

Tujuan Pembelajaran :

a. Siswa dapat memberikan contoh bilangan bulat.
b. Siswa dapat menentukan letak bilangan bulat dalam garis bilangan.

Nama : _____

Kelas : _____

PEMANASAN GLOBAL MEMBAWA BUMI
MENDEKATI TINGKAT KENAIKAN SUHU 2 DERAJAT

Pemanasan global atau efek rumah kaca yang terjadi karena emisi karbon dan metana serta dampak dari pengrusakan lingkungan oleh ulah manusia akan menjadi scenario berbahaya dan membawa dampak di bumi yang serius jika tidak ada tindakan serius untuk mencegah efek pemanasan global (global warming) dengan melakukan pencegahan dan perbaikan bumi. Bahan bakar fosil yang terus menerus digunakan yang menyebabkan emisi gas buang dari kendaraan bermotor dan industri – industri, serta pengrusakan ekosistem bumi menyebabkan efek kenaikan suhu bumi yang kian decade kian meningkat.

Dari beberapa sumber penelitian yang say abaca, ada 6 tingkat kenaikan suhu bumi dan dampaknya, di antaranya :

1.kenaikan suhu bumi 1 derajat, menyebabkan kutub utara kehilangan es setengah tahun penuh, serangan badai di Atlantik selatan.

2. kenaikan suhu bumi 2 derajat , menyebabkan beruang kutub berjuang hidup saat es mencair,lapisan es di greeenland mulai menghilang, kenaikan air laut 7 meter secara global

3. Kenaikan suhu bumi 3 derajat, menyebabkan hutan hujan Amazon mengering, eropa secara berulang mengalami musim panas yang sangat panas,jutaan orang akan berpindah dari sub tropic menuju pertengahan garis lintang.

4. kenaikan suhu bumi 4 derajat, menyebabkan air laut meluap di daerah pesisir, menghilangnya lapisan es yang menyebabkan gangguan air tawar,sebagian kutub utara akan tenggelam dan berdampak pada meluasnya kenaikan air laut.

5. Kenaikan suhu bumi 5 derajat, menyebabkan kebudayaan manusia akan mulai menghilang dengan ditandai perubahan iklim yang sangat dramatik, tsunami besar terjadi karena tenggelamnya kutub utara secara total.

6. Kenaikan suhu bumi 6 derajat, menyebabkan kepunahan massal makhluk hidup 95%, hydrogen sulfat dan kebakaran akibat gas metana yang akan menjadi senjata penghancur massal dan tidak akan yang bisa bertahan hidup kecuali bakteri.

Dari 6 tingkat itu, sekarang bumi berada mendekati tingkat kenaikan suhu 2 derajat. Tentu jika pemanasan global terus menerus di gencarkan dengan tanpa adanya pencegahan atau penyelamatan, tingkat kenaikan suhu bumi ke depan akan semakin meningkat, yang menyebabkan perubahan iklim yang secara signifikan akan berubah secara ekstrim.

Isu yang berkembang menyebutkan bahwa pemanasan Global mengakibatkan gelombang panas menjadi semakin sering terjadi dan semakin kuat. Tahun 2007 adalah tahun pemecahan rekor baru untuk suhu yang dicapai oleh gelombang panas yang biasa melanda Amerika Serikat. Daerah St. George, Utah memegang rekor tertinggi dengan suhu tertinggi mencapai 48° CeLcius. (Sebagai perbandingan, Anda dapat membayangkan suhu kota Surabaya yang terkenal panas 'hanya' berkisar di antara 30°-37° Celcius).

Suhu di St. George disusul oleh Las Vegas dan Nevada yang mencapai 47° Celcius, serta beberapa kota lain di Amerika Serikat yang rata-rata suhunya di atas 40° Celcius. Daerah Death Valley di California malah sempat mencatat suhu 53° Celcius! Serangan gelombang panas kali ini bahkan memaksa pemerintah di beberapa negara bagian untuk mendeklarasikan status darurat siaga I. Serangan tahun itu memakan beberapa korban meninggal (karena kepanasan), mematikan ratusan ikan air tawar, merusak hasil pertanian, memicu kebakaran hutan yang hebat, serta membunuh hewan-hewan ternak.

Pada tahun 2003, daerah Eropa Selatan juga pernah mendapat serangan gelombang panas hebat yang mengakibatkan tidak kurang dari 35.000 orang meninggal dunia dengan korban terbanyak dari Perancis (14.802 jiwa). Perancis merupakan negara dengan korban jiwa terbanyak karena tidak siapnya penduduk dan pemerintah setempat atas fenomena gelombang panas sebesar itu. Korban jiwa lainnya tersebar mulai dari Inggris, Italia, Portugal, Spanyol, dan negara- negara Eropa lainnya. Gelombang panas ini juga menyebabkan kekeringan parah dan kegagalan panen merata di daerah Eropa.

Mungkin kita tidak mengalami gelombang-gelombang panas maha dahsyat seperti yang dialami oleh Eropa dan Amerika Serikat, tetapi melalui pengamatan dan dari apa yang Anda rasakan sehari-harinya. Anda dapat juga merasakan betapa panasnya suhu di sekitar Anda. Cobalah perhatikan seberapa sering Anda mendengar ataupun

ungkin mengucapkan sendiri kata-kata seperti: "Panas banget ya hari ini!" Apabila Anda kebetulan bekerja di alam ruangan ber-AC dari pagi hingga siang hari sehingga Anda tidak sempat merasakan panasnya suhu elakangan ini, Anda dapat menanyakannya kepada teman-teman ataupun orang disekitar Anda yang kebetulan ekerja di luar ruang. Orang-orang yang sehari-harinya bekerja dengan menggunakan kendaraan terbuka di siang ari bolong (misalnya sales dengan sepeda motor) mungkin dapat menceritakan dengan lebih jelas betapa panasnya inar matahariyang menyengat punggung mereka.

ertanyaan :

1. Sebutkan Negara yang pernah mengalami tingkat gelombang panas tertinggi!
2. Tuliskan dampak yang terjadi akibat pemanasan global
3. Ceritakan menurut Anda apa menyebabkan terjadinya perbedaan pemanasan global di Negara luar dengan Negara Anda (Indonesia)

Figure 4.1: Student Activity Sheet of Global Warming

The translation of student activity sheet above is:

Global Warming Poses the Increase of Earth's Temperature in nearly 2 Degrees Level

Global warming as known greenhouse effect is caused by carbon and methane emissions and the impact of environmental destruction by human activity. Global Warming will be deadly scenario and pose serious impacts on the earth if no serious effort is made to prevent its effects by prevention and environmental improvement on the earth. Engines of vehicles and industries using simultaneously fossil fuels emit inevitably pollution and can deteriorate ecosystem which affect to increase the temperature of earth over time.

Based on some references that I read, there were 6 levels of the rise of Earth's temperature and its impact, including:

- Rising 1 degree of earth's temperature leads to melting and losing Arctic ice in North Pole mid-year, giving rise to deadly storms in the South Atlantic.
- Increasing 2 degrees of global temperatures can cause polar bears struggling to live when the ice melts, the ice layer in the Greenland disappears, and 7 meter sea level rise globally.
- Rising 3 degrees of global temperatures can cause the Amazon rain forest to dry, European countries can repeatedly experiences extreme summers and millions of people will move from sub tropic to the mid-latitudes.
- The increase of 4 degrees of global temperatures can cause sea water to overflow in coastal areas, disappearing the layer of ice resulting in disturbance of freshwater, and some of the North Pole will sink and widespread as the impact of the rise of sea level.
- Increasing 5 degrees of global temperatures can lead human culture to disappear tribe by dramatically climate change, and tsunami can occur because of the sinking of the Arctic in total.
- The rise of global temperatures in 6 degrees can result in massive extinction of living organism around 95%, producing deadly hydrogen sulphate and bushfire caused by methane gases which will be overwhelming destruction weapons and all creatures will not survive except bacteria.

Regarding this 6 level, the Earth's temperature is approach to 2 degree. Precisely, if global warming goes on without prevention and rescue, furthermore the level of global temperature will continue to increase, leading extreme and significant climate change.

What is the fate of our grandchildren if one day there is an increase of the earth temperature as describe above?

The current issue mentions that global warming leads heat waves to becoming more frequent and more powerful. In 2007 it was recorded that breaking new record throughout last decade was caused by reaching extreme heatwave suffered by United State, in particular the St. George area. Meanwhile, the hottest temperature hit Utah with 48° Celsius. (As comparison, you can imagine the temperature in Surabaya known as hottest city in Indonesia just reaching between 30°-37° Celsius).

In St. George followed by Las Vegas and Nevada the temperature hits 47° Celsius, as well as other cities in the United States have the average temperature above 40° Celsius. Death Valley region in California had recorded the temperature of 53 degrees Celsius. The extreme wave this time even forced the government in several states to declare emergency status 1. The extreme heat killed some people, killing hundred freshwater fish, damaging crops, triggering deadly bushfire, and killing enormous livestock.

Meanwhile, in 2003 South European Region has also ever been under the greatest heat killing no less than 35,000 people which France was the vast majorities of citizens killed (14,802 inhabitants). France had the highest death rate since residents and local authorities were unprepared for the phenomenon of extreme heat waves. Other victims had widespread from England, Italy, Portugal, Spain, to other European countries. The heat wave also caused severe drought and crop failures prevalent in the European region.

You perhaps may not face extremely heat waves as experienced by people in Europe and the United States. However, regarding your daily experience, you can also feel how hotter is the temperature around you. Just look at how often do you hear yourself whatever saying or perhaps speak idiomatically: "yeah, it is really hot today, isn't it?". If you are working in the room with air condition, staring from morning to afternoon, you will not have time to feel the heat of these days. And then, you may ask your friends or people around you who are working outside. People who drive and work daily with using an open vehicle in daylight may be able to tell you more how boiling their back is.

Question:

1. Mention the states that have experienced the highest temperature.
2. Write down the impact that is caused by global warming
3. Tell us what do you think that contribute to global warming in overseas and in your home country (Indonesia)

Figure 4.2: Translation of the Student Activity Sheet on Global Warming

On this activity sheet, there is the learning indicator (taken from the syllabus of the curriculum) aiming to identify quantities in daily life by using integers. In this case, the teacher was addressing the indicator by using global warming issues.

In answering the questions in this activity sheet before sharing the answer with the rest of the class, some of the high achieving students directly identified the state with highest temperatures by looking at the highest degree in Celsius on the sheet. Meanwhile, other students needed to compare and order the integers number from lower to highest before drawing conclusions from the data to answer the questions. Moreover, in this activity there is room to make decisions about the causes of global warming.

Prior to using the above activity sheet in her class, Iriana discussed it with me via email "Is it relevant to the approach to be implemented in this study? The aim of this task is to allow students to examine the order of integers using degrees Celsius and also be aware of the social issues in the world." She appeared to be not sure about whether this is the type of activity that was appropriate in the study and she needed some confirmation. I said "yes, that's a good start, Mam."

Turning to the story of Iriana, at the end of the mathematics lesson in week 3 of this study, Iriana presented issues that enabled students to examine the issues of inequality of resources by using a projector to present Dokumenter Papua 2004 Membidik Pembidik (Documenter of Papua 2004 Scoping the Educator, uploaded on February 11, 2008) that can be downloaded from http://www.youtube.com/watch?v=SESx6qazZwY. In this video, the teacher aims to show the students some examples of social justice issues in Papua and allow students to comment on these issues in their own words.

Figure 4.3: Documenter of Papua 2004 Scoping the Educator

As Iriana points out, the aim of this video was to stimulate the awareness and consciousness of her students about social injustice issues. In particularly, Iriana focused on the inequality within society in Papua. She explained to the students that in this video the author states that

> We are facing a serious matter on what we can do to the future generations. In particularly, Papua makes a major contribution to Indonesia as known as one of the top 10 gold producing countries. Most of the gold in Indonesia comes from Papua. However, according to the video, citizens are poor, with low level of education, health and socially. It is lagging far behind other villages in Indonesia even though their land is rich.

After they watched the video, Iriana asked her students, "Is the condition of Papua fair or not?" Some of her students said "No, Mam." After that she gave homework to her students to write down their own definition of justice and that this would be collected in the next mathematics lesson. In this activity the emphasis of this video is on social justice issues, but the teacher failed to highlight any mathematics from the activity.

In the informal meeting in her office after the lesson, Iriana told me that she needed to know the perception of her students about social justice. In week 3 of this study, the students in SMP Pelita made presentations about the definition of social justice. Several students were chosen randomly to read their definition to the class. Some comments about justice from Iriana's students were as follows: Marselina said, "Fair is good." Nurhaedah argued that, "If someone gives me something, but at the moment I'm with my friend. Thus, my friend should get the same thing as well." Zarah stated that, "Justice is no discrimination." Meanwhile, Dea Oktora expressed that, "Justice is an expression of what we have something the same with other person or someone else as our desire and then we obtain them".

Meanwhile, in week 3, Rahmah (teacher of SMP Al-Khawarizmi), also asked her students about their understanding of justice. This engaged the students while developing their confidence communicating their opinion. The responses of Rahmah's students were as follows: Aldy said, "Justice is the right of all human beings, and we need it." Aji Kumolomuuti responded to the question, "There is no discrimination because we are all equal in God's eyes." Gayatri Endah stated that, "Justice is a good behaviour and no discrimination against others, Mam" While, Ashilah Chalista Putri Yasya commented, "Justice means no distinction or fair to two or more people, so that no one will be feeling uncomfortable and burdened." This task indicated that Rahmah noticed the importance of knowing the perceptions of her students about justice before

she continued to involve in students on the wide range of social justice issues which were related to mathematics topics. In the informal meeting with Rahmah after this lesson, Rahmah informed me that she was happy and impressed with her students' comments about justice because some students described the definition of justice in appropriate terms such as human rights, discrimination, and equity in God's eye.

From the two classes coming from different socioeconomic background classes responses, it shows that the set of answers of students from SMP Al-Khawarizmi are a bit more sophisticated and theoretical than those from students in the SMP Pelita class. This is in accordance with Zevenbergen (2001, p. 43) who states that "the rich language of middle-class parents prepares children for the language they will encounter in school mathematics. Conversely, working class children encounter forms of language in the home environment different from that which they encounter in the school."

As seen, in the above examples, the teachers attempted to deal with social justice issues in their mathematics classes. However, these initial attempts did not involve sophisticated mathematics. It seems that the teachers were not able to balance concerns about social justice with the teaching of mathematics. However, not all activities that the teachers used demonstrated this problem. The following is an example of an activity used by the teachers that consisted of considerable mathematics as well as dealing with global social justice issues.

In week 3 of this study on application of the operations of integers, the teacher participants developed a "weekly expenditure" project that was discussed in the focus group in the weekend of week 2 with all the teachers.

Weekly Expenditure

1. For this project you need to calculate your weekly family expenditure on food
1. How much in rupiah that your family spend on food weekly?
2. Change the total amount of the expenditure into US dollar.
3. Compare your expenditure to different family in the world from the hungry planet photo study which is given to you regarding to the weekly expenditure. Are we growing unequal? If yes, why do you think there is such inequality between countries in the world?

Figure 4.4: Student Activity Sheet of Weekly Expenditure

This project required the students to get the family grocery list and the money spent on food for a week. This activity encouraged students to look at the food that is consumed in their family home over a week. By calculating their family expenditure of food,

students were enabled to learn from their own families and also to compare their expenditure with that of different groups of people from around the world (given from the hungry planet photo study: what the world eats on http://world.time.com/2013/09/20/hungry-planet-what-the-world-eats/, by Peter Menzel and Faith D'Alusio). The photo of families around the world depicts everything that an average family consumes in an entire week and how much it costs.

Students worked on their own data regarding the estimate of their family expenditure on food in a week. Some students obtained the data from their parents. Furthermore, the teachers allowed their students to report their one week take home project in a creative way on paper. Below are examples of students' work on this project:

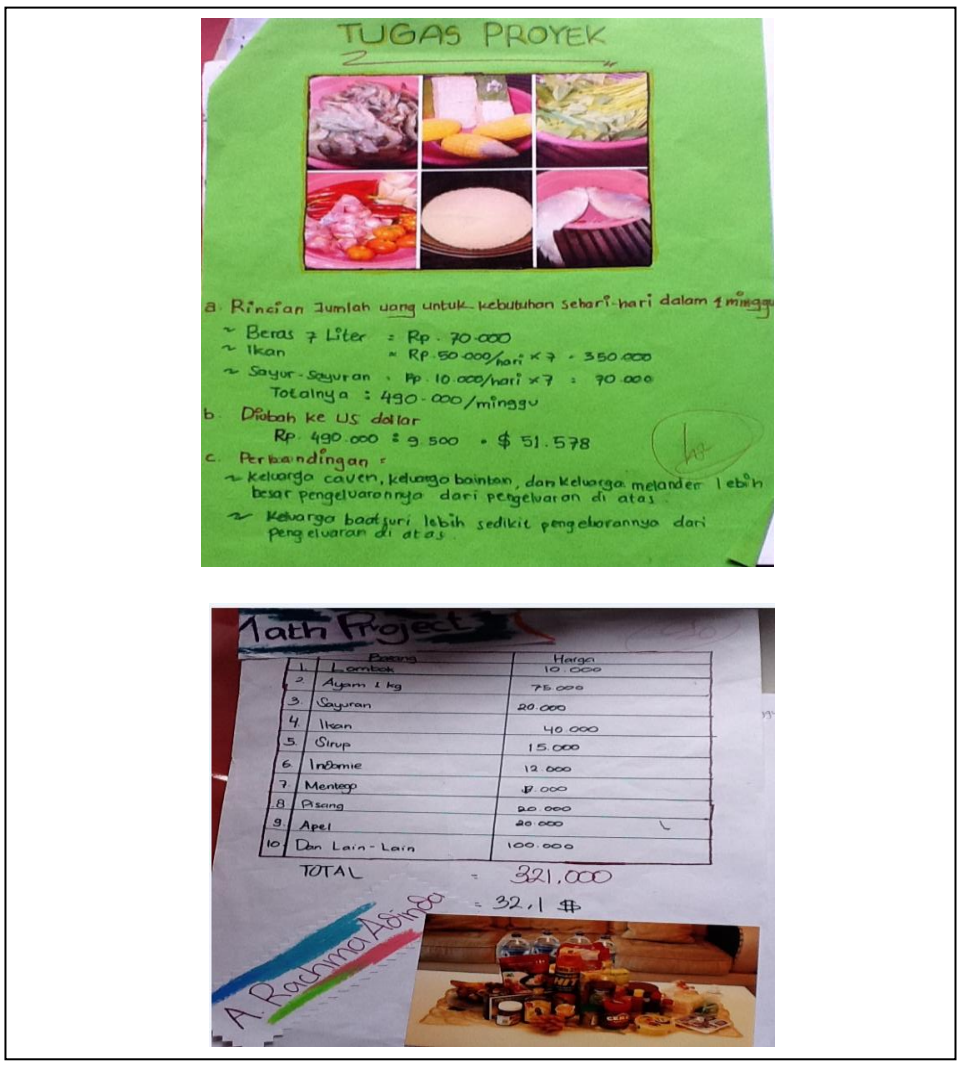


Figure 4.5: Examples of Students' Work on Weekly Expenditure Project

This project is directly linked to mathematics curriculum on integers: to perform the operations on integers (addition, subtraction, multiplication, division, powers and roots) and to apply the operations in problems solving. In addition, the social justice aims of

this task are to acknowledge and understand that the distribution of wealth in the world is not equal; some people are struggling to afford the basic necessities of life. The students' work on this project will be further discussed below in the engagement section of this chapter.

In week 5 of this study, Iriana presented a video of Cities in Indonesia on YouTube.

Figure 4.6: Picture when Iriana was Presented Video of The Cities in Indonesia on YouTube

In this video, the author presented some important cities in Indonesia by describing the population, religion, and the various ethnicities of each city in percentages. For example: Jakarta City's population is 8792000. The population by religion is divided into: Islam (83%), Protestant (6.2%), Catholic (5.7%), Buddhists (3.5%), Hindu (1.2%). According to ethnicity, the population consists of: Javanese (35%), Betawian (25%), Sundanese (15%), Chinese (6%), and Minangese (3%). Iriana asked her students "why does the author use the percentage to best give you that message?" Hadrian raised his hand and said "to enable us to make comparisons, Mam" Iriana said "that's good, Hadrian." This case is in line with the principle of social justice in mathematics as reading the world with mathematics. These data enabled students to learn about each city in Indonesia through a mathematical lens. Iriana emphasised to her students that an understanding of percentages is essential to know what happens in real life. However, it is worthwhile to mention that in this case there were not attempts by the teacher to raise any social issue regarding these figures.

From the examples above, the teachers sometimes provided opportunities to deal with teaching mathematics concepts and social justice issues at the same time. However, sometimes they could not realise the idea but focussed on either mathematics or social justice issues. For example, the video above had many potentialities in asking about

diversity within Indonesian society. However, the teacher missed the opportunity to talk about religious diversity within the country, although she tried to improve the students' understanding of percentages. As a follow up to this activity, Iriana encouraged her students, as a take home project, to find numbers everywhere including fractions, decimals and percentages as follows:

Fractions, Decimals & Percentages

Finding Numbers Everywhere

1. Find 5 examples of a fraction, decimal and percentage somewhere in your daily life. You may find a newspaper article, advertisement, television show, or anything else that includes a fraction, decimal and percentage.
2. If you are using something in print, cut it out and glue it in the paper. If not, copy down the exact words that you saw or heard.
3. What is the message that the author is trying to tell you? Why did she use a fraction, decimal or percentage to best give you that message?

Figure 4.7: Student Activity Sheet of Finding Numbers Everywhere

Moreover, there were attempts by the teachers to develop activities that achieved a balance between mathematics and the social justice issues. For example, in week 6 of this study on the percentage topic, Rahmah and Iriana provided their students with "Number of Pupils by Gender" project (see the following Table). Rahmah asked her students to discuss the project in the lesson, while Iriana gave her students the project to take home. The following data were derived by the teachers from workshop materials. The data enables comparison among the numbers of students by gender of education in Indonesia for the period 2006-2007. The students were directed to discuss some questions related to the data.

Table 4.1:

Number of Pupils by Gender Based on Education Level

No	Education level	Period	Number of Women		Number of Men		Total	
1.	Primary Education	2006/2007	12.673.327	…%	13.604.909	…%	26.278.236	…%
2.	Junior Secondary School	2006/2007	4.151.403	…%	4.288.359	…%	8.438.762	…%
3.	General Senior Secondary School	2006/2007	1.960.848	…%	1.798.045	…%	3.758.893	…%
4.	Higher Education University State and Private	2006/2007	139.305	…%	153.180	…%	292.485	…%
	Total		**18.924.883**		**19.844.493**		**38.768.376**	

Source: Data extracted from Pusat Statistik Pendidikan, Departemen Pendidikan Nasional dan Biro Pusat Statistik/ Center for Statistics of Education, Department of National Education and National Statistic Agency of Indonesia.

Discussion Questions:

1. Complete the missing columns in the table indicating the percentage of female and male students in each year at each level of education.
2. What did you learn from the data?
3. What inequalities do you notice about the data? How might they be explained?

Rahmah's students worked in small groups and made written comments based on the questions. They discussed the percentage of students of each gender at each education level. They also discussed a range of ideas about the inequalities that they noticed about the data. This activity went really well and the students were involved in sharing their understanding on how to get the percentage of each level by using a calculator. Also, the comments varied on the inequalities of gender in education. The responses of students in this project will be discussed below in the Reading the World with Mathematics section in this chapter.

4. 2. 4. The Growth of Teacher Mathematics Knowledge

According to Fennema and Franke (1992) knowledge of mathematics comprises the domain of mathematical knowledge that the teachers require student to know those topics and ideas are fundamental to the mathematical curriculum. Knowledge of the concepts underlying the procedures, the interrelatedness of these concepts, and how these concepts and procedures are used in various types of problem solving are essential components of the curriculum.

From the data collection, the teachers were at times not clear about aspects of the content that they were teaching. For example, in the week 4 of this study when exponents and radicals of integers topic was discussed, Melati prepared a lesson with some properties of integers exponents' properties as follow:

$$1.\ a^n a^m = a^{n+m}$$
$$2.\ (a^n)^m = a^{nm}$$
$$3.\ a^n b^n = (ab)^n$$
$$4.\ a^{\mathbf{0}} = \mathbf{1}$$
$$5.\ a^{-n} = \frac{\mathbf{1}}{a^n}$$

However, she was confused with the property 4. Melati asked me for an explanation why any number raised to the power of zero is equal to 1. I said suppose we have the

fraction $\frac{a^n}{a^n}$, a and n are arbitrary. We know that $\frac{a^n}{a^n} = 1$ .Thus, $\frac{a^n}{a^n} = a^n \; x \; a^{-n} = a^{n-n} = \; a^0 = 1$. Hence, any number to the zero power is 1. This explanation satisfied her.

Another example came from Rahmah in the lesson on fractions. While the students were doing the mathematical exercise, Rahmah came to me and asked: "Can I categorize decimals as a fraction." I said: "Yes, of course. From arithmetic, we know that we can write a decimal as a fraction. All the decimals are a fraction as they have a fraction equivalent. When two numbers represent the same quantity, the numbers are equivalent. Since we can express any fraction as a decimal, we can categorize decimal as the fraction." Then Rahmah told me: "I am going to teach about the forms and kinds of fractions. Now, I know that decimals are a kind of fraction and I will explain that to my students as well."

Often, instead of asking me questions about mathematics content, the teachers also looked at other sources for information on the content being taught. For example, in week 8 of the focus group discussion of this study Rahmah asked me a favour: "Can you please accompany me to search for a good mathematics book in the bookstore?" Rahmah bought three algebra books on the basic mathematical concepts and including related exercises to the topic being taught. This incident shows that their involvement in this study encouraged teachers to seek knowledge that they did not have before through referring to other references, watching videos, and searching for information on the internet. Also, this incident demonstrates that the teacher participants were building a relationship of trust with me and were not hesitant to address their lack of mathematical knowledge.

Another case came from the students of SMP Al-Khawarizmi. Sometimes the students were presented with a challenge on mathematics history itself, but this also presented a need for the teacher to continually develop her knowledge about mathematics to be able to answer questions from her students. For example, Taufiqurrahman, one high achieving student, after completing the task earlier than other students in week 7 of this study, suddenly asked me whether it is possible that the Pythagorean relationship between the sides of a right angle triangle is always true. I answered the students' question by asserting that a mathematical theorem is a statement that has been proven on the basis of previously establish statements, such as others theorems, and previously

accepted axioms. There is no example of a right angle triangle that does not demonstrate the Pythagorean relationship between its sides. Thus, it is always true for any right angle triangle. Spontaneously, I reflected on the natural beauty of mathematics: what a beautiful theorem! Furthermore, Gilang asked her teacher, "Where does the Pythagorean Theorem come from? Is it from Arabic or from Greek, Mam?" At the moment, the teacher smiled to me and wanted me to answer the question. Regarding the question about where the theorem comes from, I said the theorem is named for the Greek philosopher and mathematician Pythagoras.

4. 2. 5. The Growth in Teaching Methods

There was an acknowledgement by the teachers that their teaching methods had changed over time within this study. In particular, in the last focus group meeting in week 10 of this study, Melati explained that she tended to engage students in presenting a different way of solving a problem than was her habit before participating in this research. She also indicated that she has developed more respect for the solutions that students offered. Similarly, Iriana said that previously she had engaged in direct instruction, with many students sitting in the back row of the class sometimes ignoring what was happening in the classroom. However, when she tried to engage students with realistic problems and group discussions during this study, most of the students were much more engaged in the mathematics lessons. Indeed, all the three teacher participants said that, previously, they had preferred relying heavily on mathematical questions from the textbook as the classroom practice and homework for the students. However, according to them, during this study, they have tried to create exercises and student activities in line with the RME model promoted by this study. In addition, often they have become more active in searching for other activities and resources to support their teaching. In summary, during this study, the teachers tended to engage students in presenting a various ways of solving problem and respected the variety of solutions that students offered, tried to engage students with realistic problems, provided the students with more group discussions, and tried to create exercises and student activities with a focus on real life contexts including social justice issues.

The Teachers Tended to Engage Students to Present Various Ways of Solving

During this study, Melati tried to vary her teaching methods. Sometimes she encouraged the students to present a variety of ways of finding solutions to a problem. In week 5 of this study, Melati created working groups by quickly arranging the students' positions.

Afterwards, Melati presented the students with the following verbal problem: “There is 120 square meter garden, 2/5 planted with oranges, 3/8 planted with mango, and the remaining portion planted with papaya. How much is the portion of papaya?” Then, she asked her students to discuss the problem by saying “Please discuss the solutions in the small groups so everyone should know the answer.” Melati asked her students “Is there any group that can help me to solve the problem?” One student, Ayu, representing her group, drew on the board a whole of the garden as follows:

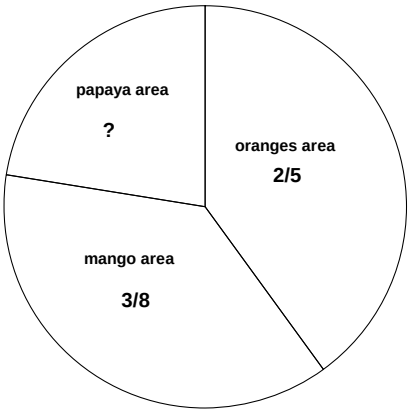


Figure 4.8: Example of Students Work on Papaya Portion task

She added, so (1 - ((2/5) + (3/8))) = 9/40 portion of the garden planted with papaya. Thus, the total area of the papaya = 9/40 x 120 = 27 square meter. Then, Melati asked the students in the class “Is there another way to solve the problem?”

A representative from another group raised his hand and said “from our group discussion, we multiplied first each known portion with the whole area which led us to get the papaya area [by subtraction]”.

He wrote on the board:

$$\textbf{oranges area} = \frac{2}{5} x 120 = 48\ m^2$$

$$\textbf{mango area} = \frac{3}{8} x 120 = 45\ m^2$$

$$\textbf{Thus, papaya area} = 120 - (48 + 45) = 120 - 93 = 27\ m^2$$

Melati said “You are right.”

In this activity, the students improved their mathematical skill and confidence through discussions in their small groups in line with the interactivity characteristics of RME. Also, the intertwining characteristic of RME appeared in which the teacher offered students an opportunity to implement a mathematical concept to solve the gardening

problem.

They Tried to Engage Students with Realistic Problems

During this study, the teachers tried to engage students with real life contexts and encouraged students to work together in their small group discussion. The following examples come from Rahmah. The first example she created herself while the second example, was taken from the textbook.

Example 1: In week 10 of this study, Rahmah provided her students with an explanation about the form of linear equation as follow: "Suppose that Andy's mother gives him 4 books and 4 pens for Rp50.000,-. The price of 2 pens is Rp 3000,-. But Andy did not know the price of the book and the pen. Now, the given information can be written in mathematical form. The books and pens respectively can be symbolized by using the alphabet from a to z. Now we symbolized book and pen with x and y. So it can be written as 4x + 4y = 50.000. And 2y = 3000. Well, such forms are examples of the linear equations." She goes further to say that the linear equation as a mathematical expression has an equal sign and linear expressions. In this case, rather than just give her students a common form of a linear equation; she connected the concept to a realistic context. In particular, in this example, she tried to introduce the concept by connecting the Linear Equations with One Variable (LEOV) to the realistic problem.

Example 2: The second example, taken from the textbook, was also connected to the application of LEOV. At this stage, the students moved from their own intuitive strategies to the formal mathematical procedures. Indeed, students' contribution could build their confidence to become active participants in the class discussion. The teacher gave the following problem:

> Ihsan saves some of his pocket money every day except Sunday. He saved Rp300 every day in the first week, Rp400, every day in the second week Rp600, every day in the third week and Rp700, every day in the fourth week. On a Sunday he took his savings from the third and fourth weeks to buy books, Rp3.000, and Rp4.000, respectively.

a. How much money does Ihsan have now?
b. If on the following Sunday, Ihsan wants to buy a pencil box at Rp9.000, he needs more money since his savings will not be sufficient. How much more money does he need?

Figure 4.9: Classroom Atmosphere when Rahmah was Providing Scaffolding to The Students

In this class Rahmah provided her students with scaffolding and played a role as facilitator so enabling students to become independent in answering the question. For example: from data observation, Fahri was confused when facing the question. Thus, he paid attention to his classmates while they were discussing and answering the question. Because of this, Rahmah approached him and asked: "Do you understand what the question means, Fahri? Please try to write down whatever you know from this problem." Therefore, Fahri started to write the days from Monday to Saturday. He concluded that overall, Ihsan saved Rp400, until Saturday for the first day while he was writing the amount of money for every day on the table; for the second day, Ihsan saved Rp400,- every day likewise the third and fourth weeks, thus creating the following table:

Table 4.2:

Illustration of Fahri's Solution to a Problem

Day	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Amount
1	Rp300,-	Rp300,-	Rp300,-	Rp300,-	Rp300,-	Rp300,-	Rp 1800,-
2	Rp400,-	Rp400,-	Rp400,-	Rp400,-	Rp400,-	Rp400,-	Rp 2400,-
3	Rp600,-	Rp600,-	Rp600,-	Rp600,-	Rp600,-	Rp600,-	Rp 3600,-
4	Rp700,-	Rp700,-	Rp700,-	Rp700,-	Rp700,-	Rp700,-	Rp 4200,-

Rahmah then suggested that Fahri discuss his understanding of the problem with other members of his group in order to find the answer to the question. Hence, the teacher noted that some students showed that they need such scaffolding to commence working on the task. Also, this incident shows that the teacher ensured that all students were actively involved in the process working at their groups.

At the end of students' discussion, Rahmah encouraged her students to present the result of the discussion at the front of the class while she was providing feedback on the students' work. Also, respect for the students' answers was demonstrated in the following picture where the teacher and the students were clapping when Calista gave her correct answer.

Figure 4.10: Group Discussion Presentation Result in Front of the Class

They Provided the Students with more Group Discussion

During this study, the lesson more provided with problems to be discussed in groups and then to be presented the results of the discussion in the front of the class. For example, in The Number of Different Segments of Population in Indonesia, The Number of Pupil by Gender Project and The Global Warming task discussed above, the students worked cooperatively in answering the questions. These tasks will be discussed further in How to Integrate Social Justice section of this chapter.

Another teaching method that Melati often used was providing her students with a group competition in order to motivate the students. Indeed, she said "Although the time to answer the question on the mathematics group competition was short, the students enjoyed the lesson." She challenged the groups of students with mathematical questions given verbally. Afterwards, the answers of the students were assessed and marked to determine which group of students attained the highest scores. It seems that there was a change of effective pedagogy through the competitions in which the teacher encouraged the students to practice their knowledge of mathematics, to answer the question rapidly and correctly, to show confidence in presenting their view, and to work together in their group to solve the problem.

In this case, interactivity as the characteristic of RME appeared from competition and

discussion in which the students communicated with each other. In this group competition, Melati marked the point at which each group first raised their hand and had the right solution. Through this activity, the skill and confidence of the students improved.

They Tried to Create Exercises and Student Activities with a Focus on Real Context Including Social Justice Issues

The following examples demonstrate several efforts of the teachers in designing mathematics tasks or student activities with a focus on real context. Furthermore, examples of student activities or tasks that integrated social justice issues in mathematics lessons will be discussed further in the next section of social justice issues of this chapter.

In week 3 of this study, Iriana raised the question to her students about the definition of justice. Also, in week 5 on the fraction topic, Rahmah raised the Finding Numbers Everywhere project as one for her students to complete in the percentage topic. The samples of student work on this project will be presented in the learning mathematics section of this thesis.

In the middle of this study, Iriana reflected that she was used to teaching without much preparation. She just considered the mathematics topic for each lesson according to the syllabus then took some exercises from the mathematics book as practice for her students after she had explained the topic. However, since this study was in progress she has changed her habits. She was doing her best to prepare lessons and to vary her teaching, including looking for references, searching for videos, making up student activities, engaging students in group discussions, and connecting her lessons to real context of mathematics including social justice issues. Indeed, she told me: "Rather than just use my previous student activity sheets which consist of more abstract concepts using a series of arbitrary rules, arithmetic computations, and mathematics drill exercises, now I would prefer to prepare all the lesson material beforehand including a lesson plan which is connected to real life problems, and student activity sheets which related to social justice issues." An example of this assertion is seen in Iriana's lesson with the students' activity sheet of global warming using the topic of integers as a focus (as mentioned above).

Figure 4.11: Classroom Atmosphere in Discussion of Global Warming Activity Sheet

Iriana claimed that she made up the activity sheet by searching on the internet for global warming issue which included numbers (integers). This action indicates that Iriana tried to connect mathematics with real world facts by considering other sources of information to supplement to her mathematics lesson and that she actively involved her students in cooperative learning in her lessons.

In the above examples, the teacher tried to connect mathematics to the real world by using contexts that she thought students that would be familiar with, and she frequently used cooperative learning strategies. Also, the phenomenological exploration as the characteristic of RME appeared in these examples in which the teachers encouraged students to engage in issues connected to their daily life that make sense to them particular in learning mathematical concepts.

4. 3 Effect of the RME Approach with a Focus on Social Justice on Students

The research aim discussed in this section is to investigate the effects on students of the implementation of RME with a focus on social justice. In particular, the study investigated effects on: students' learning in mathematics; students' engagement; students' agency; and students' knowledge about social justice issues.

4. 3. 1. Learning Mathematics

This study has observed that students demonstrate their learning of mathematics topics specified in the official curriculum for that level; in particular: (a) the operation on integers (addition, subtraction, multiplication, division, powers, and roots), (b) different representations of fractions (proper, improper, mixed fraction, decimal, percentage and per thousand), and (c) The Greatest Common Factor (GCF) and Least Common Multiple (LCM). These will be illustrated in the different examples given below.

In particular, this section indicated that the effects of the implementation of the RME approach on students' learning mathematics included: helping students to enhance their learning experience of mathematics through real life application; encouraging students to explore and verbalize their mathematical ideas; and encouraging students to work cooperatively to gain confidence in their study of mathematics.

Enhancing the Students' Learning Experience through Real Life Contexts

During the study, the students were provided with opportunities to develop formal mathematical knowledge meaningfully by connecting various mathematics concepts and procedures with real life contexts.

Example 1: In week 3 of this study, Melati provided her students with the following activity sheet which focused upon health and nutrition in which they applied the concept of positive and negative numbers.

The information given in the activity contains artificial numbers. This is a common practice with many teachers making up realistic but not real data to illustrate mathematics. Furthermore, this example illustrates a limitation in the use of mathematics to model real world contexts. In mathematics, the number zero is often considered as a balance point between negative and positive numbers. At times it may be a desired state of mathematical manipulations. This may not be the same in real life. The teacher in this example, arguably, has chosen the specific values of negative and positive calories to add up to zero. In real life, however, a zero calorie intake is not meaningful nor desirable.

Health and nutrition

Calories or food energy can be used by your body or turned into fat. Consider 0 to be the ideal number of calories needed for you to function, including exercise. Consider any number to the right (positive) as extra calories, or stored as fat, and any number to the left as used up, or burned calories.

Burned Zero Stored

If you consume a piece of chocolate cake, to the tune of 350 calories, then do exercise for one hour, you burn up that 350 calories and are nicely back at 0 or no change.

Put ticks on the boxes of the following activities by completing the appropriate columns whether it is store or burn up calories.

Calorie consumption and burning	(+)	(-)
Eat rice, slice of toast with butter and jam, and glass of milk for breakfast		
Walk to school 15 minutes		
Eat fried rice and sausage for lunch		
Go to a class for 30 minutes		
Snack after school on a chocolate bar		

Figure 4.12: Health and Nutrition Project

After finishing the above task, the following conversation between the teacher and the students occurred:

Feby: If I am thinking or studying, do I store or burn more calories, Mam?

Melati asked the class: What is your answer for Feby's question?

Students shout out, it is burn up calories, Mam.

Melati: Why is that so?

Jason: It is because our brain requires calories for thinking activities, Mam.

Melati: Regarding the table of your task, is it (+) or (-)?

Student yelled, Negative, Mam.

Melati: Are negative numbers helpful in thinking about these relationships?

Students: Of course, Mam

Melati: Are there any other helpful examples of the negative and positive numbers helpful in thinking about something in your daily life?

Israq: Mam, according to my religion, if we help someone in righteousness and piety means I will get reward from God (positive), but if I have sinned we will get punishment (negative).

Melati: Excellent

The example indicates that interaction occurred among students and teacher as the whole class participated in the lesson. Indeed, most of the students participated in the integers lesson because it was relevant to their daily lives. Furthermore, student made a

connection of negative concept to their daily activity.

Example 2: Another example comes from Melati. In week 5 of this section, she posed the question orally as follows: "In this classroom what is the percentage of male students?" Israq answered: "35%, Mam." Student: "how come, Israq?" Israq: "there are 14 male students and 26 female students. All together are 40, thus 14/40 x 100% = 35%." Melati appreciated Israq answer by said: "Excellent."

The guided reinvention and progressive mathematizing principle of RME appeared in this activity as the teacher raised a problem from the classroom context that led students to apply mathematical procedures to reinforce their understanding of the concept of percentages.

Example 3: In week 5 of this study, when the class was considering the different forms and types of fractions, after several mathematics lessons that provided students with real or realistic problems, finally Gilang asked his teacher to present examples of the use of per thousand concepts in daily life.

Gilang: Could you please give me an example the use of per thousand in daily life, Mam?

Rahmah: The salinity is amount of salt dissolved in water. It is usually measured in parts per thousand. For example, the average salinity of seawater is 33‰ (33 parts per thousand) = 33/1000 = 0.033 = 3.3%

Gilang: Oh, it is much easy for me to understand mathematics concept when it presents on story problem or when it is connected to reality, Mam.

From this case, students themselves liked to connect a mathematics concept to their daily life now because it made sense to them. Moreover, the connection to real life context enabled the student to understand the mathematics concept. Also, the usefulness of the context in mathematics potentially influences the motivation of the students to learn it. As Boaler (1993) states that it is hoped that students will perceive the links between problems encountered in school and the "real world" in different task contexts.

Encouraging the Students to Explore and Verbalize Their Mathematical Ideas

The results of this study reveal that the RME approach with a focus on social justice is effective in bringing about an enhancement in students' learning of mathematics by developing their understanding through verbalization. Through this approach, the students were able to construct valuable meanings about mathematics. The following examples illustrate instances to support this assertion.

Example 1: In the early stage of this study, the students' work showed that most of them did not perform well on the operations on integers. Many students seemed to only manipulate the numbers without understanding the meaning of the operations and their use in solving problems. However, it can be shown that the classrooms were now enabling students to learn mathematics in a way that encouraged them to explore and verbalize their mathematical ideas in answering word problems. This is in contrast to previous teaching style where, according to the teacher, the provision for the students to talk or discuss mathematical problem was limited. For example, Melati raised the question on the white board: "In the night time the temperature of the city of Liverpool is -6^0C. However, it rises to -1^0C in the morning. Calculate the change in temperature." In answering this question, some students didn't understand the procedure to get the solution. Only a few students found the right answer.

Thasa asked Melati: Should I add (-6) and (-1), Mam?
Haekal: I think we have to do subtraction between -6 and -1, the result is -5. Am I right?
Danatul: If I put the number on the number line, I can see that the change of the degree is 5.
Melati: How do you know it is 5 not -5, Danatul?
Danatul: Because the shift from -6 to -1 is a change to the right hand side of the number line which means positive change, Mam.
Sandy raised his hand and said: I agree with Danatul, Mam. (-1) – (-6) = 5.

In this way, the example includes explorative real life context that connected with integer topic to develop the students' mathematical concept meaningfully.

Example 2: Data analysis has also shown that this research has provided the participants with the opportunity to demonstrate their mathematical learning of fractions that is connected to their real life. In the "Finding Partial Numbers Everywhere" project, the students were requested to find an example of a fraction, decimal or percentage somewhere in their daily life. A student from SMPN 4 Makassar, Israq, raised the following recipe for balado kentang putih (a kind of Indonesian food). Melati asked him, "Why do you choose this as an example?" Israq said, "One of the ingredients is $1\frac{1}{4}$ teaspoons extract lime, which is a fraction, Mam." He commented that this recipe for 4 portions, then Melati asked, "How much of each ingredient is needed if I just want 2 portions?" Then he replied, "We just need a half size of every single ingredient and the seasoning, Mam".

Also, it is interesting to notice here that Melati provided the students with a question

which is a reflection of the didactical phenomenology principle of RME in which the meaningful context can be generalized and taken as a tool for the students to construct mathematical insight.

Example 3: In the project Weekly Expenditure in the integers topic, the students needed to calculate their family expenditure of food then compare these with different groups of people as mentioned above. In this project, question number 1 aimed to involve the students with the operations on integers. In this case, students calculated their family expenditure per day at home and then multiplied by 7 to get their weekly expenditure. Question number 2 was to encourage students to convert the total weekly expenditure of their family in rupiah into USA dollars by using division. Question number 3 required the students to compare their family's weekly spending on food with average expenditure five different countries around the world from the paper that the teacher gave them.

The following example is Khaerunnisa's work on the project. She listed and calculated her family food expenditure for a week as shown below:

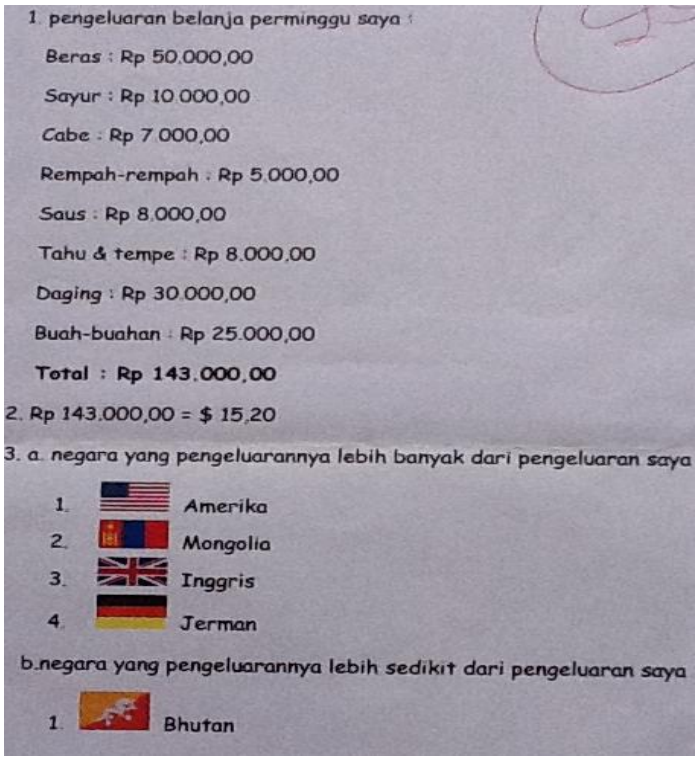


Figure 4.13: Khaerunnisa's Work on the Family Food Expenditure Project

According to Khaerunnisa's project no 1 and no 2, her family spent on food around Rp143.000,-/week which is around US$15.20. From this task, the students applied mathematical work to find the answers. For example, they applied the operations of the

integers. Furthermore, task no 3 illustrates that from this projects the students also learnt about the world by comparing their expenditure to that of other families around the world. The way the teacher created the project corresponds with the phenomenological exploration characteristic of RME in which the teacher should encourage student to engage with a real world context that make sense to them in learning mathematics.

In particular, in answering question number 2, some students asked the teacher how many Indonesian rupiah are there to one United States dollar. The teachers said around Rp10.000,-. However, when I and the teachers checked the students' projects some of them had a different exchange rate. For example, Feby wrote 1 USD = Rp9600,-. After the class finished, I asked her how she got the rate of Rp9600 per dollar. She explained that she had watched the rate on the television program on the news that morning. Other students found the exchange rate from the newspaper. This indicated that some students were involved deeply in searching for the rate, while others just followed their teachers' estimation of the rate. Undoubtedly, the real world context of the problem encouraged students to do some research about the exchange rate.

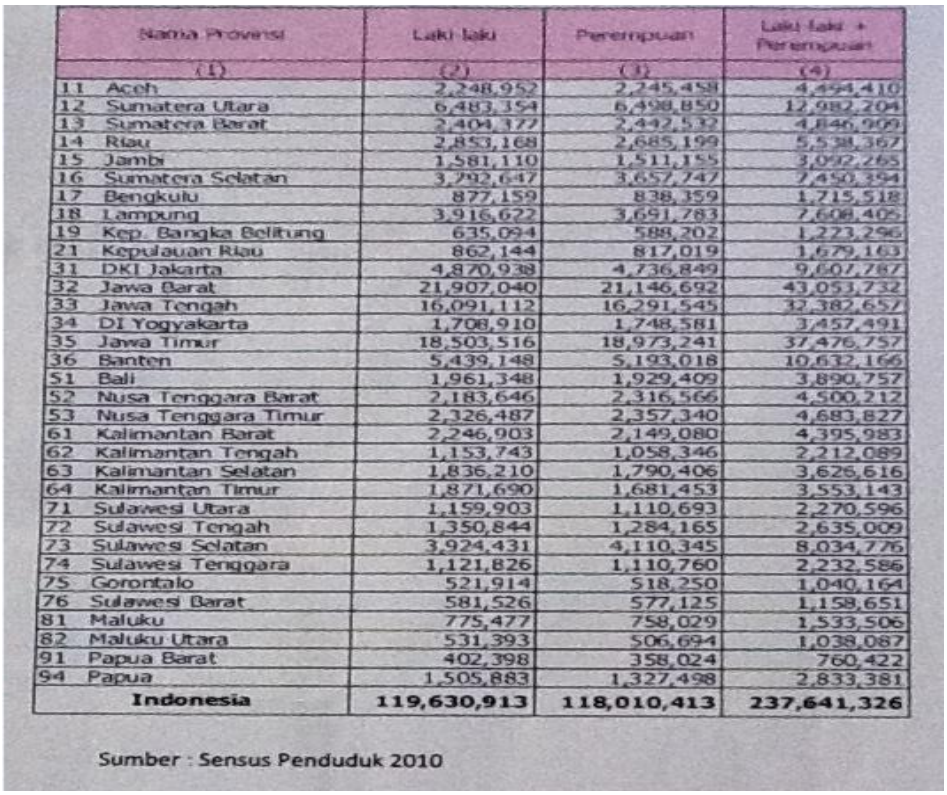
Helping Students Gain Confidence in Their Study of Mathematics

From the classroom observations and the discussions in the focus groups, by connecting mathematics with a realistic context and conducting students' work cooperatively, the students' confidence in their mathematical learning increased. In particular, throughout this study, the teachers provided the students with cooperative learning experiences. This process promoted students' confidence in the development of their mathematical knowledge. As Davidson (1990) states, cooperative learning must be employed in mathematics classes because mathematical concepts and skills are best learned as part of a dynamic process with active engagement on the part of the students, and this helps student gain confidence in their individual mathematical abilities.

Example 1: In week 3 of this study, Iriana raised an issue related to The Number of Different Segments of the Population in Indonesia. The students worked cooperatively to answer the questions. She adopted the data "Jumlah Penduduk Indonesia Hasil Sensus Tahun 2010" (2010 Indonesian Population Census). Retrieved July 3, 2012, from http://indonesiadata.co.id/main/index.php/jumlah-penduduk as illustrated in the Figure 4.15.

As data showed several provinces' population according to the census in 2010, the pupils were able to investigate the total population of each province by gender.

Furthermore, the pupils could identify which provinces had the largest and the smallest populations. Meanwhile, by determining populations of males and females, they practiced subtraction. Further, they were encouraged to reflect on the real world by being asked to give their opinion as to why each province had different population sizes.



Nama Provinsi	Laki-laki	Perempuan	Laki-laki + Perempuan
(1)	(2)	(3)	(4)
11 Aceh	2,248,952	2,245,458	4,494,410
12 Sumatera Utara	6,483,354	6,498,850	12,982,204
13 Sumatera Barat	2,404,377	2,442,532	4,846,909
14 Riau	2,853,168	2,685,199	5,538,367
15 Jambi	1,581,110	1,511,155	3,092,265
16 Sumatera Selatan	3,792,647	3,657,747	7,450,394
17 Bengkulu	877,159	838,359	1,715,518
18 Lampung	3,916,622	3,691,783	7,608,405
19 Kep. Bangka Belitung	635,094	588,202	1,223,296
21 Kepulauan Riau	862,144	817,019	1,679,163
31 DKI Jakarta	4,870,938	4,736,849	9,607,787
32 Jawa Barat	21,907,040	21,146,692	43,053,732
33 Jawa Tengah	16,091,112	16,291,545	32,382,657
34 DI Yogyakarta	1,708,910	1,748,581	3,457,491
35 Jawa Timur	18,503,516	18,973,241	37,476,757
36 Banten	5,439,148	5,193,018	10,632,166
51 Bali	1,961,348	1,929,409	3,890,757
52 Nusa Tenggara Barat	2,183,646	2,316,566	4,500,212
53 Nusa Tenggara Timur	2,326,487	2,357,340	4,683,827
61 Kalimantan Barat	2,246,903	2,149,080	4,395,983
62 Kalimantan Tengah	1,153,743	1,058,346	2,212,089
63 Kalimantan Selatan	1,836,210	1,790,406	3,626,616
64 Kalimantan Timur	1,871,690	1,681,453	3,553,143
71 Sulawesi Utara	1,159,903	1,110,693	2,270,596
72 Sulawesi Tengah	1,350,844	1,284,165	2,635,009
73 Sulawesi Selatan	3,924,431	4,110,345	8,034,776
74 Sulawesi Tenggara	1,121,826	1,110,760	2,232,586
75 Gorontalo	521,914	518,250	1,040,164
76 Sulawesi Barat	581,526	577,125	1,158,651
81 Maluku	775,477	758,029	1,533,506
82 Maluku Utara	531,393	506,694	1,038,087
91 Papua Barat	402,398	358,024	760,422
94 Papua	1,505,883	1,327,498	2,833,381
Indonesia	**119,630,913**	**118,010,413**	**237,641,326**

Sumber : Sensus Penduduk 2010

1) Which province has the largest population of males and females?
2) Which province has the lowest population of males and females?
3) What is the difference between the male and female populations in the whole of Indonesia?
4) Explain why there is a difference among the provinces regarding the number of male and female populations.

Figure 4.14: The Number of Different Segments of the Population in Indonesia Project

In particular, the group consisting of Musdalifa, Herawati, Nurhaedah, and Miftahul Janna presented their group discussion of each of the above questions with excitement and confidence.

Figure 4.15: Classroom Atmosphere when Musdalifa's Group Presented Their Discussion

After the group discussion, the teacher asked for a representative of each group to share the results of their discussion in front of the class. When the teacher evaluated the students' group answer, the member of group that had the right answer said, "yes" while they were raising his/her hands as an expression of pride. Whereas, according to the teacher, prior to this study the student in the class were very passive learners.

Indeed, from this activity, the interactivity as a characteristic of the RME was demonstrated in which the mathematical discussion made the whole class a united community of learning. Furthermore, didactical phenomenology and the intertwinement of the RME was implemented in this context, as the mathematical task related to the social contextual problem provided an opportunity for the students to examine the context by applying mathematical concepts.

Example 2: In week 6 of this study, Melati wrote question on the board: "A chicken farmer intends to give his chickens to his three children. He has 99 chickens. If the first child gets 1/5 part, the second child has ¾ parts, and the third son gets 1/25 part, how many chickens will be given to each child?" From this question, the phenomenological exploration emerged as the students were confronted with a problem situation in which they applied fractions and gradually developed an algorithmic way of multiplication, based on an informal way of working in solving the puzzle. The following is the conversation among students and teacher in solving the problem:

Ayu: Can he cut the chicken then distribute it to the children, Mam?

Melati: No, Ayu. They want to follow their father as a chicken farmer as well.

Israq: I think we need to make it 100 chicken first, Mam.We could not round the following multiplication of 1/5 x 99, ¾ x 99, and 1/25 x 99. It means that farmer needs to borrow 1 chicken from someone else but after the division is finished the chicken should be returned again, Mam.

Israq, stood up and said: May I explain my answer on the board, Mam?

Teacher: Yes, go ahead, Israq

Israq: Child 1: 1/5 x 100 = 20
Child 2: 3/4 x 100 = 75
Child 1: 1/25 x 100 = 4
Thus, child 1, child 2, and child 3 will get the number of chickens: 20, 75, and 4.

From the above conversation, Israq demonstrated a creative way to solve the non-routine mathematics problem and confidently verbalize his idea to round the amount of the chickens into 100, thus demonstrating creativity and thinking outside the box for the mathematical puzzle. However, the teacher didn't find ways to intertwine social justice ideas especially for real context into their teaching of such topic..

Example 3: In week 9 of this study, Melati provided her students with the following tasks that required the students to think the right method to be chosen greatest common factor (GCF) or Least Common Multiple (LCM):

There are 175 bags of sugar and 105 bottles of frying oil. How many people can share these so that different people get equal amounts of each?

The following is Fatur's work on the question

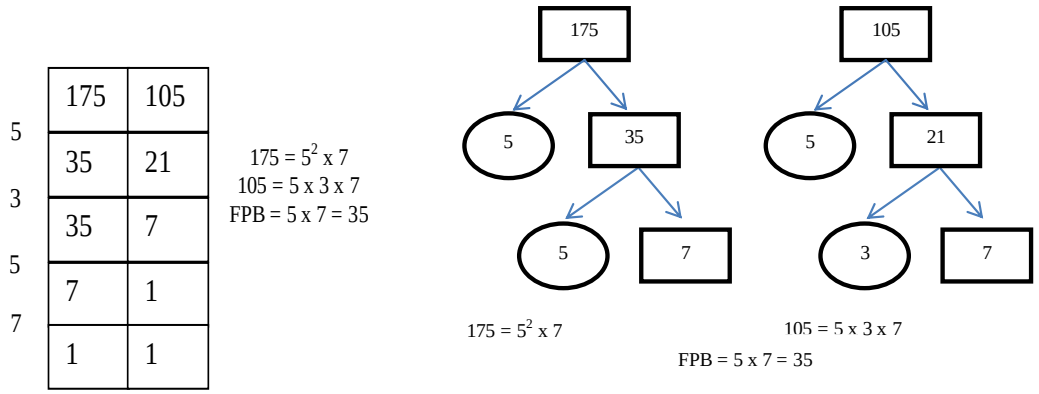


Figure 4.16: Fatur's Work on the GCF and LCM Question

Fatur presented his answer on the whiteboard by using the two solution strategies of prime factorization (by listing the prime factors of each number using prime factor trees and listing the prime factors of both numbers on the table) to obtain the same greatest

common factor (GCF). After he found the GCF using table prime factorization of both numbers, he clarified the prime factor by using a factor tree. He did this both ways to ensure that his answer was right. It made him confident about the answer of 35 people who would have the same portion of the sugar and the oil.

4. 3. 2. Engagement

This section presents the effects of the implementation of the RME approach on students' engagement. In this study student engagement levels will be analysed as cognitive engagement, behaviour engagement, and affective engagement (Chapman, 2003).

4. 3. 2. 1 Students' Cognitive Engagement

Cognitive engagement indicates the extent to which students are attending to and expending mental effort in the learning tasks encountered and as efforts to monitor and guide task comprehension through the use of cognitive strategies and to integrate new material with previous knowledge (Chapman, 2003).

In some lessons, many students enjoyed the way their mathematics lessons were facilitated. They gave full effort to solve the mathematical tasks because they saw connections to their own world. For example, in the project Weekly Expenditure of the integers topic, for example, the students demonstrated their engagement in terms of the punctuality of the submission of their project; all the students from the three schools did their project and submitted it on time. By doing this project, there were no two students who had the same answer because they worked on their own data. Iriana told me that, prior to this project; it was not uncommon for some students to copy the answers to homework question from the more able students in the class. However, according to Iriana, no student did the same thing in this project because the data were about them so that they engaged with the project individually.

During the classroom observations, some students also showed that they attempted to integrate new mathematical material in mathematics with their previous knowledge. In particular, I found students using previously learnt procedures to solve tasks at hand. For example, in week 3 of this research in the topic of integers, when Melati wrote the following question in the white board: "Ryan picked 12 apples. He picked 2 times as many apples as Safdar. How many apples did Safdar pick?" I saw Andi drawning a picture on his book, and then I asked him about his work, he said 12 divided by 2 is 6.

He illustrated his understanding as shown in diagram below:

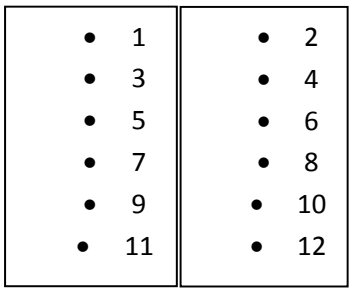


Figure 4.17: Illustration of Andi's Understanding on 12 Divided by 2

He explained his work as follows:

Andi:	If I have 12 then I should divide it into 2 from the picture, I can conclude that the result is 6 because everyone gets 6 equally now.
I:	who did teach you that way?
Andi:	My primary school teacher, Mam.

Andi was reflecting back to his knowledge gained from primary school. In this case, the way Andi found the solution is known as a partitative division problem or equal group distribution. Furthermore, Melati told me that Andi is a low achieving student. However, during this study he preferred using his mathematics knowledge to solve the problem rather than wait for his friends or the teacher's answer, which is what he usually did in the past. Therefore, in his own way he was engaged in different ways from his friends in the class who had developed more efficient ways to solve the problem. The particular mathematical model used in his solution was chosen by him in bridging the gap between informal knowledge and formal mathematics as one of the key principles self-developed models of RME (Gravemeijer, 1994).

In week 4 of this study, Rahmah, a teacher of SMP Al-Khawarizmi, tried to grab the interest of the students by folding paper to demonstrate the operation of integers (powers and roots). Below are activities that Rahmah conducted in mathematics lessons that obviously motivated her students:

Rahmah asked her students "how much is 2^6?" At that moment some students looked confused, while some of high achieving students directly answered $2^2 \times 2^2 \times 2^2 = 64$. However, when Rahmah was folding the paper 6 times, other students were asked to count how many times it was folded, the students enjoyed it more. Melati said: "The model requires you to fold up a strip of paper (any size piece of paper is suitable for folding, but at least two of its edges must be straight). If you fold the piece of paper in

half, it will now be twice as thick as it is before. Note: zero folding is one page thick. When I fold a page once, it will be 2 pages thick. When I fold it twice on itself, it is 4 pages thick. If I fold it a third time, you will see that it is 8 pages thick. Can you see a pattern here?" most of the students, yelled "it represents 2^1 =2, 2^2 = 4, 2^3 = 8." Rahmah: "Right! Paper folding is exponential, so that if I fold it a fourth time, it will be 16 pages thick and if I fold it a sixth time, it will be 64 pages."

By watching the physical representation of folding the paper, the students engaged in the activity which could help them to develop a more conceptual understanding of mathematics. It was followed by engaging students in mathematical thinking.

4. 3. 2. 2 Students' Behaviour Engagement

Chapman (2003) states that behavioural engagement is a measure of the extent to which students are making active responses to the learning tasks presented (e.g., a student responding to an instructional antecedent, such as asking relevant questions, solving task-related problems, and participating in relevant discussions with teachers/peers).

The data collection from the focus group, classroom observations, and interviews suggests that during this study the students became more active participants in the mathematics lessons. For example, Padilla, a student from SMPN Mutiara who is usually a rather quiet student was not a frequent participant in problem solving discussions, according to Melati. However, during this study, there was a noticeable change in Padilla's level of engagement. Melati told me that she was pleasantly surprised at the speed at which Padilla engaged in learning mathematics where she often tried to solve the problems given in class all by herself.

Indeed, Padilla seemed to be behaviourally engaged during the observation. The first time I saw her, she didn't have the courage to solve a problem on her own; she was accustomed to waiting for her friends' answer. However, after several lessons she had shown a noticeable improvement in her confidence to come up with her own solutions and had developed the confidence to ask for clarification from the teacher when she needed it. This change in Padilla's working illustrates the advantage of students sharing and discussing their strategies with each other according to the interactivity characteristic of the RME.

Similarly, Iriana claimed that most of her students demonstrated an improvement in their behaviour in the classroom. They became more active and more likely to take risks. Also according to Iriana, the students enjoyed the activities they were involved in

and they were happy to work collaboratively. In week 5 of this study, Mirna and her group came to me, a total stranger in the class, and asked if their answer was right. According to Iriana, before this study, Mirna and her friends were truly shy.

Taking another case which came from Melati's class in the week 5 of this study on the topic of fractions, she asked the students to mention the examples fractions that they were familiar with in their daily life. Most of the students raised their hand, an indication that most of the students were engaged in the task. For instance, Israq responded the question by raising the portion ingredients of the pie recipe: "half a spoon of sugar; quarter cup of water."

In particular, most students took an active part in discussions in the mathematics lessons. For example, in week 5 of this study at SMP Al-Khawarizmi, even though the teacher did not tell them to work cooperatively, some students preferred cooperating with other students in working on their task as shown in the following picture.

Figure 4.18: SMP Al-Khawarizmi's Students Cooperating with Each Others

Data analysis also shows instances during which participants have directly, or indirectly, expressed their sense of enjoyment at the tasks in which they were engaged. For example, in week 7 of this study, when the students at SMPN Mutiara worked on the mathematical competition, I could see the enthusiasm and positive expressions on their faces. They were clearly having fun as shown from Feby and other students' response when the bell rang for a break; they said to the teacher "Keep going, Mam. We can take a rest later."

4. 3. 2. 3 Students' Affective Engagement

Affective engagement can be measured through opinions related to how useful students think the content they are learning would be in bringing benefits to them in school, student-teacher relationship and life (Stipek, 2002). In addition, students demonstrate

their engagement through four aspects namely, students' interest and achievement orientation, and lower anxiety and frustration (Kong, et al. 2003).

After attending the focus group in week 8 of this study, all teacher participants developed tasks for their students illustrating the use of mathematics, such as integers and fractions, in their everyday life. In the last meeting of this study, the students were asked to write down the usefulness of the mathematics topics they had learnt. Below are some students' comments from the three schools demonstrating their interest in learning mathematics topics during this research.

Mathematics is Important when Shopping for Everyday Items:

Aldy (SMP Al-Khawarizmi's student) stressed that: "By learning mathematics I know the price of a discounted item, and also I know how much in rupiah if I buy some overseas product". In similar fashion, Ashilah Chalista (SMP Al-Khawarizmi's student) commented: "There are many benefits of it. Suppose that when we go shopping and get the discount, then we can determine the amount to be paid." Sandy (SMPN Mutiara's student) acknowledged: "In my opinion, mathematics is the centre of all learning. For instance, without mathematics we cannot count anything. Suppose we buy an item and the change was less but we do not know about it. Mathematics is very useful for me." Dea Oktora (SMP Pelita's student) commented that: "By learning mathematics, I can arrange my daily activities such as obtaining finances, measurement and many more."

Mathematics helps us to think and make us smart:

Marselina (SMP Pelita's student) said: "The benefit of mathematics is that I will be clever." Nurhaedah asserted: "If we do not know mathematics, it is easily to be fooled by others." Fitriani (SMPN Mutiara's student) said: "Mathematics enables me to learn anything. Frankly, I call mathematics as the science of all sorts of subjects." Meanwhile, Fiqry (SMPN 4 Mutiara's student) commented: "mathematics makes me always smart."

Mathematics Improves Calculation Skills:

Israq (SMPN Mutiara's student) responded to the question: "By learning mathematics I can calculate very well, and I am very pleased with the mathematics." Ashilah Chalista commented "we can determine the distance, speed and time when doing long trips, and much more, Mam."

The students' comments indicate that they value knowing mathematics in their lives in terms of counting, calculating discounted items, and making them clever which can lead them to potentially invest for their future.

In particular, in the last meeting of this study in SMPN Mutiara, the classroom came alive, the students were singing a song as appreciation for the teachers and I, when Melati told them that today was the last day I was in their classroom. However, Melati explained to her students that the approach will be continued. The following is the hymn:

Lagu wajib nasional "Hymne Guru" Ciptaan: Sartono
Terpujilah wahai engkau ibu bapak guru
Namamu akan selalu hidup dalam sanubariku
Semua baktimu akan kuukir di dalam hatiku
Sebagai prasasti terimakasihku
Tuk pengabdianmu
Engkau sebagai Pelita dalam kegelapan
Engkau laksana embun penyejuk dalam kehausan
Engkau patriot pahlawan bangsa
Tanpa tanda jasa

National education song "Teacher Hymn" Author: Sartono (English version)
Being blessed you, our teachers
Your name will always live in our soul
All your devotion will be carved and embedded in our heart
As the inscription of our thankfulness
For your total devotion
You are such as a candle in the darkness
You are like fresh moisture to our thirst
And you are a great patriotic hero for the nation
Without reward.

Interestingly, from the above examples the teaching process lead to student centred learning in which the mathematics lessons provided real life contexts with students valuing the learning of mathematics. Moreover, teachers facilitated student interest, confidence and performance in the mathematics lessons. This situation facilitated learning and student agency.

4. 3. 3. Agency

Data analysed from the focus group, interviews, and classroom observations suggest that this research has provided the participants with the opportunity for the development of their agency. As Empson (2002) points out, mathematical agency consists of the power to use mathematics to affect personal and social transformation, identification of oneself as a mathematical thinker, and capacity to use and to critique the uses of mathematics in the context that matter to oneself and one's communities.

Similarly, as Tate (1995) states, students' capacity to use mathematics in personally

and socially transformative ways is the mathematical component of critical mathematics agency. The following examples demonstrated how the RME approach with a focus on social justice affected the personal and social transformation of the students and the identification of students as problem solvers.

Example 1: During this study, according to Melati, most of her students took responsibility to answer the tasks by themselves or in groups without seeking assistance from the teacher or waiting for answers from higher achieving students. Before this approach was implemented, usually her students would ask her what to do when they encountered difficulties in solving problems. However, during this study, she noted that her students tried to solve the problem by themselves first, and then collaborated with their friends if they so needed.

Example 2: The following example shows how students in this research demonstrated their confidence and transformation from shy students to individual who are no longer afraid to voice an opinion.

In the middle weeks of this study, Iriana asked the students what is the decimal fraction of 23 divided by 9? Musdalifah raised her hand and answered: "2.5" (in a hesitant shy voice); Iriana: "yes 2.5." At that moment Musdalifah, Murni, Mirna smiled as a sign of pride after hearing Iriana agreed with their answer. Furthermore, after Iriana finished explaining the percentage topic, she asked her students to explain their understanding of the concept in their own words. Spontaneously, Dea and Linda raised their hand and said: "May I explain in the front, Mam?" Iriana said, "Yes, please." As shown in the following picture:

Figure 4.19: Two Shy Students Explained their Understanding of Percentage in Their Own Words

After the lesson, I met Iriana in her office to ask her about her reflections on the lesson and she said: “Before this study, usually only a few students responded when I asked them a question. However, today Musdalifah, Linda, and Dea, as I know they are shy students, answered my question so promptly and correctly.”

Additionally, on the same day, Murni saw Iriana and I in the office and she immediately came over with excitement and said to me “Is that right, Mam?” while she pointed her mathematics homework. She needed Iriana and I to check her work to make sure she was on the right track before the submission of the homework for the next mathematics lesson.

Instead of using mathematics for transformative ways, as illustrated in above examples, during the period of the research many students demonstrated mathematical thinking, one theme of mathematical agency according to Empson (2002). It can be shown that the vast majority of students were involved in the mathematics discussions. The following examples demonstrate students thinking deeply in solving mathematical problem and verbalising their opinions confidently.

Example 1: In week 7 of this study while students were undertaking a quiz on previous material, Melati asked a question of her students: “What is the result of 0.45/0.125.” All the students tried to answer her question.

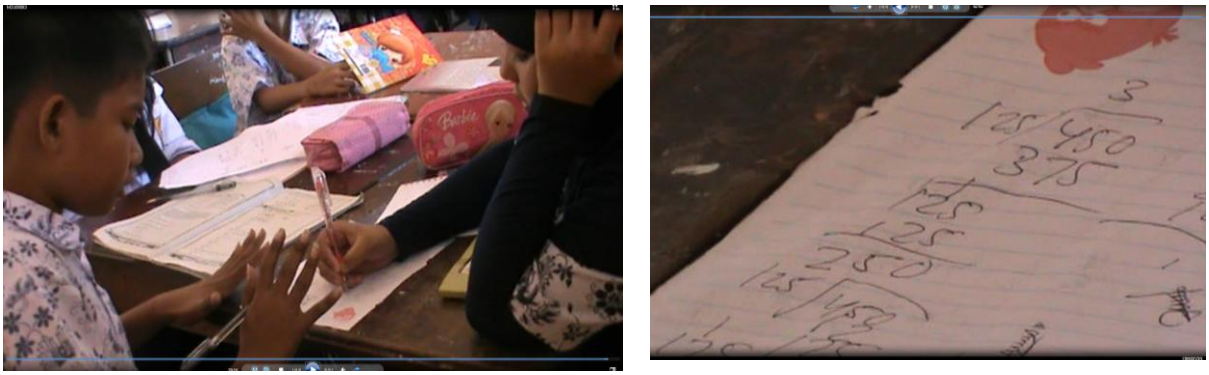


Figure 4.20: Israq and Dana Working Together in Solving the Problem

In order to find the answer, Dana completed the calculation of Israq on the same paper. From the observation, they struggled with the solution even though they did the right thing in the first step: 0.45 divided by 0.125 is equivalent to 450 divided by 125. However they did not continue their work to the end because her teacher just gave the students 5 minutes to solve the problem. They were involved in serious thinking to solve the problem together while the other students work individually.

Example 2: In the lesson on the Greatest Common Factor (GCF) and Least Common Multiple (LCM), Melati asked question of the class: "There are 3 buses with different routes. They depart together from the central station at 06.00 am. Bus A will leave from the station every 45 minutes from 06.00am, while the bus B leaves every 60 minutes, and bus C leaves every 75 minutes. When will all the buses start together again from the station?"

Dhifa's work:

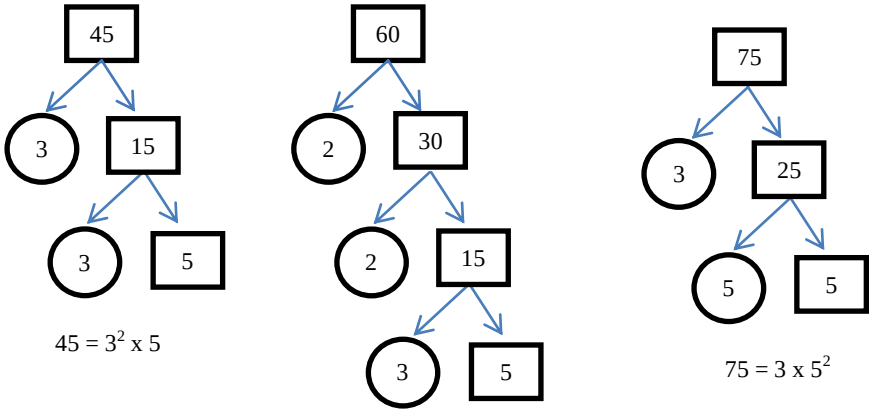
Bus Schedule

Bus A	Bus B	Bus C
06.00 + 45 minutes= 06.45	06.00 + 60 minutes= 07.00	06.00 + 75 minutes= 07.15
06.45 + 45 minutes= 07.30	07.00 + 60 minutes= 08.00	07.15 + 75 minutes= 08.00
07.30 + 45 minutes= 08.15	08.00 + 60 minutes= 09.00	08.00 + 75 minutes= 09.45
08.15 + 45 minutes= 09.00	09.00 + 60 minutes= 10.00	09.00 + 75 minutes= 11.00
09.00 + 45 minutes= 09.45	10.00 + 60 minutes= 11.00	11.00 + 75 minutes= 12.15
09.45 + 45 minutes= 10.30	11.00 + 60 minutes= 12.00	12.15 + 75 minutes= 13.30
10.30 + 45 minutes= 11.15	12.00 + 60 minutes= 13.00	13.30 + 75 minutes= 14.45
11.15 + 45 minutes= 12.00	13.00 + 60 minutes= 14.00	14.45 + 75 minutes= 16.00
12.00 + 45 minutes= 12.45	14.00 + 60 minutes= 15.00	16.00 + 75 minutes= 17.15
12.45 + 45 minutes= 13.30	15.00 + 60 minutes= 16.00	17.15 + 75 minutes= 18.30
13.30 + 45 minutes= 14.15	16.00 + 60 minutes= 17.00	18.30 + 75 minutes= 19.45
14.15 + 45 minutes= 15.00	17.00 + 60 minutes= 18.00	19.45 + 75 minutes= **21.00**
15.00 + 45 minutes= 15.45	18.00 + 60 minutes= 19.00	
15.45 + 45 minutes= 16.30	19.00 + 60 minutes= 20.00	
16.30 + 45 minutes= 17.15	20.00 + 60 minutes= **21.00**	
17.15 + 45 minutes= 18.00		
18.00 + 45 minutes= 18.45		
18.45 + 45 minutes= 19.30		
19.30 + 45 minutes= 20.15		
20.15 + 45 minutes= **21.00**		

When I asked Dhifa about her strategy, she explained: "I need to know when the three buses will start from the station together again. So, I calculate when each bus will start from the station first. Sometimes I can see only two buses start together while the others do not yet come up. At 21.00 pm is the same time for each bus will start from the station. Thus, all the buses will commence together again at 21.00."

Israq's work:

The least common multiple (LCM) of 45, 60, and 75:



Israq's strategies for calculating the time differ from Dhifa's strategy. He was using factor trees as shown below:

LCM = 2^2 x 3^2 x 5^2 = 900. Therefore it takes 900 minutes for all the buses to start together from the central station again, means 900/60 = 15 hours. Thus, 06.00 + 15 hours = 21.00.

From this example, Israq was confidently using LCM rather than listing the times that the buses reach the station as did Dhifa's. He was thinking flexibly and fluently about the problem and considering LCM as the strategy for problem solving.

Example 3: The following example demonstrates that some students presented confidently solutions to mathematical problems. Sandy, a student of SMPN 4 Makassar, displayed transformational freedom in critiquing his teachers' and his friends' answer. Sandy also drew upon a sense of agency as he positioned himself as someone who had correct mathematical procedures, and someone who is not hesitant to defend them publically. In one task, Melati gave this question to her students "How many pieces of 0.3423 km wire can be cut into the same size 3.26m?" All the students calculated the answer by hand.

Sandy raised his hand and answered: 105, Mam
Melati: Are there any other answers?
Israq: 15
Melati: Right, 15.

Melati asked Israq to write down his answer on the white board. In particular, before the lesson finished, Sandy raised his hand again and criticised Israq's answer by saying "if I am not wrong the answer is 105 because 15 multiplied by 3.26 is not 342.3. The result

is 48.9, Mam." He has shown his calculation to Israq and Melati, while the other students paid careful attention to Israq's answer on the whiteboard.

Figure 4.21: Sandy Shows his Calculation to Israq and Melati

Additionally, when Melati asked Sandy if his answer was right or wrong, Sandy said "I am sure it is right, Mam." After Melati saw Israq's work on the whiteboard, Melati realised that Sandy was right by saying "the right answer is 105 pieces of wire." As this conversation indicates that Sandy went beyond critiquing Israq's and his teacher's answers with confidence; he was able to demonstrate the correctness of his solution.

Example 4: The following students' responses indicate that they were able to demonstrate their opinion based on their mathematical knowledge. This is the power of teaching for social issues; it educates students to realise their rights and responsibilities and to express their voice. In the global warming task, Isnayanti, Umra, Rini, and Sri Wahyu who are students from SMP Pelita, commented that the impact of environmental degradation by human activity will become a dangerous scenario and bring serious impacts on the earth if there is no serious action to prevent it. This clearly shows that they have developed a sense of social agency.

4. 3. 4. Knowledge about Social Justice Issues

The aim of this section is to analyse the students' work in terms of reading the world with mathematics as Gutstein's (2003) social justice pedagogical goals. Reading the world with mathematics means to develop an understanding of power, resource inequities, and disparate opportunities and explicit discrimination among different social groups using mathematics.

The following examples described in which mathematics can help students to

understand the world around them.

Example 1: In the Number of Pupils by Gender activity, Iriana, the teacher from SMP Pelita, provided her students with data about education with data adopted from the Department of National Education and National Statistic Agency as presented on Table 4. 1. The questions about social justice that were included in this task were "What did you learn from the data that you did not know before? What inequalities do you notice from the data?" From this activity, didactical phenomenology and intertwinement characteristic of RME appeared as the students were given the data about the number of pupils by gender and then asked to determine the percentage for each educational level in order to further develop mathematical tools and insights into their applications.

The following are comments on the above questions which came from some students of SMP Pelita. Murni: "The injustice here is that there are more students in the elementary schools than in the secondary schools. Similarly, the students in the university are fewer than those in the senior high school." Linda mentioned that: "most students drop out from the school because they cannot afford the cost of schooling." Hadrian shared the same view, stressing that: "There are many people who cannot get into university because of the cost. It is an injustice in education." Merliana asserted: "There are many children who cannot go to university because of the lack of funds." Sriwahyuningsih had another possible explanation that was not particularly a social justice reason. She commented: "Children just have more passion to study in elementary school than in junior high school, they might be thinking that the material in primary education is easier than in the junior high school."

From this students' work, it can be concluded that many students have developed an understanding of inequalities and disparate opportunities among different social groups in their society.

Example 2: The Global Warming project may serve as a mean of consideration how mathematics can be used to help students read the world and begin to make sense of things by going beyond mathematics. The project contained a question: What do you notice about the global warming? How would it affect the world?" Hadrian and his group members wrote, "Maybe we do not experience the powerful heat waves as being experienced by Europe and America. However, we also felt how hot the temperature is around us." Isnayanti's group wrote: "The implications of environmental destruction by human activity will become a dangerous scenario and bring serious impacts on the earth

if there is no serious action to prevent the global warming." Asriana's group wrote, "The destruction of the ecosystem of the earth rising temperatures outside increased." In this project, realistic situations have a significant place in the learning of mathematics in which mathematics can help students to understand the condition of the world.

Example 3: In the project about Indonesian population and wealth, Nur Hikmah, a student from SMPN Mutiara, commented on the questions: "Do you think that, within a particular continent or nation, wealth is distributed fairly? What can be done about the unequal way wealth is distributed?"

Figure 4.22: Data about Indonesian Distribution of Poverty

She argued that "It's not fair, in Indonesia there are many poor people, sometimes they do not have food to eat, and sometimes they also eat unhealthy rice. They all should be able to eat the same food as people commonly eat which is tasty and nutritious. They should have a decent and convenient place to live. All their rights are taken away by corrupt people. Their rights must be restored so that there is no more poverty in this country. The government should fight for poverty eradication and justice in this country and in other countries." In the same case, Sandy commented that "The government should offer job opportunities to the poor people in accordance with their abilities and give them salary commensurate with what they are doing so that everyone has a good livelihood and there is no more unemployment."

In this way, the mathematics classroom became a place that valued, invited, and even fostered the critical world view and strong sense of justice that the students brought with them to school. Furthermore, the students can draw on mathematics to assist them in realizing individual and collective intentions, or to critically make sense of and act

upon the world. This is in accordance with Gutstein (2006) terminology of writing the world with mathematics is the use mathematics to change the world.

4. 4 Effect of Socioeconomic Background on Implementation of this Study

In reforming mathematics classroom for achieving equity, we need to apply an approach to mathematics teaching that is substantially different from the more traditional approaches (Zevenbergen and Niesche, 2008). Furthermore, the authors suggest that students from low socioeconomic backgrounds must learn to crack the code of the mathematics classroom in order to successfully participate in it. Indeed, they state "for students from backgrounds that are not part of the success regime, significant scaffolding by teachers is needed if they are to be successful" (p. 21).

From this research, it was found that there is an inequality of access and opportunity for education in Indonesia. Education in Indonesia is in the hegemony of capitalism. Parents have to spend a lot of money to get quality education. Based on these observations, it seems that there are significant differences among schools for the rich people, for the middle, and for the poor. Ironically, all the students have to face the same national education exam. How will the poor pupils have the same achievements as those pupils from a higher socioeconomic background? In fact, the national education exam would be a part of the requirements to continue study at higher education levels.

In particular, Coleman et.al (1966) found that characteristics of schooling, facilities, curriculum and teachers made the most difference for low achieving students and those who came to school least prepared in terms of the demands of schooling. This can be linked to the discrepancies in opportunity to learn, the attitudes of the students, their previous knowledge, and the quality of teaching.

4. 4. 1. Conditions and School Facilities

Edward (1991) states that school condition can influence students' achievement. However, the assumption that a school in good condition might have more success than one in bad condition is not necessarily valid. More importantly, providing a meaningful context in which students can understand lessons contributes to improved student achievement.

From the observations carried out in this study, the environment of SMP Pelita suffered

from poor hygiene and sanitation and general untidiness which led to poor air quality both inside and outside the classrooms. For instance, outside the classroom there was a noticeable amount of rubbish scattered around and the dust in the air produced dizziness and unpleasant smells causing respiratory problems. These conditions have become serious problems as they directly affect students' attention and concentration throughout the learning process. Indeed, these conditions sometimes caused distractions in classrooms, as the students had to close their noses and waggled their book to dispel the smells.

These conditions were in contrast to the environment of SMP Al-Khawarizmi, one of the international schools equipped with an air conditioning system in each classroom. In this school, every pupil was given a cabinet to store their belongings. The general conditions in this school were conducive to keeping students focused on their lessons. Meanwhile, SMPN Mutiara with good services and had equipment better condition than those in SMP Pelita.

Furthermore, SMP Pelita, with less funding and lower amounts of donations it could raise from its low income community, could not provide adequate numbers of textbooks, library recourses, and other learning resources in the classroom. With the absence of textbooks, the pupils had to take notes during the lesson. Unfortunately, after asking several of the students to explain their notes in their own word, most of them did not really understand and could not explain what they copied from the whiteboard. The pupils tended to have poor academic performance. In comparison, students at SMP Al-Khawarizmi and SMPN Mutiara schools had their own individual mathematics textbooks and exercise books, and had access to teaching resources in their mathematics classes. It was easier for them to perform daily homework from the textbooks. As Bullock (2007) argues, the students who learn in an environment with good facilities perform their academic studies and developed better skills than the students who learn in poorer environments.

In the international private school, the teachers earned high salaries because they were generally paid by the school whereas in the other schools whose salaries came directly from the government. Additionally, the private school provide one to one tutoring from teacher assistants during the lessons. This service is offered to the parents of students with learning difficulties or with lower achievement in certain subjects such as mathematics. The teachers who provided teaching assistance commonly have high qualifications, reputations and much experience in teaching. An additional fee for this

assistance is paid by the parents. These conditions indicate school inequalities before the project commenced.

Education is the best weapon to reduce poverty. As Mandela (1994) argues, education is the most powerful weapon which people can use to change the world. However, considering the inequity between private and the public schools in terms of facilities and services, eradication of poverty is difficult to achieve. Therefore, the benefits of education in society are not equally accessible to students in the country. Schools in lower SES areas do not provide a rich academic environment for students which will influence their chances of academic success.

Another concern was the overcrowding of classrooms in the low SES school. In SMP Pelita, the numbers of students in the classroom were 51 students, consisting of 19 males and 32 females, while in SMPN Mutiara there were 40 students consisting of 14 males and 26 females. Of all the schools participating, SMP Al-Khawarizmi had the least numbers. It had only 31 students, consisting of 14 males and 17 females. From the classroom observations, it has been noted that school teachers had difficulties in managing classrooms, lessons and students. Among the three schools, the teacher at SMP Pelita had the most difficulty in managing classrooms lessons and students. Thus, Iriana (mathematics teacher of SMP Pelita) sometimes struggled to engage the whole class actively and maintain their interest throughout the lesson.

However, the use of the RME approach could result in the growth of students' achievement in learning mathematics. As Iriana, the teacher from SMP Pelita stated in the middle of this study, "I can see some of my students are getting active now." Moreover, Melati explained that she tended to engage students to present various ways of solving problem in order to improve the mathematical confidence of her students. This approach to teaching was quite different from her approach before the study.

In the beginning of this study, there were many students who had very little understanding of some mathematics topics because they were not yet sufficiently cognitively developed to think about the abstractness of mathematical ideas. However, evidence obtained here indicates that students from low socioeconomic backgrounds have benefited from this study because the teacher participants created some contextual student activities on their own instead of adopting examples from the textbook. Thus, the mathematics topic became more meaningful. In particular, for the student from low socioeconomic backgrounds, their teacher provided student activity sheet for some

lessons. It was very useful for the student as they did not have a mathematics textbook. Furthermore, realistic contexts that the teacher participants provided within this study have a significant place in the learning of mathematics in which mathematics can help students to understand the world around them. Indeed, the ways the mathematical task or projects are incorporated into the classroom have the potential to encourage students in learning mathematics.

The great majority of students also had a strong sense of satisfaction after the use of this approach of this study. As Merliana (student of SMP Pelita) said "From week to week I become more excited with the mathematics lessons because some projects required me to use my own data and my perceptions such as The Weekly Expenditure project." In addition, Gilang (student of SMP Al-Khawarizmi) commented that "Because the mathematics material related to real life, it became more easily understood." Moreover, Padilla (student of SMPN Mutiara) argued that "I got a lot of help from friends in my group discussion and my teacher during this research."

4. 4. 2. The Attitudes of the Students

Morriset and Vinsonhaler (1965, p. 132) states "it is generally recognized that attitudes towards mathematics in adults can be traced back to childhood." In particular, high socioeconomic parents are taught to reason, discuss, initiate, and reflect while children from low socioeconomic background are taught to conform and mimic (Lubienski, 2000). Since their childhoods are different, their attitude toward mathematics could be different. Furthermore, according to Ferguson (1998), lower socioeconomic background students commonly receive drill based instruction as the teachers have low expectations of them.

In the workshop at the start of the project, Iriana expressed some doubt about the weakness of her students' language skill, especially the terminology on social justice issues. She firmly believed that prior to enrolling at the school; her students' language skill was limited. They lacked knowledge of words that can affect their academic performance. This is in line with Aikens and Barbarin (2008) who asserted that children from low-SES environment acquire language skills more slowly, exhibit delayed letter recognition and phonological awareness, and they are at risk of reading difficulties.

The findings showed that in the beginning of this study, the students from high SES surroundings are used to asking many more questions than low SES students. Indeed, from the classroom observations, students from SMP Al-Khawarizmi and SMPN Mutiara asked many more questions of their teacher and participated in the lesson at a higher frequency than the students from SMP Pelita. For example, when Gilang asked about the application of per thousand in the real life to enable him understand this mathematics concept. Meanwhile, the students from SMP Pelita seemed to ask fewer questions and were content to write notes about what the teacher said at the beginning of the lesson.

However, during this study the teachers provided more opportunities for students to express their mathematical thinking and reasoning. As a consequence, students were comfortable and showed better performances in doing mathematics and in sharing their ideas with others, especially for the students from SMP Pelita. The context of the students' activity that the teachers created encouraged students to participate in the lesson. This assisted students in developing richer understandings of the mathematics concepts.

Also, the study revealed that students held positive attitudes toward mathematics. As illustrated previously, some students from SMP Pelita presented their group discussion with excitement and confidence. Additionally, Iriana claimed that most of her students became more active and enjoy the activities they were involved in. Melati, a teacher from SMPN Mutiara also told me that she was pleasantly surprised at the speed at which some of her student, for example Padilla, had improved and gained the confidence to come up with her own solutions.

Since the findings confirm that some students now more actively participated, the RME approach played a significant role in encouraging students to sustain positive attitudes toward mathematics.

4. 4. 3. Prior Knowledge of the Students

Children with higher SES backgrounds were likely to be more proficient in the tasks of addition, subtraction, ordinal sequencing, and mathematics word problems than children from lower SES backgrounds (Coley, 2002). Meanwhile, according to Knapp (1995) low SES classrooms tend to teach the basic elements of the curriculum and not

allow students to master higher level concepts. Indeed, in low SES schools, less curriculum material is taught to the students which cause grading standards to be lower.

In particular, from the classroom observations at the beginning of this study, students at SMP Pelita greatly depended on what their teacher explained. The following conversations reflect this.

Iriana: Let's move on to the next topic of the square root.
Students: Should we write it down, Mam?
Iriana: Of course. What is square root?

There were no answers from her students when Iriana asked them the definition of square root. There seemed to be a lack of background knowledge of many of the prerequisite concepts and skills necessary for teaching at this level. Some of the students did not have sufficient knowledge of square roots. Meanwhile, the students from SMPN Mutiara and SMP Al-Khawarizmi seemed to be quite familiar with this topic. Sadly, in the beginning of this study, some of the students just copied what their teacher wrote on the white board. They did not seem to attempt to understand the concept or ask for clarifications.

With regard to the lack of prerequisite knowledge, it is an important concern because as Dowker (2005) argues that arithmetic tends often to be taught in a hierarchical way. This means that if students lack the prerequisite knowledge early on, they may have difficulty with later lessons. As the consequence, students in this case have a tendency to avoid mathematics.

In implementing the RME approach with a focus on social justice, the teacher participants created some student activity sheets which are connected to real life situation. Also, students were asked to present their solutions or their work in front of the class in order to help them to better understand the mathematics. Some students from SMP Pelita expressed their sense of enjoyment at some project as mentioned previously because the data were about them so that they engaged with the project individually. Therefore, this approach helps students gain background knowledge because the teachers supplied the missing information, especially for the students from low socioeconomic status. This is in line with Hiebert's (1996) statements that mathematics connected to realistic situations will be perceive by students as being useful rather than in an abstract and meaningless knowledge .

4. 4. 4. The Quality of Teaching

Hayes, Mills et al. (2005) state that whether a student succeeds or fails at school may well be a result of personal effort: it may reflect individual capacities and choices. But it may also be the result of structures of opportunity that lie beyond the control of single individuals: what school individuals attend, the curriculum and pedagogies they experience, where they live, what cultural and material resources they have at home. In particular, the quality of pedagogy is an important social justice matter. Such quality includes intellectual demand and connection to the world beyond the classroom.

In the beginning of this study, the teachers work throughout the curriculum with their students. Some of the students recognized that they must complete their lessons mandated by the syllabus. However, not all students were ready for that because of their lack of prior mathematics knowledge. So in that sense, there is no guarantee that all the materials have been mastered by the students but at this level, the teacher should finish every single topic in the syllabus.

Kumashiro (2009, p. 21) points out that oppression can result from what students learn as well as from how students learn. If a teacher just follows the syllabus without an awareness of their students' understanding of the lesson, this kind of education would be categorised as oppression. As Freire (1970) states, people cannot learn through banking education in which the student is a depository and the teacher becomes depositor; knowledge emerges only through invention and re-invention. Freudenthal's concern is that mathematics should not seen as a ready-made product.

Furthermore, prior to this study, the teacher participants tended conducting direct instruction and preferred relying heavily on mathematical questions from the textbook. However, according to them, during this study as mentioned previously, they have tried to create exercises and student activities connect to realistic contexts. In addition, often they have become more active in searching for other activities and resources to support their teaching.

In terms of participation, students from SMPN Mutiara and SMP Al-Khawarizmi were more active and more critical than students from SMP Pelita at the beginning of the study. However, during the study, some students of SMP Pelita became more active. Some of them dare to ask confirmation from their teacher whether their answer was correct or not for the questions that was given. The use of realistic contexts in this

study has enhanced the students' engagement. Additionally, throughout the study, the students have become more and more active (in performing classroom activities) and brave (in answer the questions and present them to other students). Furthermore, in the middle of this study, Iriana told me that she always tried her best in every lesson during this study. It indicates the positive endeavour from Iriana for better teaching practices. As a consequence, her students demonstrated a growth in their engagement.

More students were more likely engage in the lessons at SMP Pelita in spite of the different conditions during this research study. Such comments highlight the importance of considering the use of the RME approach. This suggests that the RME approach is effective means of teaching for students from a low socioeconomic background. Also, the use of realistic contexts in this study made mathematics more meaningful and accessible for all students.

4. 5 Summary of the Chapter

This chapter provided the data analysis results and addressed the research questions associated with the study. In general, the teachers faced some initial difficulties in combining mathematics and social justice. In particularly, the data revealed that tensions arose early around balancing social justice issues and mathematics knowledge in implementing this approach. However, there were many areas of development of the teachers observed in this study: a growth in their confidence, an improvement in relationships with their students, a growth in their knowledge about social justice, a growth in their mathematical knowledge, and growth in teaching methods. Furthermore, the study also provided positive effects on: students' learning in mathematics; students' engagement; students' agency; and students' knowledge about social justice issues. Indeed, the ways the mathematical task or projects are incorporated into the classroom have the potential to encourage students in learning mathematics, especially for the student from socioeconomic background. Since the findings confirmed that some students more actively participated, the RME approach played a significant role in enabling mathematics more meaningful and accessible for students.

Chapter 5 provides an interpretation of these findings and discuss the implication of the findings. In addition, the limitation of the study will be discussed and the recommendation for the future research will be provided.

CHAPTER 5

DISCUSSION AND CONCLUSION

5.1. Introduction

The research work presented in this thesis focused on the implementation of the RME (Realistic Mathematics Education) approach with a focus on social justice issues in teaching and learning mathematics in schools in Indonesia. This research investigated the process and results among students and the teacher participants of implementing this approach. The research questions examined by this study are: 1) How did the teachers demonstrate growth to implement the RME approach?; 2) How effective was the approach on students' mathematical learning, engagement, agency, and knowledge about social justice issues?; and 3) What were the effects of the socioeconomic background of the students on the implementation of the approach and on its effects?

This study took place during semester one mathematics lessons in junior high schools. A two day workshop was conducted to provide an orientation to the project and to skill the teachers in appropriate strategies to explore and improve their own teaching skills in designing some activities related to the RME approach with a focus on social justice issues.

In order to address Research Question 3, the schools selected in this study represented the wide range of school choice based on socioeconomic status of the school community. There were 51 student participants in classes in a low socioeconomic background school (SMP Pelita). There were 31 student participants from a high socioeconomic background school (SMP Al-Khawarizmi) and 40 students from a middle socioeconomic background school (SMPN Mutiara). The data collection of this study was obtained from observations, focus group discussions, informal meetings, field notes, and interviews.

The previous chapters discussed the rationale and the background of the study, its theoretical background, the methodology and sources of data used, and data analysis of this study. This chapter discusses and summarizes the major finding by addressing the research aims. The chapter is divided into three major sections. Section 5.1 addresses the findings in relation to research aims. Section 5.2 presents the limitations of the study, and Section 5.3 discusses the implications of the study and makes

recommendations for future research.

5.2. Addressing the Research Questions

To conclude this thesis, the major findings in relation to the three research questions of this study are addressed. A number of quotations from Chapter 4 are presented here to highlight the different issues discussed.

5.2.1. The First Research Question of This Study

How did the teachers demonstrate their growth in implementing the RME approach?
Reform requires creating conditions for change. Particularly, educational change is only effective if it starts from the teachers as the agents of education (Atweh, 2001). This study supported this purpose as the design of the study targeted professional development of the teachers. According to Mewborn (2003), mathematics teachers may not master teaching, but rather find themselves in a continuous state of growth and change. Thus, the development of teaching is a continual journey. This study started with a workshop to support teachers implementing the RME approach with a focus on social justice in their classroom. Then, the teachers developed their students' activities on their own in line with the theme of this study. By doing this, as previously mentioned, sometimes their lesson plan and student activity sheet was discussed with me by phone or email. Indeed, I was working together and supporting teachers through informal meetings and focus group discussions during the study.

There were many areas of development of the teacher observed in this study: their growth in confidence; the growth in their ability to incorporate social justice issues in mathematics education; the growth in their relationships with their students; the growth in their mathematical knowledge; and the growth in their ability to use different teaching methods.

5.2.1.1. The Growth in Confidence

According to Ernest (2002), only through the development of their self- confidence will teachers' sense of personal ownership of mathematics enable them to use mathematics across all contexts, in school and society. As previously mentioned, at the beginning of this study, a two day professional development workshop was conducted to support teachers in incorporating the RME approach with a focus on social justice. The professional development workshop was the key for initiating new practice to enable

the teachers to better understand the study. Indeed, building teacher confidence contributes to teacher readiness to develop skills and motivates the implementation of new practices (Vartuli, 2005). Furthermore, the successful implementation of new practices increases a teacher's sense of efficacy and suggests specific needs for further knowledge and skill development (Chen and Horsch, 2004).

A certain level of confidence in implementing the RME approach with a focus on social justice was demonstrated by the teachers during this study. Initially the teachers expressed some doubt about their skills in incorporating social justice issues into their lessons. However, they developed and enhanced their use of this approach during the study with the students' active participation motivating the teachers to maintain their confidence in the use of this approach; and the demand of the schools relevant to this approach that maintaining the confidence in implementing this approach.

The Teachers Expressed Some Doubt in the Beginning

The teacher participants expressed concern about their skills and ability to participate in such research due to lack of previous knowledge about integrating social justice issues in mathematics lessons. This is in line with Frezier and Sterling (2005), who point out that teachers often find themselves doubly challenged by change: they are struggling to incorporate a new pedagogy, one that is not understood and not often supported by experienced classroom teachers; and they are unsure how to incorporate mathematically and scientifically correct content into a social justice framework.

However, as previously mentioned, the teachers had put in the effort to incorporate social justice issues in their mathematics lessons. Indeed, various student activities in implementing the RME approach which is focused on social justice issues were developed in their mathematics lessons throughout this study, even though sometimes they could not realise the idea but focussed on either mathematics or social justice issues. This is in line with Jacobsen and Mistele (2010), who claimed that teachers struggled to balance quality emphasis on the social issues with quality emphasis on the mathematics in relevant ways for understanding the social issues when incorporating social issues into their mathematics lessons. According to Jacobsen and Mistele, another struggle faced by teachers was the effort needed to make meaningful connections between the social issues and mathematics. For example, in week 2 of this study, Iriana provided her students with a "Global Warming" project. This case represents an early attempt of hers to introduce social justice thinking into her mathematics lessons. In this project, she used a powerful idea in providing a context to deal with teaching integers

and the real life issue of global warming at the same time. However, she focused on the global warming issue during the discussion of this task. Additionally, from the presentation of a video of Cities in Indonesia, as mentioned previously, she missed the opportunity to talk about issues such as religious diversity within Indonesian society or the population of the country, although she tried to improve the students' understanding of percentages from the video. Moreover, in the video of "Dokumenter Papua 2004 Membidik Pembidik", there were many opportunities to ask students about integers, including the ratio of the gold product contribution of Papua to Indonesia and the world in terms of commodity product. However, she just asked her students whether the conditions of Papua were fair or not. Apart from these examples, the teachers were ready to put in the effort to create their own mathematical tasks instead of just depending on the textbook as they usually did.

Another example comes from Melati, who demonstrated confidence when providing her students with a "Health and Nutrition" project. She made up a realistic context to connect mathematics with the negative number concept instead of giving her students a series of routine problems. The context of the activity is: *If you consume a piece of chocolate cake, to the tune of 350 calories, then do exercise for one hour, you burn up that 350 calories and are nicely back at 0 or no change*. From this, one can say zero indicates balance in mathematics as it represents the midpoint of any line segment. However, in real life balance or zero in the metabolism of the body is a problem. If the numbers of calories deposited in the human body and burned are balanced, the person will die. This example might indicate a limitation in simplistic applications of realistic contexts to school mathematics. Some concepts in mathematics are simplifying the reality in that they model a certain part of reality but not the whole part of the reality. This is in line with Skovsmose (2011) who questions whether mathematics can ever fully and objectively describe a given reality. However, from this task, as mentioned in the previous chapter, the discussion of the task enabled the students to become actively engaged in the lesson. This is in line with the RME approach in which the teachers should encourage students to engage with the real world context that makes sense to them in learning mathematics.

Their Students were More Active

According to Gutstein (2006), when pre-service and student teachers recognize that the incorporation of social justice thinking into mathematics and science content enhances student understanding and better prepares the students for standardized testing, they

maybe more inclined to better incorporate social justice into their daily lesson planning. Keeping the students motivated and interested during the implementation of the RME approach with a focus on social justice was another factor fostering the confidence of the teachers as they experienced success in implementing this approach. As teachers gained confidence, they challenged themselves to develop and create real world student activity sheets. This is in line with Tschannen (1998) who points out that a teacher's confidence should rise when students display learning progress. For example, Iriana stated that during this implementation of the RME approach with a focus on social justice, she was doing her best to prepare lessons and to vary her teaching, including looking for references, searching for videos, making up student activities, engaging students in group discussions, and connecting her lessons to the real context of mathematics including social justice issues.

This Approach is Relevant to the School's Demands

The need for improving education quality is one of the concerns of the Indonesian government. The school system in Indonesia is decentralised whereby the district report to the local governments. Then provinces will retain a hierarchical relationship with the central government (Alm & Bahl, 2001). As decentralisation is adopted, the broad involvement of stakeholders becomes a key factor, including the role of the school supervisor. And also, each school has their own curriculum syllabus and can decide which textbook they use and develop their own lesson plans and student activities.

At the later stages of this study, as previously mentioned in the analysis chapter, Iriana expressed her confidence in implementing this approach by informing me:

> I am happy with this project, because what I have done within this study is in the line of the expectations of my school supervisor in terms of the approach to teaching mathematics by implementing RME and the design of my student activity sheets. Those things that I have designed will be the materials I can present for my next regular supervision meeting.

The same interest in maintaining their confidence in implementing this approach comes from Melati and Rahmah when they asked for some literature related to RME and social justice issues. As previously mentioned in the chapter methodology, Melati has her teacher's certification[2], for which the teacher needs to develop a portfolio or conduct

[2]With regard to teacher certification, Ministry of National Education (2011) states Indonesia implements a nationwide program of teacher certification to develop teachers' competence in academic, professional, social, and also personal qualities. The salary of the teachers is doubled whenever they get their teaching certificates.

research which is submitted to the local technical agency. In this case, she was very excited to join this research to enable her to conduct action research as one of the requirements of her professional certification.

5.2.1.2. The Growth in the Ability to Incorporate Social Justice Issues in Mathematics Education

Teachers themselves often have difficulties with beginning teaching about social justice issues. The main challenge to implementing this approach was that the integration of social justice issues into mathematics education was still new for the teacher participants. Indeed, the approach is still new in Indonesia. As Iriana and Melati admit, they had not heard issues about teaching mathematics for social justice. Specifically, Iriana worried if when raising social justice issues her students would be focused on the social justice issues instead of on mathematics. Indeed, when first implementing these approach teachers faced challenges about which they did not feel confident in overcoming. To deal with this issue, at the beginning of this study a two day workshop was conducted to provide an orientation to the project and to skill the teachers in appropriate strategies to explore and improve their own teaching skills in designing activities related to the RME approach with a focus on social justice issues. In particular, a variety of approaches were included in the training program, such as presentations, discussions, watching a video related to the RME approach and a social justice video. Also, the workshop allowed participants to reflect and discuss focusing on other ways of the teacher participants understanding the RME approach. Moreover, they shared with others their teaching experiences, their students' performance, the curriculum, and the possibility of implementing RME in their classroom. Indeed, all the teacher participants were provided with an example of a student activity sheet in the workshop session as guidance for them in creating their own student activity sheets. Then, the teacher participants were asked to develop student activity sheets and lesson plans. The teachers then discussed each student activity sheet and lesson plan result.

In fact, as mentioned previously the teachers struggled with the incorporation of social justice issues into their lessons. This struggle was evidenced in the example that almost used inappropriate social justice examples and tensions around balancing social justice issues and mathematics knowledge in implementing this approach. This is in accordance with Jacobsen and Mistele (2010) who state that another struggled faced by teachers in integrating social justice in mathematics lessons is the effort to make meaningful connections between the social issues and mathematics. Indeed, according

to Romo and Chaves (2006), many student teachers still perceive that social justice is not an integral part of the content area in teaching and suggest that social justice issues should be taught as its own subject, as time allows. They fail to recognize that the inclusion of social justice issues in the mathematics enhances student understanding because sensitivity to social justice concerns often reflects life experiences (Gutstein, 2006).

During classroom observations, the teachers appeared to enjoy themselves when their students achieved the mathematics aims by incorporating social justice issues into the lesson. However, the teachers needed to consider another real life context including social justice issues when planning their next lesson. As Leonard (2010) argues, the teachers must observe an example of effective social justice teaching within a classroom before they are comfortable and effective in teaching themselves. Even after being comfortable teaching social justice, many teachers have difficulty finding examples to use that are purposeful and meaningful (Leonard, 2010). Moreover, Gregson (2011) points out that mathematics educators and researchers should consider the difficulty of teaching for social justice under real-world conditions and spend more time seeking sites where social justice mathematics teaching is developing organically. In this study, the role of informal meetings and focus group discussions was very important. During informal meetings, the teachers were reminded of the importance of teaching mathematics itself, in the context of a social justice issue when creating their student activities. Meanwhile, in focus group discussions the teachers were provided with opportunities to share their experiences during the implementation of the RME approach in this study. Sometimes in the focus group, teachers got an idea about the project or task that they should provide to their students for the next lesson. For example, as previously mentioned in the focus group discussion in week 4 of this study, the teachers critically reflected on their experiences. Both Rahmah and Melati claimed that to improve their teaching practices they still need some literature related to RME and social justice issues, in particular samples of activities in the line of the RME approach. Additionally, in the focus group meeting of week 6 of this study, the teacher participants suggested the use of cooperative group discussions within the lesson. McDonald (2008) suggests that allowing new teachers to integrate social justice through student centred or classroom community approaches, rather than addressing social justice through a national or international lens, gives new teachers the confidence in their abilities to simultaneously negotiate both academic and social justice content. Furthermore, this will give students more opportunities to expand their knowledge and

confidence to present interesting and relevant lessons that meet academic and societal needs that allow for student growth and development (Garii, 2009).

Some of the tasks that the teacher participants raised within the study in accordance with Gutstein (2006) delineated two sets of pedagogical goals in teaching mathematics for social justice, of which one is focused on issues of social justice (involving reading and writing the world with mathematics) and the other is focused on mathematics (concerned mainly with learning, understanding and connecting mathematics to real world situations). For example, in week 5 of the research, Rahmah and Iriana provided their students with "Number of Pupils by Gender" Activity. Using data about the number of students by gender connected to percentage, the students were asked to determine the percentage for each educational level. Furthermore, the insight gained from the percentage calculations provided an alternative to answering the question regarding what inequalities they noticed from the data. In this way, the students engaged in reading the world with mathematics. As previously mentioned in the analysis chapter, students have developed an understanding of inequalities and disparate opportunities among women and men in education in their society.

Additionally, as RME focuses on understanding and problem solving (Dickinson, 2012), teacher participants created more real life problem projects that enabled more students to understand and engage with mathematics. For example, in week 3 all the teacher participants provided their students with the "weekly expenditure project." In this project, the students studied data on their family's weekly expenditure. They also studied data about the currency conversion which required them to use operation in integer. As seen in the description of the project given above, this topic was directly related to the content prescribed in the official curriculum. This is in accordance with Garii (2012) who points out that the use of curricular materials to help strengthen teachers' abilities to incorporate social justice into mathematics will help them expand their understanding of social justice practices and mathematics teaching.

5.2.1.3. The Growth in Relationships with the Students

Academic achievement and student behaviour are influenced by the quality of teacher-student relationships (Jones, 1981). The more teachers connect or communicate with their students, the easier students learn and attain the high level of knowledge. Furthermore, relationships and interactions among teachers and students have effects on the students' engagement and social development (Pianta, 2012).

The research data collected in this study reveal that the teachers tried to understand their students. For example, in the early stage of this study, Iriana mentioned a gap between students' knowledge in her class. She points out that:

> There was a gap between students' knowledge in my class. Some students could do the task in the exact time, while the others would struggle to solve the problem. Some of them required step by step individual help and did not fully grasp the process.

Throughout the study, Iriana tried to meet the needs of the students' knowledge represented in the classroom. For instance, from the observation of Iriana, Akbar could not pay attention to the mathematics lesson caused by the distressing atmosphere in his home from his parents' conflict. He did obtain any attention from his parents regarding his mathematics achievement. Iriana planned to give him individual help in the classroom. Personal attention was found to be very useful, especially with the lower-achieving students. Moreover, according to Iriana, there was a need to prepare a parents' forum in the school. This is support by Henderson and Mapp (2002) who suggest that when schools and families work together, children have higher achievements and tend to fare better in school.

Additionally, Iriana created activities which required students to work in groups. According to Van den Heuvel-Panhuizen (2000), by discussing and sharing solution strategies in class, the students who first solved the problem by means of a long winded strategy may benefit from seeing other, more efficient solutions and, hence, progress to a higher level of understanding. Group work gave the students the opportunity to teach each other to improve the learning. As a result of this process, which is called progressive mathematisation, new mathematical concepts can be understood. In this situation, the role of teachers is as a facilitator.

Another example of improved relationship with students comes from Melati, who recognized that some students had trouble in the subtraction of negative numbers as she read her students' mathematical test answers on the concept of numbers and their operations in week 2 of this study. To deal with this case, Melati tried to connect mathematics to the real world by using contexts that she thought students would be familiar with and she used cooperative learning strategies. For example, she equipped her students with applications of integers in problem solving such as in the weekly expenditure project and the health and nutrition task. This resulted in a growing understanding of her students, indicating a positive response toward the use of this approach. Additionally, her students were allowed to work on their own data and to

develop their own ideas, and also they were encouraged to present their work in the front of the class.

5.2.1.4. The Growth of Teacher Mathematical Knowledge

Effective teaching of mathematics is dependent on teacher subject matter knowledge (McDougall, 2005). Therefore, teachers certainly need to be able to understand mathematical concepts correctly and perform procedures accurately. As Hill, Sleep, Lewis and Ball (2007) state, teachers need to have a deep conceptual understanding of the mathematics they are teaching and be able to demonstrate to their students why mathematical algorithms work and how these algorithms may be used to solve problems in real life situations.

Sometimes teachers in this project did not deeply understand the mathematical content that they were teaching. In fact, in Indonesia, some of the teachers maintained that knowing and teaching the underlying mathematics concepts beyond the content they were teaching is not important. They just focus on what materials have to be taught in line with the syllabus and to be able to cover the content in the allocated time. Also, some teachers tend to have the students memorize the content of the textbooks and to teach them techniques about how to answer multiple choice questions for the national examination by providing drill type exercises.

Indeed, the findings of this study indicate the limitations of the teachers' own mathematical knowledge. For example, in week 4 of this study on the exponents and radicals of integers topic, and before the lesson started, Melati asked me why any number raised to the power zero is equal to 1. I gave her an explanation (as mentioned in the previous chapter) to increase the teacher's understanding of mathematics within the content area. Undoubtedly through the focus on RME she became aware of her knowledge limitations and gained the confidence in asking for assistance. As regards this case, Powell (2006) states that a teacher needs to have a knowledge of mathematics for teaching and pedagogical knowledge to assist students to develop their understanding of underlying mathematical concepts. This is in line with Wu (2011, p. 18), who claimed that "A teacher who well aware of the importance of coherence in mathematics would be more likely to find a way to present the concepts of fraction and decimal from a unified perspective, thereby lighten the cognitive load of students and make these traditionally difficult concepts more transparent and more learnable."

According to Alexander, Rose, and Woodhead (1992) improving teachers' own mathematical knowledge base will lead to better teaching. As Hill (2005) states, teachers' intellectual resources significantly affect student learning. Indeed, one way to facilitate teachers' mathematical development is by deepening their mathematical understanding and changing their mathematical epistemological beliefs via professional development experiences (Hill & Ball, 2004). This is relevant to Faulkner's and Cain's (2013) suggestion that to deepen teachers' understanding of mathematics, effective professional development should be part of the equation to improve mathematical learning in students. Furthermore, the mathematical knowledge and pedagogical competence of teachers are intertwined, and improving both is a key to upgrading students' mathematical achievement (Powell, 2006).

5.2.1.5. Growth in Teaching Method

Mathematics teachers are being asked to examine teaching methods to help students develop reasoning skills to compete in the technological world (NCTM, 2000). However, Giroux (1986) notes that teachers are often trained to use various models of teaching and evaluation yet are not taught to be critical of the assumptions that underlie these models. He advises that teachers must be more than technicians and be transformative intellectuals engaging in a critical dialogue. Furthermore, Ernest (1989, p. 249) states, "Teaching reforms cannot take place unless its teaching and learning change."

Prior to conducting the research, the teacher participants said that they used to be more concerned about covering the syllabus than developing students' deep learning, and conducted direct instruction, preferring to rely heavily on mathematics questions from the mathematics textbook, and providing a series of exercises as homework for the students. As Schoenfeld (2007) states, ultimately, many teachers rely solely on the textbook to guide their classroom practice. The context of the exercise might be meaningless for the students. However, during this research study, there was evidence of growth in the teaching methods of the teacher participants. In order to ensure the students were actively engaged during the mathematics lessons during this study, a variety of teaching strategies were applied by the teachers. For instance, the teachers frequently made real life connections of mathematics concepts and provided group discussions for the students when they were solving mathematics problems. The students were provided with realistic and real contexts in their mathematics activities, and projects within the integers, fraction, percentage and the algebraic form topics were

included as a part of the regular teaching. Students studied using a wide range of sources of mathematical knowledge as the teachers included material for their lessons from the internet, their mathematics book and videos, etc. Additionally, the teachers provided individual help and scaffolding to their students.

Teachers Made Frequently Real Life Connections with Mathematics Topics

The abstractness of mathematics is synonymous for many with a cold, detached, remote body of knowledge (Boaler, 1993). It is argued that this image may be broken down by the use of contexts which are connected to the real life applications of mathematics. As can be seen from this study, the teachers produced some projects and activity sheets as real or realistic problems which enabled students to solve mathematical problems posed with integers, fraction, and decimals. For example, the *Global Warming* task, *The Ratio of Population in Indonesia, Health and Nutrition* project, the *Weekly Expenditure* project, and the *Number of Pupil by Gender* project were the result of efforts by the teachers to show students that mathematics is used in their daily life. Further such activities allowed students to think about social justice issues in their everyday life. This is in accordance with one aspect of hope from Freire (1970) that the development of teachers' and students' critical consciousness would result from dialogue. Contexts are also presented as general motivators, offering students exciting and real life examples that engage their interest.

By emphasising the real life applications of mathematics by relating a mathematics topic to something relevant in a student's life, teachers can help to increase their students' interest in the topic, and help make mathematics more meaningful to them. Many real life applications of mathematics can make the content more interesting to struggling students. This is in accordance with realistic term in RME in that students learn mathematics through engaging in solving problems in contexts that are meaningful to them. Furthermore, solving real-life problems improved students' motivation to engage with their studies in mathematics. Also, the strength of the intertwinement principle is that it appears in this case. This principle involves the mutually reinforcing relationship between the real life issues and mathematics.

In creating their students' activities, teachers were reminded of the importance of teaching the mathematics itself, in the context of a social issue. In fact, the teacher participants still struggled with the incorporation of social justice into mathematics lessons. The struggle was evidenced in the examples they articulated as previously mentioned. However, according to Garii (2013), both good and inappropriate examples

of social justice in mathematics lessons contribute to teacher education in helping the teacher to be more successful, resourceful, and ethical in incorporating social justice into their classroom.

Teachers Designed Cooperative Groups for Mathematics Discussions

In the last focus group discussion with the teacher, Iriana said I always used the lecturing method when I was teaching mathematics. However, according to her, throughout this research, she tried to probe questions and created student activity sheets on her own. Also, based on the data, the teachers designed group work for the students when they were solving mathematics problems. For example, in week 2 of this study Iriana tried to encourage students to use group work to discuss global warming issues. In addition, in week 5 of this study, Melati questioned her students verbally as follows: there is a 120 square meter garden, 2/5 planted with oranges, 3/8 planted with mango, and the remaining portion planted with papaya. How much is the portion planted with papaya? She asked her students to discuss the question in a group by saying "Please discuss in group discussion so everyone should know the answer." After several minutes during which her students tried to solve the problem within their group, Melati asked her students "is there any group that can help me to solve the problem?" One student as a representative from Ayu's group drew on the board a whole of the garden in 1 portion.

This is in line with Johnson and Johnson (2009) suggestion that students are able to achieve more when they work with others. In addition, having the students work in small groups or in student pairs is a beneficial instructional strategy for struggling students. This is also closely aligned with the suggestion of Ferreira (2001) who suggested that cooperative learning has a positive influence on students' involvement in mathematics. In addition, students appear to enjoy working cooperatively and are willing to cooperative with others in the group (Krol, 2004). However, when grouping students teachers need to consider that the ability levels of the students should be different in order to generate scaffolding among them, but within a suitable range to enable the students to work in their zone of proximal development. Teacher's interactions with students will promote student talk during the group work providing a person to person scaffold.

Finally, findings show that using the RME approach with a focus on social justice in this study indicated the struggle of the teacher participants. This observation supports

Steinberg's (1994) claim that in the implementation of new approaches or teaching methods, teachers encounter conflicts, dilemmas, and sometimes problems, many with no obvious solutions. However, generally, in this study, attempts were made by the teachers to incorporate social justice in teaching mathematics by using the RME approach. Some challenges in the application of the approach were faced. However, the use of the professional development workshop, informal meetings, focus group discussions and action research enabled the teachers to improve their practice. As Atweh (2004) stress that action research aims at empowering participants as a result of their involvement in their projects and through the reflection of their practice.

5.2.2. The Second Aim of This Study

How effective is the RME approach in terms of students' mathematical learning, engagement, agency, and knowledge about social justice issues?

5.2.2.1 Students' Mathematical Learning

Melati noted in the beginning of this study that a common problem students face was that they did not understand how multiply negative numbers; some did not complete all the answer on the test; some lacked understanding of the word problem; other students had difficulties in understanding the direction of the questions; and others were inaccurate in their calculations. As Romberg (1992) points out, there needs to be a shift from the "notion that mathematics is a set of rules and formalisms invented by experts, which everyone else is to memorize and use to obtain unique correct answers" (p. 453) to a view that learning mathematics involves processes of abstraction, inference and logical reasoning.

Many students also initially struggled to calculate percentage and fraction when the task was presented in a word problem. For example, in week 5 of this section, Melati posed an authentic task orally as follows: "in this classroom what is the percentage of male students?" Israq answered: "35%, Mam." Students: "how come, Israq?" Israq replied: "there are 14 male students and 26 female students. All together are 40, thus 14/40 x 100%= 35%." According to data observation in this case, some students were confused about which way they should transform the context of the problem into mathematics language, and only a few students were able to answer the question. One suggested explanation is that students' solution strategies comprise mindless calculations and do not include considerations of the real life aspects of the situations described in the task (Maluleka, 2013). However, the students have been faced with an authentic

mathematical task described in the word problem above, and Israq provided a realistic response to it. This is in accordance with Pugalee (2001), who stated that authentic tasks are a critical tool in developing the level of mathematical understanding and conceptualizing indicative of mathematical literacy.

During this study, from week to week, some projects and activities have developed that supported students in achieving a greater awareness of the extent to which mathematics is involved in day to day life. This follow Skovsmose's (2011) claim that the powerful resource of mathematics in action describes what is and what might be, and what could be through modelling aspects of the world. For example, in the "Weekly Expenditure" project, which links to the mathematics curriculum of integers material to solve the operation of integers (addition, subtraction, multiplication, division), the students worked on their own data. In this case, whilst were involved with real life issues they also developed their understanding of the mathematics concepts. Indeed, this project engaged students in analysing their weekly family spending on food and supported them in learning mathematics with understanding and in developing mathematical power.

Rahmah's students when they worked in small groups made written comments based on the questions in the *Number of Pupil by Gender* project. They discussed the percentage of students at each education level and a range of ideas about the inequalities they noticed from the data. Based on observations, this activity went really well and the students were involved in sharing their understandings about how to get the percentages for each level by using their calculator. In this example, the students analysed the information by using mathematics lenses whilst applying their understanding of how to carry out calculations involving percentages. Dealing with this subject may not only offer advantages for the study of this mathematics topic, but also provide authentic information about social issues to the students.

Involving students with the context of a problem made them more confident in solving the mathematical problem. As Obodo (2002) explains, if students have a positive attitude to mathematics, they will definitely be interested in its learning process. For example, Israq was confident in his own ability to shows creativity and thinking outside the box for the mathematical puzzle. Indeed, by using multiple ways to solve a mathematical problem as in Fatur's work on the algebraic forms (Greatest Common Factor (GCF) and Least Common Multiple (LCM) of algebraic form) topic, the students felt confident about the correctness of their answer. Additionally, from such a project, students learnt mathematical ideas while solving interesting problems.

The findings of this study strongly suggest that the involvement of students in the projects assured the growth in their ability to learn mathematical content. In addressing the first research question section of this chapter, some activities had been developed by the teachers. In particular, the Global Warming activities sheets provided by Iriana, a teacher from SMP Pelita, aiming to identify quantities in daily life by using integers. The sheets provided images showing the condition of the earth with different increases in global temperature. The mathematics integers indicator was being addressed by using global warming issues. Particularly, in this project, realistic situations have a significant place in the learning of mathematics in which mathematics can help students to understand the condition of the world. In answering the questions in this activity sheet before sharing the answers with the rest of the class, some of the high achieving students directly identified the state with highest temperatures by looking at the highest degree in Celsius on the sheet. Meanwhile, other students needed to compare and order the integers number from lower to highest before drawing conclusions from the data to answer the questions. This is in line with NCTM's (1989) claim that the application of mathematics to contexts which have relevance and interest is an important means of developing students' understanding and appreciation of the subject of those contexts. It further helped students develop a significant understanding of the mathematics topics targeted in this research and also to learn about some issues in their wider surroundings. This observation is in accordance with Atweh (2012), who points out that by giving students real world context problems, they will attempt to engage in deeper thinking behind the mathematics developed and the social practices being investigated.

Overall, the findings suggest that this study has provided the students with the opportunity to demonstrate their learning and understanding of (a) the operation of integers (addition, subtraction, multiplication, division, powers, and roots), (b) different representations of fractions (proper, improper, mixed fraction, decimal, percentage and per mile), and (c) the algebraic forms including: Greatest Common Factor (GCF) and Least Common Multiple (LCM) of algebraic form. It is relevant to point out that all of these competencies are part of their adopted curriculum.

5.2.2.2 Engagement

The degree of student engagement in mathematics classroom was investigated in this study in accordance with Chapman's criteria to assess students' levels of cognitive, behavioural, and affective engagement. As Chapman (2003) states, learning task engagement refers to cognitive criteria, behavioural criteria, and affective criteria.

The findings in this research suggest that the opportunity to investigate real issues increased the students' engagement and also helped them to construct and apply important mathematical concepts. This is in line with Atweh's (2009) claim that the development of mathematical knowledge through real world activities demonstrates the usefulness of mathematics at the same time as engaging students. Indeed, some projects and student activity sheets developed by the teacher participants during this study that involved real life issues including social justice issues led to students' increased engagement. For example, from *The Weekly Expenditure* project, the students also learnt about the world by comparing their expenditure to those of other families in the world. During this project, the students demonstrated their engagement in terms of the timely submission of their project: all the students from the three schools completed their project and submitted it on time. The data were about them so that they engaged within the project. This observation supports the view of Helme (2001), who points out that classroom learning tasks and activities provide the vehicle for a student's engagement. Indeed, many studies show that authentic and challenging tasks are associated with higher behavioural, emotional, and cognitive engagement. If students are solving problems which are involved in the real world and related to their own data, they are more likely to engage. This is in line with Newmann (1992) who suggests that authentic work might affect student engagement.

Additionally, the engagement of the students has also been increased because their teachers gave them an activity about social justice issues. For example, in the project about *The Number of Pupils by Gender*, students shared different views when commenting on the inequalities from the data while they working on percentage. According to Helme (2001), students verbalising their thinking and answering teachers' questions are indicators of cognitive engagement. Particularly, through mathematical discourse, teachers can foster students' engagement and participation while focusing on the mathematical concept (Miller, 2013). This supports Gutsteint's (2007) argument that teaching mathematics for social justice is a means of engaging students to use mathematics to think about and act in the world.

The data analysis revealed that the student 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. For example, in week 7 of this study when the students of SMPN Mutiara worked on a mathematics competition, which they really enjoyed. Feby and several students made comments when the bell was ringing for break which

reflected the feelings of many of the students that "Kept going, Mam, we can take a rest later." These findings give support to the suggestion of OECD (2004) that interest in and enjoyment of mathematics can be regarded as the driving forces of the intensity and continuity of engagement in learning situations.

In addition, as previously mentioned in chapter 4, Andi, is low achieving student, he hesitated depending on his mathematical knowledge. He illustrated his understanding on dividing 12 apples by 2 using diagrams, reflecting back to his knowledge gained from primary school. He was engaged in different ways from his friends who were categorised as high achieving students in mathematics. This is in accordance with Helme (2001) who contends that cognitive engagement involves the thinking that students do while engaged in academic learning task. Furthermore, mathematics is more accessible and applicable when it is learned in the context of life. Apart from this, all students should have access to learning significant mathematics, and not only high achieving students. As Croom (1997) points out, mathematics affects every aspect of life; therefore, all students deserve an opportunity in mathematics classrooms to develop their reasoning and analytical skills and to achieve their full potential. Indeed, this supports Walshaw's (2006) claim that quality teaching ensures that participation in classroom discussion is safe for all students in that the norms of students' participation and contribution are equitable.

The findings of this study also reveal that student participants expressed positive views about the ways in which their mathematics lessons were facilitated. Some of the students enjoyed the mathematics lessons in which their activity sheets were discussed in group work. Also, students get along well with teachers and the teachers provided their students with scaffolding during discussions and gave students some personal attention. This is in accordance with Hughes (2007) who states that students who enjoy a close and supportive relationship with a teacher are more engaged in that they work harder in the classroom. Particularly, learning is enhanced by social interaction which provides students with the chance to vocalize their knowledge and to learn from their friends (Cooperstein, 2004). This is in line with the interactivity characteristics of the RME, as van den Heuvel Panhuizen (2000) contends that through discussion and group work, students share their ideas with others and that the reflection involved helps students to reach a higher level of understanding.

Furthermore, from the data analysis, the students appreciated the advantages of mathematics knowledge in their lives. The students' comments about the benefits of

mathematics also indicate that the students value the benefits of mathematics in their lives in terms of counting, calculating discounted items, and making them clever, which leads them to potentially invest for their future after learning integers, fraction, percentage, and the algebraic form. It demonstrates that the students appreciated the applicability of mathematics in everyday use that might lead to engagement in learning mathematics. This is in accordance with Newmann (1989), who argues that only when students perceive that their academic achievement will lead to rewards will their engagement in the subject increase. Indeed, through the engagement with a particular context and time, agency might be achieved (Biesta and Tedder, 2006).

5.2.2.3 Agency

With regard to the term agency of Empson (2002), in this section I will discuss the evidence for the ways in which the RME approach with a focus on social justice affected the personal and social transformation of the students and identification of students as problem solvers. It support Atweh (2009, p. 272) contention that "Quality in mathematics education is measured not as, or not only as formal abstraction and generalization, but by its capacity to transform aspects of the life of the students both as current and future citizens." Even though most of the tasks that were created by the teachers during this study did not articulate what actions students might take as a result of such transformation, some of the tasks or projects undertaken during this study connected mathematics and society or they were effective in raising students' awareness of a social issue. Of particular significance was the development of students' social awareness encompassing the level of social consciousness that leads to their social transformation and their participation in social movements. Furthermore, according to Gutstein (2008), students should develop a deep socio-political consciousness of their immediate and broader contexts and also acquire a sense of social agency through reading and writing the world, that is, they should develop strong cultural and social identities, to be rooted in who they are as a people and to develop the confidence to stand up for their beliefs. Also, Gutstein (2008) points out that there is a need to change students' orientations toward mathematics, to realize that it has real meaning in life and can specifically be used to read and write the world. Additionally, several projects in this study provided opportunities for students to draw on a range of skills and knowledge in order to solve mathematical problems as a reflection of the development of their agency.

Andersson (2011) argues that in mathematics education research, agency can be used both as a tool for locating certain forms of communication in the mathematics classroom and for locating students' activity and intentions in the communication. According to NCTM (2000), rich mathematical tasks are a key in classrooms that have communication as a central goal in which students reflect upon, clarify and expand their ideas and understanding of mathematical relationships and mathematical arguments. In particular, as students assert their intentions in an effort to impact their experiences in a particular figure world, their expressions become enactments of agency. Indeed, Turner (2010) states that intentions which are referred to desires, needs, plans, hopes, interests and goals are linked to agency.

Moreover, according to Andersson (2011), certain forms of acting and communicating in the mathematics classroom may support the development of citizenship. During this study, some comments of students on their task or project demonstrated this kind of communication. For example, in the project about Indonesian population and wealth on percentage topic, a student argued that

> It's not fair, in Indonesia there are many poor people, sometimes they do not have food to eat, and sometimes they also eat unhealthy rice. They all should be able to eat the same food as people commonly eat which is tasty and nutritious. They should have a decent and convenient place to live. All their rights taken away by corruption people. Their rights must be restored so that no more poverty in this country. The government should fight for poverty eradication and injustice in this country and in other countries.

This example explores the agency as evidenced in the student's response to the task provided. This comment also illustrates the praxis of the students as a collective endeavour that begins by encouraging students to generate, discuss and reflect upon issues that impact their lives. In this way, the mathematics classroom became a place that valued and fostered the critical world-view and the strong sense of justice that they brought with them to school.

The following example also demonstrates students' agency in which some shy students became no longer afraid to voice their opinions. After Iriana finished explaining the percentage topic, she asked her students to explain their understanding of this concept. Spontaneously, Dea and Linda, who prior to this study had been reluctant participants in mathematics lessons, raised their hands and said: "May we explain in the front of the class, Mam?" Iriana said, "Yes, please." An important aspect of the statements made by the students was the demonstration of her development of agency through the way of

responding to her teacher.

To know when to draw on mathematical ideas and to be able to solve mathematical problems is a critical part of the dance of agency (Boaler, 2003). Boaler uses the 'dance of agency' metaphor when illustrating the importance for mathematics learners to have an empowering identity in relation to school mathematics. According to Melati, some of her students worked more independently on their tasks as the study proceeded. Before the RME approach was implemented, usually her students would ask her what to do when they encountered difficulties in solving or commenting on a problem. However, during this study, her students tried to solve the problem by themselves first, and then collaborated with their friends to solve the problem. Another example comes from Israq's strategies for calculating the time of the three buses starting together again from the station with different routes. His solution differs from Dhifa's strategy. He was using factor trees of the least common multiple (LCM) to solve the problem instead of listing one by one the bus stop times as Dhifa's did. This is also in line with Freudenthal (1991), who uses the term mathematising as the use of mathematical tools within a problem solving activity.

During this study, such agency was demonstrated by the students. For instance, Sandy displayed transformational freedom in critiquing his teacher's and his friends' answer. When Melati gave a question to her students, all the students calculated the answer by hand, which asked for 0.3423 km of wire to be cut into the same size pieces of length 3.26m. How many pieces of the wire would there be?

Sandy raised his hand and answer: "105, Mam"
Melati: "Are there any other answers?"
Israq: "15"
Melati: "Right, 15."

Melati asked Israq to write down his answer on the white board. However, before the lesson finished, Sandy raised his hand again and challenged Israq's answer by saying "if I am not wrong the answer is 105 because if I multiply 15 by 3.26 it is not equal to 342.3. The result is 48.9, Mam." He has shown his calculation to Israq and Melati, while the other students paid attention to Israq's answer on the whiteboard carefully. In this case, Sandy expressed his concern in mathematical language. Sandy's explanation indicates the achievement of agency in that the way that he talked about his answer was linked to his actions in showing his teacher and friends the proof of the right answer.

This is in line with Chapman (2003) who used the term transformational freedom to denote the action of students who have the facility to use language appropriate to the situation by using more mathematical or less mathematical language.

5.2.2.4 Knowledge about Social Justice Issues

Seeger (p. 222) points out that, as mathematics educators, there is a need to acknowledge that everything that is done in the classroom is producing meaning. Indeed, through the process of using mathematics to study and understand their world, students strengthen their knowledge of mathematics. It is consistent with Atweh's (2009) argument that in order to developing an understanding of mathematics and the world, there is a need to engage mathematics with the life of student not only with the physical and economic world, but also with the social world of students' current world and what will student experience as an adult. So, when they become adults, they will start to improve their world.

During this study, there were many student activity sheets and projects that were provided for the students by teacher participants in line with developing an understanding of mathematics and the social world of the students. This is in accordance with Stemhagen (2009) who states that thinking of the mathematics class as a forum for students to learn to analyse and understand is a radical shift from both traditional and contemporary notions. For example, in the project *Number of Pupils by Gender*, the students were sharing their understanding on how to get the percentage for each level of education while they examined the inequalities seen in the data. The students quoted below are among the sample of students' who responded to the student activity sheet that their teacher developed during this study. In week 5 of the research, Rahmah and Iriana provided their students with "*Number of Pupils by Gender".* After completing the missing columns in the table by calculating the percentages at each level of schooling, the following comments came from some students of SMP Pelita. Murni asserted: "The injustice here is that there are many more students in the elementary school than in the secondary school. Similarly, the students in the university are less than those in the senior high school." Linda mentioned that: "Most students drop out from the school because they do not have the money to pay for school." Hadrian shared the same view, stressing that: "There are many people who cannot get into the university because of the cost. It is the injustice in education." Merliana asserted: "There are many children who cannot go to university because of the lack of funds." Sriwahyuningsih commented: "Children just have the passion to study in elementary

school rather than in junior high school; they might be thinking that the material in primary education is easier than in the junior high school." In this case, students would benefit from opportunities to discuss social issues while they strengthen their mathematics skills.

In the above case, students were involved in the activity of understanding the concept of percentage while they learnt the social justice context of the project. This is in accordance with the terminology of Gutstein (2003) who stated that reading the world with mathematics means to use mathematics to understand relations of power, resource inequities, and other differences. Indeed, when the knowledge and understanding of mathematics are used to solve problems, it shows the power of mathematics. Developing mathematical knowledge and capacity helps the students to not only, using Freire's (in Gutstein, 2006) terminology, "read the world", and to understand it, but it should lay the foundation for their capacity to "write the world, i. e., to change it. In the traditional wisdom of mathematics, reading the world (at least some aspects of it) is the function of the school, whereas writing the world is often constructed as a possible capacity that might arise later when the students enter the workforce and civil society (Atweh, 2009, p. 270).

The discussion above that relates to Research Question 2 summarised the results showed the effects of the implementation of the RME approach with a focus on social justice on students' mathematical learning, engagement, agency, and knowledge about social justice issues.

5.2.3. The Third Research Question of this Study

What are the effects of the socio economic background on the implementation of the approach and on its effects?

From this research, it was found that there is an inequality of access and opportunity of education in Indonesia. In contrast with Law No. 20 of 2003 of National Education System Act, the Indonesian education system must be able to ensure equal education opportunities which were held to be democratic and fair and not discriminatory to uphold human rights, religious values, cultural values, and national diversity. Regardless of Indonesian students' socioeconomic background, they have equal rights to education as it is mandated by the law. Apart from this concern, Lubienski (2007) contends that there is a need to promote equity in mathematics education in an effort to reach the goal of mathematics achievement for all and to close achievement gaps in mathematics. There is a need to ensure that low SES and minority students get the best

possible education.

In particular, the inequalities between richer and poorer students vary greatly in the instructional resources and facilities of the school participants. This led to a great disparity in students' participation and performance in mathematics lessons. For example, the building of the SMP Pelita has not kept pace with their number of students, with 51 students being in a classroom of poor condition. According to Berner (1993), good infrastructure is truly at the base of a quality education. Additionally, the overcrowded number of students in schools as compared with its capacity has a negative influence upon students and teachers (Earthman, 2002). Indeed, based on the data collection, students from low and middle SES were sometimes disturbed by the condition of the school. For example, frequently in SMP Pelita, students were distracted by the smell of garbage in the yard outside the classroom when there was a scavenger picked up the trash. Spontaneously, this stopped the learning process while the students and teachers covered their noses or fluttered a notebook until the odour had gone. Similarly, the students and the teacher wiped off their sweat or fluttered their notebook during the hot weather. Meanwhile, SMP Al-Khawarizmi, that was equipped with air conditioning (AC), did not experience such disorders. This is in line with Earthman (2002), who states that poor schools, including those with a poor thermal environment do reduce the effectiveness of the teachers and subsequently have a negative influence upon the ability of students to learn.

Based on the data collection, students from low SES schools tend to have less prior knowledge of mathematics concepts than the students who came from schools of middle and high SES areas and therefore tended to have difficulties in the mathematics learning process. For example, when Iriana (a teacher of SMP Pelita) asked the students about the square root concept, most of them did not know the definition as the basic mathematical concept for their next learning material. Here, the implication is that the students should have known what was taught in elementary school. Low SES students begin school at a kindergarten or a primary school of lower quality than the higher SES students. Ironically, all the students have to face the same national education exam. In fact, the national education exam is a part of the requirements to continuing study to higher education.

In the workshop at the start of the project, Iriana firmly believed that, prior to enrolling at the school; her students' language skills were limited. They lacked knowledge of the words aligned with social issues as considered in this study. Such comments highlight

the doubt about the weakness of her students' language skill. Zevenbergen (2000) argues that the language that is part of the working class has less synergy with school mathematics than that of the middle class. In contrast, middle class learners' language aligns more closely with that of school mathematics because it is being closely aligned with their home language.

One possible method of assisting students overcome their mathematical difficulties is to employ teaching assistant to provide additional support for such students. Ironically, it only could happen in SMP Al-Khawarizmi, where the school offered students parents' this option, especially for the low-achieving students. If their parents wanted to pay for the teaching assistant, then somebody would assist these students during the mathematics lessons. The teaching assistants are people who are good at maths who graduated from university that was selected by the school. Unfortunately, students in the low socioeconomic background school did not have this chance. In terms of participation, at the beginning of the study mostly students from SMPN Mutiara and SMP Al-Khawarizmi were more active and more critical than students from SMP Pelita.

Under the above conditions, intervention should take place at an early stage otherwise the low SES students will be left behind further from the mathematics school aims. There were several efforts from the teachers regarding strategies for dealing with individual differences within a class, and including children with mathematical difficulties. As previously mentioned, in order to help students learn considering their lack of prior achievement, the teachers provided individual help and scaffolding to their students. Also, a variety of teaching strategies have been applied in line with the RME approach with a focus on social justice. For instance, the teachers created mathematics classrooms that gave students opportunities to discuss real life connection of mathematics within the integers, fraction, percentage, and the algebraic form topic as a part of the regular teaching. Some of the materials the teachers found from the internet, the mathematics book and videos, etc. This is in contrast to the situation prior to conducting the research as, according to the teacher participants, they used to be more concerned about finishing the syllabus. Rather than just providing the routine and time saving approach to teaching and learning mathematics, during this study the teachers created some student activities in line with the RME approach with a focus on social justice to ensure that their students engaged in mathematics lessons.

Through the focus group discussions in this study, the teachers critically reflected on their experiences in order to learn and improve as professionals. Every teacher shared

their own experiences, their students' performance, and students' activities in line with the RME approach with a focus in social justice. From these discussions, all the teacher participants learnt about each other. The discussions might have been of more benefit to the teacher from the low SES school so that she could see ways by which her students could succeed at higher and higher levels of achievement in line with curriculum frameworks and standards as the middle and the high SES students did.

Indeed, during this study students had the chance to develop their mathematics skills while they are doing the mathematics activities. As a consequence of their involvement in the activities, some students of SMP Pelita became more active. Some of them dared to seek confirmation from their teacher as to whether their answer to a question was correct or not. Yet, according to the recognition of the teacher, those were the shy students. Additionally, some of the students enjoyed the mathematics lessons in which their activity sheets were followed in the group work. Students appeared to engage more actively with the mathematics when they were excited about real life contexts. As a consequence, they were motivated to pay attention in mathematics class. Indeed, it has shown that the RME approach with a focus on social justice could prepare low SES students for school mathematics and reduce the SES related learning gap. It is suggested that this innovative approach in mathematics education could be implemented in schools in Indonesia.

5.2.4. Conclusion

In the opening chapter of this thesis, I set a series of three research objectives that guided this study. The aims of this study were to investigate the professional growth of teachers as they implemented the RME approach with a focus on social justice; to investigate the effects of this approach on students' in terms of their mathematical learning, engagement, agency, and knowledge about social justice issues; and, to investigate the effects of the school's socioeconomic background on the implementation of this approach.

In this final chapter, I summarize the themes that emerged as I carried out my research study; I then address the implications of this study for future research. Finally I outline the limitations of my study, followed by recommendations for further research.

In regards to the first research aim, findings show that the teacher participants have considerable effort into implementing the RME approach with a focus on social justice

into mathematics lessons. As previously mentioned, this approach to mathematics education is still new in Indonesia. Some challenges were faced in the application of this approach. For example, the teacher participants worried if when raising social justice issues her students would be focused on these social justice issues instead of mathematics. Indeed, when teachers first implemented this approach they did not feel confident in overcoming this challenge. Other challenges to be faced including ensuring examples of social justice issues that were used were appropriate and the tensions arising from balancing social justice issues and mathematics knowledge in implementing the approach. However, there were many areas of development of the teachers during this study: the growth in confidence, the growth in the ability to incorporate social justice issues in mathematics education, the growth in their mathematical knowledge, and growth in teaching methods.

In regards to the second research aim about the effect of this study on the students' learning, this research also showed the effects of the implementation of RME approach with a focus on social justice on students' mathematical learning, engagement, agency, and knowledge about social justice issues. Particularly, students were involved in the activity of understanding the mathematics concept, an understanding of mathematics and the social world of the students drawn on a range of skills and knowledge in order to solve mathematical problems as a kind of agency. Moreover, some comments of students on their task or project demonstrated communications that support the development of citizenship. Additionally, some students was happily engaged and enjoying what they were working on because it made sense in their world

In regards to the third research aim, the findings showed that there were discrepancies in school facilities, the attitudes of the students, students' previous knowledge, and the quality of teaching of the school participants. These discrepancies led to great disparities in students' participation and performance in mathematics lessons. However, during this study students had a chance to develop mathematics while they learnt social issues through realistic or real context problems. As a consequence, some students became more active participants in mathematics lessons, especially students from the low socioeconomic background school. Indeed, the RME approach with a focus on social justice was seen to play a significant role in encouraging students in learning mathematics.

5.3. Limitations of the Study

There were some limitations to this study that need to be clarified.

First, the time spent on this research was not long enough to create more appropriate student activities which focus on social justice context, because the approach was totally unfamiliar for the teacher participants. Indeed, the approach was adopted by the teachers at the school who were familiar with routine instruction, so that they still had to learn to adapt to the RME approach in their teaching. If I had conducted this study for the whole academic year it would have allowed the teachers to create more appropriate social context mathematical problems, including social justice issues. Additionally, it would have helped the teachers to review their teaching practice through focus groups and informal meetings. As a consequence, a lot of change could have happened in their professional growth such as confidence, mathematical knowledge, and their ability to incorporate social justice issues into mathematics lessons. Indeed, it would have enabled me to study in more depth phenomena arising from the students and the efforts of the teacher participants in integrating the social justice issues in mathematics lesson by using the RME approach, including other problems that might be faced by the participating teachers. In this case, six months were chosen to meet the demands and time limitations of a doctoral program

Second, the lack of literature with regard to implementing the RME with a focus on social justice issues, especially in Indonesia, impacted on the teacher participants as they had to develop their own activity lessons and projects with little access to other materials. Indeed, both Rahmah and Melati claimed that they still needed some literature related to RME and social justice issues, and especially more samples of students' activities. These references, for use with students from the same cultural background as their students, could be used as to further enrich their students' activities in mathematics classes. This research mostly had to use references from other cultural contexts.

Thirdly, the qualitative research itself had limitations. The desire of the teacher participants to share their experiences depends upon their willingness to do so. The quality of social interactions between the participants and I might facilitate or inhibit access to information. As I knew just two of the teacher participants when this studies begun, my relationships with the participants probably had an effect on their willingness to share their experiences.

5.4. Implications and Recommendations for Further Research

5. 4. 1. Implications

This research has brought to light a new range of research areas in mathematics education. This research has made a major contribution to the field of teaching for social justice as well as to mathematics education. It is the first study to investigate the influence of teaching mathematics for social justice by using the RME approach in Indonesia. Particularly, the combination between the RME approach and social justice in mathematics education may provide new insights that allow an improvement in the understanding of mathematics education in a social context. Indeed, through the application of this approach, students may develop an awareness of issues of their society and an opportunity to learn about the world around them while strengthening their mathematical knowledge.

The findings of this study stressed that the RME framework is applicable to mathematics education. Involving social justice issues in the RME approach may improve the quality of mathematics education in terms of empowering students to use mathematics to solve the real life problems. Furthermore, one of the important implications of this study is related to the practice of teaching mathematics in this context. Indeed, it draws attention to the need for meaningful mathematics lessons which are connected to students' real life experiences. Therefore, mathematics teachers should provide their students with more challenging contexts, including social contexts to make their mathematics lessons more meaningful to them.

Another important implication of this study is related to the theory and research on social justice teaching. By combining real and realistic contexts through a focus on social justice using the RME approach, it is strongly suggested that curricula reforms to teach more real context mathematics will provide a means to see the ways in which mathematics is applicable and relevant to students' lives. Furthermore, it calls for more real-life mathematics problems to be presented in mathematics textbook exercises. Moreover, this study provides a framework for future researchers to conduct further studies using this approach.

The RME approach was also useful to the teachers in developing their understanding of teaching and learning mathematics. The findings of this study reveal that there was growth in the teachers' confidence, mathematics knowledge and teaching methods. Furthermore, during this study, the teacher participants had opportunities to reflect on

their practices that contributed to the growth of their mathematics teaching and learning. This study highlighted the importance of the approach for teacher participants to reflect critically on their classroom practices. It would help them review their teaching practices. As Rushton and Suter (2012) state, none of us is the finished product, but through reflective practice, teaching and learning can be improved.

This study also raised an awareness of the unequal opportunities in learning and teaching mathematics among students from schools of different socioeconomic status (SES) in Indonesia. It is important to promote an equal opportunity for all students to experience meaningful mathematics lessons. Furthermore, there is a need to stimulate access to high quality mathematics instruction for all students as the equality of education.

5. 4. 2. Recommendations for Further Research

The need to investigate what occurred after the researcher had left the schools with regard to the sustainability of the use of the RME approach in the schools. In addition, I recommend a further exploration of the experiences of the teacher participants and the impact the use of the RME approach might have had on their growth as a teacher.

This study focussed on an innovative approach to mathematics education in Indonesia. Additional research on the implementation of the RME approach with a focus on social justice in other schools could be conducted to have a more significant impact on the current education reform movement in Indonesia because this study was just implemented in one region and on a small scale.

Future research needs to focus on the barriers to the implementation of this approach: how teachers are being trained to develop more mathematics projects with a focus on social justice issues; how the students' activities in mathematics lessons with a focus on social context are being designed; and how the teachers may be assisted in their efforts to implement the RME approach. Such research will be helpful in guiding the efforts of the teachers in developing their ability to incorporating social justice issues into their mathematics lessons.

Future research could be conducted using this approach to reduce the achievement gap among students of higher, middle, and lower socioeconomic background. Further research could also be conducted to determine the effectiveness of the quality of teaching and the effect of parent involvement in reducing the deep gaps in students'

achievement based on socioeconomic status.

5.5. Summary of the Chapter

This Chapter has presented the discussion and conclusion of the major findings of the study. This Chapter also discussed the implications of the study for the practice of teaching mathematics at school, the limitations of the study, and suggestions for further research.

The teacher participants encountered several challenges in implementing the RME approach. However, given this challenge and concern there was growth seen in the teachers' confidence, their relationships with their students, their mathematics knowledge, their teaching methods, and their ability to incorporate social justice issues in mathematics education. Also, the findings of the study showed that the application of the RME approach with a focus on social justice gave produced changes in students' learning of mathematics, their engagement, sense of agency and knowledge about social justice issues. Furthermore, the implementation of the approach could prepare low SES students for school mathematics and reduce the SES related gap in mathematics achievement.

REFERENCES

Adams. (2007). *Teaching for diversity and social justice.* London: Routledge.

Aikens, N. L., & Barbarin, O. (2008). Socioeconomic differences in reading trajectories: The contribution of family, neighborhood, and school contexts. *Journal of Educational Psychology*, *100*, 235-251.

Alexander, Rose, & Woodhead. (1992). *Curriculum organisation and classroom practice in primary schools-A discussion paper.* London: Department of Education and Science.

Alm & Bahl. (2001). Can Indonesia Decentralise Successfully? Plans, problems and prospects. *Bulletin of Indonesian Economic Studies, Vol. 37, No. 1, 2001: 83–102*.

Alrø, H., & Skovsmose, O. (2004). *Dialogue and Learning in Mathematics Education: Intention, Reflection, Critique*: Springer.

Appelbaum. (2007). Mathematics education and social justice: Gatekeepers, politics, and teacher agency. Philosophy of Mathematics Education Journal, 22, 1-23.

Atweh & Clarkson. (2001). Issues in globalisation and internationalisation of mathematics education. In B. Atweh, H. Forgazs, & B. Nebres. (Eds.), Sociocultural research on mathematics education: An international perspective (p. 77-94). New Jersey: Lawrence Erlbaum.

Atweh, B (2004). Understanding for changing and changing for understanding: praxis between practice and theory through action research in mathematics education. In *Researching the socio-political dimensions of mathematics education: issues of power in theory and methodology*.

Atweh. (2007). What is this thing called social justice and what does it have to do with us in the context of globalisation? Philosophy of Mathematics Education Journal (No. 21).

Atweh, B., & Brady, K. (2009). Socially response-able mathematics education: Implications of an ethical approach. *Eurasia Journal of Mathematics, Science and Technology Education, 5*(3), 267-276.

Atweh, B. and K. Brady (2009). "Socially response-able mathematics education: Implications of an ethical approach." Eurasia Journal of Mathematics, Science and Technology Education **5**(3): 267-276.

Ayer. (1998). Teaching for Social Justice: A Democracy and Education Reader. New York: New Press and Teachers College Press.

Bartell, T. G. (2013). Learning to Teach Mathematics for Social Justice: Negotiating Social Justice and Mathematical Goals. *J. Res. Math. Educ., 44*(1), 129-163.

Bartell, T. G. (2013). "Learning to Teach Mathematics for Social Justice: Negotiating Social Justice and Mathematical Goals." J. Res. Math. Educ. **44**(1): 129-163.

Bazeley. (2007). *Qualitative data analysis with Nvivo.* London: Sage.

Berner. (1993). Building conditions, parental involvement and student achievement in the District of Columbia public school system. *Urban Education, 28(1),* p. 6-29.

Boaler. (1993). The role of contexts in the mathematics classroom: Do they make mathematics more "real"? *For the Learning of Mathematics, 13*(2), 12-17.

Biesta & Tedder. 2006. How is agency possible? Towards an ecological understanding of agency as achievement. Working paper 5. Exeter: The Learning Lives Project. http://www.tlrp.org/project%20sites/LearningLives/papers/working_papers/Working_paper_5_Exeter_Feb_06.pdf

Bigelow. (2001). *Rethinking Our Classrooms: Teaching for Equity and Justice.* Rethinking Schools.

Bigelow, B. (2001). Rethinking Our Classrooms: Teaching for Equity and Justice, Rethinking Schools.

Bigelow, B. and B. Peterson (2002). Rethinking Globalization: Teaching for Justice in an Unjust World, Rethinking Schools Press.

BSNP. (2006). Model KTSP dan Model Silabus Mata Pelajaran SD/MI. jakarta: BP. Cipta Jaya.

Boaler. (2000). Identity, agency, and knowing in mathematics worlds. In J. Boaler (Ed.), Multiple perspectives on mathematics teaching and learning (pp. 171-200). Westport, CT: Ablex Publishing.

Boaler. (2003). Studying and capturing the case of the dance of agency. In N. Pateman, B. Dougherty & J. Zillox (Eds.), *Proceedings of 27th annual conference of the International Group of Psychology of Mathematics Education* (Vol. 1, pp. 3-16). Hawaii: PME.

Borgatti, (2005). Introduction to grounded theory. Retrieved 6 June 2012, from http://www.analytictech.com/mb870/introtogt.htm

Boylan, M. (2009). Engaging with issues of emotionality in mathematics teacher education for social justice. *Journal of Mathematics Teacher Education, 12*(6), 427-443. doi: 10.1007/s10857-009-9117-0

Boylan, M. (2009). "Engaging with issues of emotionality in mathematics teacher education for social justice." Journal of Mathematics Teacher Education **12**(6): 427-443.

Broomes, D. (1989). The Mathematical Demands of a Rural Economy, in Keitel, C., Damerow, P., Bishop, A., Gerdes, P. Mathematics, education and society. United Nations Educational Scientific: Paris.

Bullock. (2007). The relationship between school building conditions and student achievement at the middle school level in Commonwealth of Virginia. Retrieved March, 2014 from http://scholar.lib.vt.edu/theses/available/etd-08212007-163313/unrestricted/calvinbullock.pdf

Chapman. (2003). Alternative approaches to assessing student engagement rates. *Practical Assessment, Research & Evaluation,* 8(13).

Chapman, T. K. and N. Hobbel (2010). *Social Justice Pedagogy Across the Curriculum: The Practice of Freedom*, Taylor & Francis.

Chapman, T. K., & Hobbel, N. (2010). *Social Justice Pedagogy Across the Curriculum: The Practice of Freedom*: Taylor & Francis.

Charmaz. (2000). Grounded theory: Objectivist and constructivist methods. In N. K. denzin & Lincoln (Eds.), *Handbook of qualitative research (2nd ed., p. 509-536).* Thousand Oaks, CA: Sage.

Chen & Horschn. (2004). *Effective partnering for school change: Improving early childhood education in urban classrooms.* New York: Teachers College Press.

Cipolle. (2010). *Service learning and Social Justice: Engaging Students in Social Change.* UK: Rowman & Littlefield.

Coleman, et.al. (1966) Equality of Educational Opportunity Report. U.S. Government Printing Office, Washington D.C.

Cohen et.al., (2000). *Research Methods in Education*. Routledge: London.

Coley, R. J. (2002). *An uneven start: Indicators of inequality in school readiness*. Princeton, NJ: Educational Testing Service.

Connolly. (1981). Freire, praxis, and education. In Mackie, R. (Ed.). *Literacy and revolution: The pedagogy of Paulo Freire*. New York: Continuum Press.

Cooperstein. (2004). Beyond active learning: a constructivist approach to learning. *Reference Services Review, 32(2).* P. 141-148.

Creswell, J. (1998). *Qualitative inquiry and research design: Choosing among five traditions*. Thousand Oaks, CA: Sage.

Creswell, J. (2002). *Educational research: planning, conducting, and evaluating quantitative and qualitative research / John Creswell*.

Cresswell, J.W (2005) *Educational research: Planning conducting and evaluating qualitative and quantitative research (2nd ed.),* Upper Saddle River, New Jersey, Merrill.

Creswell, J. (2008). *Qualitative Inquiry and Research Design: Choosing Among Five Approaches (2nd)*. Thousand Oaks, CA: Sage.

Croom. (1997). Mathematics for All Students: Access, Excellence, and Equity. In *Multicultural and Gender Equity in the Classroom: The Gift of Diversity.* Yearbook of the NCTM. p. 1-9. Croom, L. (1997). Mathematics for all students: Access, excellence, and equity.

Davidson, N. (1990). *Cooperative learning in mathematics, A handbook for teachers*. Menlo Park, California: Addison-Wesley Publishing Company.

Depdiknas. (2003). *Kurikulum Berbasis Kompetensi*. Balitbang: Jakarta.

De Haan. (2010). Local workshops in PMRI: learning from experiences. In R. Sembiring, K. Hoogland & M. Dolk (Eds.), *A decade of PMRI in Indonesia*. Bandung, Utrecht: APS International.

Denzin, N. & Lincoln, Y. (eds.) (1994) *Handbook of Qualitative Research*. Thousand Oaks, CA: Sage.

Denzin. (2000). *Handbook of Qualitative Research, 2nd edn.* Thousand Oaks, Sage.

Dick. (1999). What is action research? (Online). Available at http://www.scu.edu.au/schools/gcm/ar/whatisar.html

Dick. (2001). Grounded theory and action research can be both used as emergent, data driven methodologies.

Dick. (2003) *What can action researchers learn from grounded theorists?* Paper prepared for the research symposium at the Australia and New Zealand ALARPM/SCIAR conference, Gold Coast, 4-5 May 2003.

Dick. (2010). What can grounded theorists and action researchers learn from each other? In Bryant, A. Charmaz, K. 2010. *The SAGE Handbook of Grounded Theory: Paperback Edition*. SAGE Publications.

Dickinson. 2012. Using Realistic Mathematics Education in UK classroom.

Documenter of Papua 2004 Scoping the Educator, uploaded on February 11. (2008) that can be downloaded from http://www.youtube.com/watch?v=SESx6qazZwY

Dowker, A. (2005). *Individual Differences in Arithmetic*. Hove: Psychology Press.

Earthman. (2002). *School facility conditions and student academic achievement, Retrieved April 4, 2014,* from http://mfc205.wikispaces.com/file/view/wws08-Earthman.pdf/152320791/wws08-Earthman.pdf

Ebbutt, D. (1985). Educational action research: Some general concerns and specific quibblers. In R.G. Burgess (Ed.), *Issues in educational research: Qualitative methods* (pp. 152-174). London: The Falmer Press.

Ebrahim, G. J., & Sullivan, K. R. (1995). *Mother and child health: Research methods*. London: Book-Aid.

Edward. (1991). *Building conditions, parental involvement and student achievement in the D. C public school system*. Georgetown University. Master's Thesis.

Empson. (2002). Is teaching mathematics for understanding sufficient? *Journal of Curriculum Studies, 34 (5), pp.* 589-602.

Ernest. (1989). The impact of Beliefs on the Teaching of Mathematics. In *Mathematics Teaching: The State of The Art ed. P. Ernest, p. 249-254.* London: Falmer Press.

Ernest, P. (2002a). Empowerment in mathematics education. *Journal of Philosophy of Mathematics Education*. Retrieved from http://people.exeter.ac.uk/PErnest/pome15/empowerment.htm

Ernest, P. (2002b). What is empowerment in mathematics education? In p. Valero and O. Skovsmose, (Eds.), Proceedings of the 3rd International MES conference (p. 1-12). Copenhagen: Centre for Research in Learning Mathematics.

Ernest, P. (2007). Epistemological Issues in the Internationalization and Globalization of Mathematics Education. In B. Atweh, A. Barton, M. Borba, N. Gough, C. Keitel, C. Vistro-Yu & R. Vithal (Eds.), *Internationalisation and Globalisation in Mathematics and Science Education* (pp. 19-38): Springer Netherlands.

Ernest, P. (2007). Epistemological Issues in the Internationalization and Globalization of Mathematics Education. *Internationalisation and Globalisation in Mathematics and Science Education*. B. Atweh, A. Barton, M. Borba et al., Springer Netherlands**:** 19-38.

Faulkner & Cain. (2013). Improving the mathematical content knowledge of general and special educators: evaluating a professional development module that focuses on number sense. *Teacher Education and Special Education: The Journal of the Teacher Education Division of the Council for Exceptional Children, 36(2),* p. 115-131.

Fauzan. (2002). *Applying Realistic Mathematics Education in Teaching Geometry in Indonesian Primary Schools.* Thesis University of Twente. Enschede: Print Partners Ipskamp Press.

Fennema & Franke. (1992). Teacher's knowledge and its impact. In D. A. Grouws (Ed.), *Handbook of research on mathematics teaching and learning.* (p. 147-164). New York: McMillan.

Ferguson. (1998). Teachers perceptions and expectations and Black-White test score gap. In C. Jencks & M. Phillips (Eds.) *The Black-White test score gap* (p. 273-317). Washington DC: Brookings Institution Press.

Ferreira. (2001). The Effect of an After-School Program Addressing the Gender and Minority Achievement Gaps in Science, Mathematics, and Engineering. In *ERS Spectrum, 19 (2)*. p. 11-18. ERIC.

Foucault. (1972). *The archaeology of knowledge.* New York: Pantheon.

Fosnot, C.T. & Dolk, M.L.A.M. (2001). Young mathematicians at work: constructing number sense, addition, and subtraction. Heinemann: Portsmouth.

Frankenstein. (1987). Critical mathematics education: An application of Paulo Freire's epistemology. In I. Shor (Ed), *Freire for the classroom: a source book for liberatory teaching,* (pp. 180-210). Portsmouth, NH: Boyton/Cook.

Freire. (1970). *Pedagogy of the oppressed*. Translated by M. B. Ramos. New York: Seabury Press.

Freire. (1998). *Pedagogy of freedom*. Lanham, MI: Rowman & Littlefield Publishers.

Freudenthal, H. (1973). *Mathematics as an educational task*. Dordrecht: Reidel Publishing Company.

Freudenthal. (1983). *Didactical Phenomenology of Mathematical Structures*. Riedel Publishing Company. Dordrecht, The Netherlands.

Freudenthal. (1991). *Revisiting Mathematics Education*. China Lectures. Kluwer Academic Publishers, Dordrecht, The Netherlands.

Frezier & Sterling. (2005). What should my Science Classroom Rules Be and How can I Get my Students to Follow Them? *Clearing House*, 79(1), p. 31-35.

Fuchs. (2007). *Agency (and intention)*. In Blackwell Encyclopedia of Sociology, ed. Ritzer. Blackwell Reference Online.(http://www.blackwellreference.com/public/tocnode)

Gates, P., & Jorgensen, R. (2009). Foregrounding social justice in mathematics teacher education. *Journal of Mathematics Teacher Education, 12*(3), 161-170. doi: 10.1007/s10857-009-9105-4

Garii. (2013). Crossing the great divide: teacher candidates, mathematics, and social justice. *Teaching and Teacher Education, 34, p. 198-213*.

Garii. (2009). Integrating social justice with mathematics and science: Ann analysis of student Teacher Lessons. *Teaching and Teacher Education, 25(3).* p. 490-499.

Gates, P. and R. Jorgensen (2009). Foregrounding social justice in mathematics teacher education. *Journal of Mathematics Teacher Education*, **12**(3). p. 161-170.

Gellert, Jablonka, & Keitel. (2001). Mathematical literacy and common sense in mathematics education. In Atweh, Forgasz & Nebres (Eds.). *Sociocultural research on mathematics education: An international perspective.* Mahwah: Erlbaum, 57-73.

Gijse. (2010). Towards a democratic future: interview with six founding fathers. In R. Sembiring, K. Hoogland & M. Dolk (Eds.), *A decade of PMRI in Indonesia*. Bandung, Utrecht: APS International.

Gravemeijer, K. (1994). *Developing realistic mathematics education = ontwikkelen van realistisch reken/wiskundeonderwijs / Koeno Gravemeijer*. Utrecht: Utrecht: CD-B Press.

GRAVEMEIJER and J. TERWEL (2000). Hans Freudenthal: a mathematician on didactics and curriculum theory. J. CURRICULUM STUDIES, 2000, VOL. 32, NO. 6, 777- 796.

Gregson. (2012). *The equity practice of mathematics teachers in a secondary school committed to community connection, social justice, and college preparation*. http://hdl.handle.net/2142/34401. Dissertation. University of Illinois at Urbana-Champaign.

Gutstein. (2003). Teaching and learning mathematics for social justice in an urban, Latino school. *Journal for Research in Mathematics Education, 34 (1).* p. 37.

Gutstein. (2004). Rethinking mathematics: Teaching social justice by the Numbers. Milwaukee: Rethinking Schools.

Gutstein. (2006). *Reading and writing the world with mathematics: Toward a pedagogy for social justice / Eric Gutstein*. London: London: Routledge.

Gutstein. (2007). Possibilities and challenges in teaching mathematics for social justice. *Philosophy of Mathematics Education Journal*. Retrieved from http://

Gutstein. (2008). Reinventing Freire: mathematics education for Social transformation. In J.f. Matos, p. Valero & k. Yasukawa (eds.) Proceedings of the fifth international mathematics education and society conference. Lisbon: centro de investigação em educação, Universidade de lisboa – department of Education, learning and philosophy, Aalborg University.

Gutstein, E. (2012). *Reading and Writing the World with Mathematics: Toward a Pedagogy for Social Justice*. Hoboken: Hoboken: Taylor and Francis.

Giroux. (1986). *The politics of schooling and culture.* Orbit, 17(4) p. 10-11.

Giroux. (2010). Rethinking Education as the Practice of Freedom: Paulo Freire and the Promise of Critical Pedagogy.

Gonzalez, L. (2009). Teaching mathematics for social justice: Reflections on a community of practice for urban high school mathematics teachers. *Journal of Urban Mathematics Education*, 2(1), 22-51. Retrieved from http://education .gsu.edu/JUME.

Gresalfi, Martin, Hand & Greeno. (2009). Constructing competence: An analysis of student participation in the activity system of mathematics classroom. *Educational Studies in Mathematics, 70 (1),* pp. 49-79.

Guba. (1981). Criteria for assessing the trustworthiness of naturalistic inquiries. *Educational Resources Information Center Annual Review Paper,* 29, 75-91.

Hannaford. (1998). Mathematics Teaching is Democratic Education. *Zentralblatt fur Didaktik der Mathematics*, 98(6), 181-187.

Hadi. (2012). *Mathematics education reform movement in Indonesia.* Paper presented at the annual meeting of the 12th International Congress on Mathematical Education. (ICME). Seoul: 8-15 July, 2012. Retrieved from www.icme12.org/upload/submission/1897_F.pdf.

Hayes, D., et al. (2005). Teachers and Schooling Making a Difference: Productive Pedagogies, Assessment and Performance, Allen & Unwin.

Hayes, Mills et al (2006). *Teachers and schooling making a difference: productive pedagogies, assessment and performance*. Sydney: Allen and Unwin.

Helme & Clarke. (2001). Identifying cognitive engagement in the mathematics classroom. *Mathematics Education Research Journal, 13(2),* p. 133-153.

Henderson & Mapp. (2002). *A new wave of evidence. The impact of school, family, and community connections on student achievement. Annual synthesis.* Austin, TX: National Center for Family & Community Connections with Schools. Southwest Educational Development Laboratory.

Hendricks. (2006). *Improving schools through action research: A comprehensive guide for educators.* Boston, MA: Allyn & Bacon.

Hiebert. (1996). Problem solving as a basis for reform in curriculum and instruction: The case of mathematics. *Educational Researcher, 25,* p. 12-21.

Hill. (2005). Effects of Teachers' Mathematical Knowledge for Teaching on Student Achievement. *American Educational Research Journal Summer, 42(2),* p. 371-406.

Hill & Ball. (2004). Learning mathematics for teaching: Result from California's mathematics professional development institutes. *Journal for Research in Mathematics Education, 35(5)*. Reston: US.

Hill, Sleep, Lewis & Ball. (2007). Assessing teachers' mathematical knowledge. In F. K. Lester (Ed.). *Second Handbook of Research on Mathematics Teaching and Learning.* P. 111-220. Charlotte, NC: IAP.

Holland, Lachiotte, Skinner & Cain. (1998). *Identity and agency in cultural worlds.* Cambridge, MA: Harvard University Press.

Holly. (2009). *Action Research for Teachers: Traveling the Yellow Brick Road*. Allyn & Bacon, Boston, Mass, USA, 3rd edition.

Hughes. (2007). The influence of student-teacher and parent-teacher relationships on lower achieving readers' engagement and achievement in the primary grades. *Journal of Educational Psychology, 99,* p. 39-51.

Indonesia. (1968). *The 1945 constitution of the Republic of Indonesia*. Jakarta]: [Jakarta] : Department of Information, Republic of Indonesia.

Jacobsen, L. J., & Mistele, J. M. (2010). Please don't do "Connect the dots": Mathematics lessons with social issues. *Science Education and Civic Engagement: An International Journal*, *2*(2), 5-11.

Jeremy, K. (2009). The Mathematics Teacher and Curriculum Change (El Profesor de Matemáticas y el Cambio de Currículo). *PNA: Revista de investigación en Didáctica de la Matemática*, *3*(3), 107.

Jones. (1981). *Responsible Classroom Discipline*. Boston: Allyn and Bacon, Inc.

Johnson & Johnson. (1999). *Learning together and alone: Cooperative, competitive, and individualistic learning (5th Ed.).* Boston: Allyn & Bacon.

Karp. (2003). Equity Claims Don't Pass the Test. Rethinking Schools.

Kemmis, S. and McTaggart, R. (2000). Participatory action research. In N. Denzin and Y. Lincoln (Eds.), *Handbook of Qualitative Research (2nd Ed.) (pp. 567-605).* Thousand Oaks CA: Sage.

Kincheloe. (2000). Contextualizing teaching. New York: Longman.

Klein. (2000). Is there more to numeracy than meets the eye?: Stories of socialization and subjectification in school mathematics. In J. M. Bana, J. & A. Chapman (eds.), *Mathematics Education beyond 2000* (Proceedings of the 23rd Annual Conference of the Mathematics Education Research Group of Australasia, Fremantle, pp. 72-78). Fremantle: MERGA.

Knapp, M.S. (1995). *Teaching for meaning in high poverty classrooms.* New York: Teachers. College Press.

Kohn, A. (2000). *The Schools Our Children Deserve: Moving Beyond Traditional Classrooms and "tougher Standards"*: Houghton Mifflin Company.

Kolman, L., Noorderhaven, N. G., Hofstede, G., & Dienes, E. (2003). Cross-cultural differences in Central Europe. (Hofstede's dimensions of national cultures) (Abstract). *Journal of Managerial Psychology*, 76.

Kong, Wong et al. (2003). Student engagement in mathematics: Development of instrument and validation of construct. *Mathematics Education Research Journal*, 15(*1)*, p. 4-21.

Kuku, A. (1995). Mathematics education in Africa in relation to other countries. In R. Hunting, G. Fitzsimons, P. Clarkson & A. Bishop (Eds.), *Regional collaboration in mathematics education*, (pp. 403-423). Melbourne: Monash University.

Kumashiro. (2009). *Against common sense: Teaching and learning toward social justice.* Taylor & Francis.

Krol. (2004). Effects of a cooperative learning program on the elaborations of students in dyads. *Educational Research and Evaluation, 10(3),* 205-237.

Leonard, J., Brooks, W., Barnes-Johnson, J., & Berry, R. Q. (2010). The nuances and complexities of teaching mathematics for cultural relevance and social justice. *Journal of Teacher Education, 61*(3), 261-270.

Leron & Dubinsky. (1995). An abstract algebra story. *American Mathematical Monthly, 102(3),* p. 247-272.

Lewin. (1946). Action research and minority problems. *Journal of Social Issues, 2(4),* p. 34-46.

Lincoln, Y., & Guba, G. (1989). *Naturalistic inquiry*. Beverly Hills, CA: Sage Publications.

Lubienski. (2002). Are we achieving mathematical power for all? A decade of national data on instruction and achievement. *American Educational Research Association* (p. 1-42). New Orleans: American Educational Research Association.

Lubienski. (2007). What we can do about achievement disparities. *In Making mathematics count, 65(3),* p. 54-59.

Malloy. (2002). Democratic access to mathematics through democratic education: An introduction. In L.D. Englisg (Ed.), *Handbook of international research in mathematics education: Directions for the 21st century* (pp. 17-26). Mahwah, USA: Lawrence Erlbaum.

Mandela, N. (1994). Long walk to freedom : the autobiography of Nelson Mandela. Boston, Boston : Little, Brown.

Marshall & Rossman. (1999). Designing Qualitative Research 3rd edition. SAGE Publications.

Marshall & Gretchen B. Rossman. (2006). Designing Qualitative Research. Sage Publications.

McDonald. (2008). The pedagogy of assignments in social justice teacher education. *Equity & Excellence in Education*, 41(2), p. 151-167.

McDougall. (2005). Scaffolded growth of knowledge using distributed collaborative learning tools in preservice teacher education. Thesis. Queensland University of Technology. Brisbane.

Merriam. (1998). *Qualitative research and case study applications in education.* San Francisco: Jossey-Bass.

Mewborn. (2003). Teaching, teachers' knowledge, and their professional development. In J. Kilpatrick, W. G. Martin, & D. Schifter (Eds.). *A research companion for NCTM Standard* (p. 45-52). Reston, VA: National Council for Teachers of Mathematics.

McNiff, J. (1992). *Action Research Principles & Practice*. London: Routledge.

McNiff. (1997). Action research: Principles and Practice. Chatham. Kent: MacKays of Chatham.

Merriam, S. (1998). *Qualitative research and case study applications in education / Sharan B. Merriam.*

Mertler, C. (2009). *Action research: teachers as researchers in the classroom / Craig A. Mertler*.

Miller. (2013). Unlocking Engagement Through Mathematical Discourse. *Best Practices for Student Engagement, 8(7).* Retrieved from http://www.ascd.org/ascd-express/vol8/807-miller.aspx

Mills, G. (2000). *Action research: a guide for the teacher researcher / Geoffrey E. Mills.*

Mills. (2003). Action research: A guide for the teacher researcher. Upper Saddle River, NJ: Merrill/ Prentice Hall.

Morrisett, L. N., & Vinsonhaler, J. (Eds.). (1965). Mathematical learning. *Monographs of the Society for Research in Child Development*, 30(1).

NCTM. (1989). Curriculum and evaluation standards for school mathematics. Reston, VA: NCTM.

NCTM. (2000). Principles and standards for school mathematics, Volume 1. Reston, VA: NCTM.

Newman. (1989). Student engagement and high school reform. *Educational Leadership, 46(5).* p. 34-36.

Newmann. (1991). Student engagement in academic work: Expanding the perspective on secondary school effectiveness. In J. R. Bliss, W. A. Firestone, & C. E. Richards (Eds.), *Rethinking effective schools: Research and practice (pp. 58-75).* Englewood Cliffs, NJ: Prentice-Hall.

Newmann. (1994). Five standards of authentic instruction. In K. M. Cauly, F. Linder & J. H. McMillan (Eds.), *Educational psychology, 95(95).* p. 157-160. Guilford, CT: The Dushkin Publishing Group, Inc.

Newmann, Wehlage, & Lamborn. (1992). The significance and sources of student engagement. In F. Newmann (Ed.), *Student engagement and achievement in America secondary schools* (pp. 11-39). New York, NY: Teachers College Press.

Niss, M. (1996). Goals of Mathematics Teaching. In A. Bishop, K. Clements, C. Keitel, J. Kilpatrick & C. Laborde (Eds.), *International Handbook of Mathematics Education* (Vol. 4, pp. 49-97): Springer Netherlands.

Obodo. (2002). *Development of positive attitude and interest and mathematics students in Nigerian secondary schools*. Paper presented during the Mathematical Science Education Summit.

OECD. (2003). The PISA 2003 assessment framework: Mathematics, reading, science and problem solving knowledge and skills. Paris, France: OECD.

OECD. (2004). PISA Learning for Tomorrow's World First Results from PISA 2003: First Results from PISA 2003. OECD Publishing.

Osler, J. (2007). A Guide for Integrating Issues of Social and Economic Justice into Mathematics Curriculum. Radical Math. Accessed on December 14, 2011. http://radicalmath.org/main. php?id=resources.

Park. (2005). Student engagement and classroom variables in improving mathematics achievement. *Asia Pacific Education Review*, 6(1): 87-97.

Patrinos, H. A. (2009). *The Role and Impact of Public-Private Partnerships in Education.* Washington, Washington : World Bank Publications.

Patton. (2002). *Qualitative research and evaluation methods (3rd ed.).* Thousand Oaks, CA: Sage.

Peraturan Menteri Pendidikan Nasional. (2006). No 24, Pelaksanaan SI dan SKL [Ministerial of National Education Decree No 24, The implementation of Content Standards and Graduate Competency Standards].

Peraturan Menteri Pendidikan dan Kebudayaan No. 68. 2013. *Kerangka Dasar dan Struktur Kurikulum Sekolah Dasar/Madrasah Ibtidaiyah*.

Peterson. (2001). *Rethinking our classrooms, volume 2: teaching for equity and justice* / [edited by Bill Bigelow ... et al.].

Pianta. (2012). Teacher student relationships and engagement: Conceptualizing, measuring, and improving the capacity of classroom interaction. In *Handbook of research on student engagement.* New York: Springer.

Pickering. (1995). *The Mangle of Practice: Time, Agency, and Science*. Chicago: University of Chicago Press.

Powell. (2006). Socially emergent cognition: Particular outcome of student to student discursive interaction during mathematical problem solving. *Horizontes, 24(1).* p. 33-42.

Pugalee. (2001). Using communication to develop students' mathematical literacy. *Mathematics teaching in the middle school, 6*(5), 297-299.

Robinson. Uploaded, 14 Oct 2010. RSA Animate: Changing Education Paradigms. http://www.youtube.com/watch?v=zDZFcDGpL4U

Romberg, T. A. (1992). *Mathematics assessment and evaluation: Imperatives for mathematics educators* State University of New York Press, State University Plaza, Albany, NY 12246 (paperback: ISBN-0-7914-0900-7; clothbound: ISBN-0-7914-0899-X). Retrieved from http://search.proquest.com/docview/62692894?accountid=10382

Romo, J. & Chavez, C. (2006). Border pedagogy: A study of preservice teacher transformation. *The Educational Forum 70*(2), 142-154.

Schon, D.A. (1996). *Educating the reflective practitioner: Toward a new design for teaching and learning in the professions.* San Francisco: Jossey-Bass, Inc.

Schoenfeld. (1988). Problem solving in context. In R. Charles & E. Silver, *The teaching and assessing of mathematical problem solving (pp. 82-92)*. Reston, VA: NCTM.

Schoenfeld. (2007). Reflection on an assessment interview: What a close look at student understanding can reveal. In A. H. Schoenfeld (Ed.), *Assessing mathematical proficiency (p. 269-277).* Cambridge: Cambridge University Press.

Seeger. (2011). On meaning making in mathematics education: social, emotional, semiotic. *Educational Studies in Mathematics, 77(2-3)*, p. 207-226.

Seeley. (2004). *Engagement as a tool for equity*. NCTM News Buletin: NCTM.

Sembiring, R., Hoogland, K., & Dolk, M. (2010). Introduction to: A decade of PMRI in Indonesia. In R. Sembiring, K. Hoogland & M. Dolk (Eds.), *A decade of PMRI in Indonesia*. Bandung, Utrecht: APS International.

Skovsmose. (2011). Scripting The World In Mathematics And Its Ethical Implications. *Philosophy of Mathematics Education Journal*, *26*.

Sriraman, B., and Knott, L. (2009). The mathematics of estimation: Possibilities for interdisciplinary pedagogy and social consciousness. *INTERCHANGE: A Quarterly Review of Education*, 40(2), 205–223.

Sriraman, B.(2008). *International perspectives on social justice in Mathematics education*. Charlotte, NC: IAP.

Sriraman, B. (2009). *Social justice and mathematics education: issues, dilemmas, excellence and equity*. Retrieved from *people.exeter.ac.uk/...*

Steinberg. (1994). *Toward instructional reform in the math classroom: A teacher's process of change.* Retrieved from http://search.proquest.com/docview/62709354?accountid=10382

Stemhagen, K. (2009). Social justice and mathematics: Rethinking the nature and purposes of school mathematics. In P. Ernest, B. Greer, &B. Sriraman (Eds.), *Critical Issues in Mathematics Education* (pp. 337- 350). Charlotte, NC: Information Age Publishing.

Stipek, D.J. (2002) Good instruction is motivating. In A. Wigfield and J. Eccles (Eds.), *Development of achievement motivation* (pp. 309-332). San Diego, CA: Academic press.

Strauss & Corbin. (1990). *basics of qualitative research: Grounded theory procedures and techniques.* Newbury Park, CA: Sage.

Strike. (1990). The ethics of educational evaluation. In J. Millman and L. Darling Hammond (eds), *A new handbook of teacher evaluation.* Newbury Park, CA: Corwin.

Stringer. (1999). *Action research: Qualitative Series Action Research*. Sage Publications.

Susanto. (2013). The Jakarta Post, Bantul | National | Mon, July 15 2013, 1:07 PM. http://www.thejakartapost.com/news/2013/07/15/2013-curriculum-launched-bantul.html.

Swope. (2006). Teaching to Make a Difference: Advice to New Teachers from Teachers Who've Been There. *PennGSE Perspectives on Urban Education*. Volume 4 Issue 1.

Tate. (1995). Returning to the root: A culturally relevant approach to mathematics pedagogy. *Theory into Practice, 34(3),* p. 166-173.

The hungry planet photo study: what the world eats on http://world.time.com/2013/09/20/hungry-planet-what-the-world-eats/, by Peter Menzel and Faith D'Alusio.

Tracy. (2010). Qualitative quality: Eight "big-tent" criteria for excellent qualitative research. *Qualitative Inquiry*, 16: 837-851.

Treffers, A. (1987). *Three dimensions: A model of goal and theory description in mathematics education: The Wiskobas Project.* Dordrecht: Reidel.

Tschannen-Moran, M., Woolfolk-Hoy, A., & Hoy, W. (1998). Teacher efficacy: Its meaning and measure. *Review of Educational Research, 68(2),* 202-248.

Turner (2009). "Everything is math in the whole world": Integrating critical and community knowledge in authentic mathematical investigations with elementary Latino / a students. Mathematical Thinking and Learning, 11(3), 136–157.

Turner. (2010). Critical Mathematical Agency in the Overcrowding at Francis Middle School Project. in Empowering Science and Mathematics Education in Urban Communities Edna Tan & Angela Calabrese Barton. July 19, 2010.

UNESCO. (2009). Indonesia-UNESCO country programming document 2008-2011. United Nations Educational, Scientific and Cultural Organization: Jakarta.

Van den Heuvel-Panhuizen. (2000). *Mathematics education in the Netherlands: A guided tour.* Freudenthal Institute CDRom for ICME9. Utrecht: Utrecht University.

Valero, P. (2004). Postmodernism as an attitude of critique to dominant mathematics education research. In Walshaw, *Mathematics Education Within Postmodern. International Perspectives on Mathematics Education* (pp. 35-54). Greenwich, Conn. : IAP Information Age Pub.

Van den Heuvel Panhuizen. (1998). Realistic Mathematics Education: Work in progress. In T. Breiteig and G. Brekke (Eds.), Theory into practice in Mathematics Education. Kristiansand, Norway: Faculty of Mathematics and Science.

Van den Heuvel Panhuizen. (2000). Mathematics education in the Netherland: A guided tour. *Freudenthal Institute Cd-rom for ICME9.* Utrecht: Utrecht University.

Van den Heuvel-Panhuizen. (2001). Realistic Mathematics Education in the Netherlands. In J. Anghileri (Ed.). *Principles and practice in arithmetic teachin*g (pp. 49-63). Buckingham/Philadelphia: Open University Press.

Van den Hoven. (2010). PMRI: a rolling reform strategy in process. In R. Sembiring, K. Hoogland & M. Dolk (Eds.), *A decade of PMRI in Indonesia*. Bandung, Utrecht: APS International.

Vartuli. (2005). Beliefs: The heart of teaching. *Young Children, 60*(5), p. 76-86.

Walshaw. (2006). Classroom Arrangements That Benefit Students. http://www.merga.net.au/documents/RP612006.pdf

Wittgenstein. (1953). Philosophical investigations. New York: MacMillan Publishing Co.

Wu. (2011). Basic Characteristics Important for K–12 Math Teaching. *math.berkeley.edu/~wu/School**mathematics**1.pdf.* www.freeworldmaps.ne. (02-11-2013)

Yeom, M.-H., Acedo, C., & Utomo, E. (2002). The Reform of Secondary Education in Indonesia during the 1990s: Basic Education Expansion and Quality Improvement through Curriculum Decentralization. *Asia Pacific Education Review*.

Young. (1990). Justice and the politics of difference. NJ: Princeton University.

Zevenbergen. (2000). Cracking the Code of Mathematics: School success as a function of linguistic, social and cultural background. In J. Boaler (Ed.), *Multiple perspectives on Mathematics Teaching and Learning.* New York: JAI/Ablex.

Zevenbergen. (2001). Language, social class, and underachievement in school mathematics. In P. Gates (Ed.), *Issues in Mathematics Teaching.* London: RoutledgeFalmer.

Zevenbergen & Niesche. (2008). Mathematics and classroom practice: Developing rich mathematical experiences for disadvantaged students. *Australian Primary Mathematics Classroom*, *13* (4), 21-27.

APPENDICES

APPENDIX A

SYLLABUS

S Y L L A B U S

NAME OF SCHOOL : SMP Al-KHAWARIZMI
SUBJECT : MATHEMATICS
GRADE/SEMESTER : VII (Seven) / 1

STANDARD OF COMPETENCE :

1. *To understand the properties of operations the numbers and capable of applying in problem solving*

BASIC OF COMPETENCE	MAIN MATERIAL	LEARNING ACTIVITIES	INDICATORS	ASESSMENT *EXAMPLES OF INSTRUMENT*	TIME	SOURCE MATERIAL
1.1 To determine estimation of operation in integers and fractions to the nearest place value.	INTEGERS AND FRACTIONS	- To discuss the rules of rounding off in integers and fractions. - To determine rounding off integers and fractions.	- To know the rules of rounding off integers and fractions. - To determine rounding off integers and fractions.	Simplify into 2 rounding off behind comma $\frac{2002}{5}$ = ...	2 x 40 `	Student Book & Worksheet
1.2 To do the operations of integers and fractions		- To discuss about the kind of integers To mention the kind of integers - To identify quantities in daily life that using integers. - To draw a number line and determine the location of integers on a number line. - To discuss about how to solve the operation of integers (addition, subtraction,	- To give some example of integers. - To classify the kind of integers. - Mention quantities in daily life that using integers. - To determine the location of integers on a number line. - To solve the operation of integers (addition, subtraction, multiplication, division, powers and roots) - To apply the operations of integers	Write 5 integers greater than – 3 and less than 10 Put these number – 1,0,and 3 on number line	23 x 40’	Student Book & Worksheet

		multiplication, division, powers and roots - To discuss about how to apply the operations of integers in problems solving. - To discuss about how to calculate the value of the exponents and radicals of integers - To mention example many form and kind of fractions (proper, improper, mixed fraction, decimal, percent and per mile - To discuss about how to change a fraction form to another fraction form. - To discuss about how to solve operations of fractions (addition, subtraction, multiplication, division, powers and roots)	in problems solving. - To calculate the value of the exponents and radicals of integers. - To give example many form and kind of fractions (proper, improper, mixed fraction, decimal, percent and per mile) - To change a fraction form to another fraction form. - To solve operations of fractions (addition, subtraction, multiplication, division, powers and roots)	Calculate 4 + (-4) = ... -3 - -(8) = ... A box contains 25 oranges, if there are 140 oranges, how many boxes should be prepared? Find $(-5)^2$ = ... 4^3 = ... $\sqrt{49}$ = ... $\sqrt[3]{-8}$ = ... write several examples of fraction in simple fraction, decimal, and percentage calculate $1\frac{1}{2}$ x $\frac{2}{3}$ = ... $\frac{3}{4}$: $\frac{1}{2}$ = ... 2,5 + .,75 = ... 21,2 – 9,85 = ...		
1.3 To apply the properties of integers and factions in problems solving.		- To discuss about how to inquire the properties of addition, subtraction, multiplication, division, powers and roots.	- To inquire the properties of addition, subtraction, multiplication, division, powers and roots. - To apply the operations of integers in problems solving (Repeated).	Fill the following blank 2 + 9 = ... 9 + 2 = ... 3 x (9 x 4) = ... (3 x 9) x 4 = ... what can you conclude from	5 x 40’	Student Book & Worksheet

			- To apply the properties of addition, subtraction, multiplication, division, powers and roots in fractions and applying in daily life.	your answers on saturday, Candra share his marbles to Aan as many as 25 and Yudha as many as 17. on sunday candra share 13 marbles to Novan. How many marbles shared by candra to Aan, Yudha, and Novan?		

STANDARD OF COMPETENCE :

2. *To understand the algebraic form, linear equations with one variable (LEOV) and linear inequalities with one variable (LIOV)*

BASIC OF COMPETENCE	MAIN MATERIAL	LEARNING ACTIVITIES	INDICATORS	ASESSMENT/ EXAMPLES OF INSTRUMENT	TIME	SOURCE MATERIAL
2.1 To know the algebraic forms and their elements.	ALGEBRAIC FORM	- To discuss about the definition of algebraic form, variable, constant, factor, term and like/unlike term.	- To explain the definition of algebraic form, variable, constant, factor, term and like/unlike term.		5 x 40′	Student Book & Worksheet
2.2 To do the operations of algebraic form.	ALGEBRAIC FORM	- To do the operations (addition, subtraction, multiplication, division, powers) of algebraic form. - To discuss about Greatest Common Factor (GCF) and Least Common Multiple (LCM) of algebraic form - To apply the operations of algebraic form in problems solving	- To do the operations (addition, subtraction, multiplication, division, powers) of algebraic form. - To explain about Greatest Common Factor (GCF) and Least Common Multiple (LCM) of algebraic form. - To apply the operations of algebraic form in problems solving	Calculate $2x + 3 + 5x - 6$ $4xy \,.\, 2x$ $(4x)^2 : 2x^2$	7 x 40′	
2.3 To solve linear equations with one variable (LEOV).	LINEAR EQUATIONS WITH ONE VARIABLE (LEOV)	- To discuss the characteristics of linear equations with one variable (LEOV). - To discuss about how to determine the equal form of linear equations with one	- To know linear equations with one variable (LEOV) in many kind form and variable. - To determine the equal form of linear equations with one variable (LEOV)	Which is LEOV of the following equation $2x + 5 = 4x$ $2xy + x^2 = 10$ $4t + 2p = 11$	7 x 40′	Student Book & Worksheet

		variable (LEOV) by both of sides add, subtract, multiply or divide to the same number - To solve the solution of linear equations with one variable (LEOV)	by both of sides add, subtract, multiply or divide to the same number. - To determine the solution of linear equations with one variable (LEOV)	find the solution of $4x - 4 = 5x + 7$		
2.4 . To solve linear inequalities with one variable (LIOV)	LINEAR INEQUALITIES WITH ONE VARIABLE	- To discuss the characteristics of linear inequalities with one variable (LIOV) - To discuss about how to determine the equal form of linear inequalities with one variable (LIOV) by both of sides add, subtract, multiply or divide to the same number - To solve the solution of linear inequalities with one variable (LIOV)	- To know linear inequalities with one variable (LIOV) in many kind form and variable. - To determine the equal form of linear inequalities with one variable (LIOV) by both of sides add, subtract, multiply or divide to the same number - To determine the solution of linear inequalities with one variable (LIOV)	Which is LEOV of the following equation $2x + 8 < 4x$ $2pq + p^2 > 10$ $4t + 2p \leq 11$ find the solution of $2x - 1\ 4 > 9x + 7$	7 x 40'	Student Book & Worksheet

STANDARD OF COMPETENCE :

3. *To use the algebraic form, linear equations with one variable (LEOV) and linear inequalities with one variable (LIOV), and proportion in problems solving.*

BASIC OF COMPETENCE	MAIN MATERIAL	LEARNING ACTIVITIES	INDICATORS	EXAMPLES OF INSTRUMENT	TIME	SOURCE MATERIAL
3.1 To make mathematics model from the problems that connected by linear equations with one variable (LEOV) and linear inequalities with one variable (LIOV)		- Teacher gives daily problem contains LEOV and LIOV - Teacher asks student to present their work in front of class - Teacher discuss the students work	- To change the problems into the mathematics model in form linear equations with one variable (LEOV) - To change the problems into the mathematics model in form linear inequalities with one variable (LIOV	Maximal of the velocity of vehicles on highway is 50 km/hr. Write in mathematical model.	5 x 40′	Student Book & Worksheet
3.2 To solve mathematics model from the problems that connected by linear equations with one variable (LEOV) and linear inequalities with one variable (LIOV)		- Discuss mathematics model from the problems that connected with linear equations with one variable (LEOV) - Discuss mathematics model from the problems that connected with linear inequalities with one variable (LIOV)	- To solve mathematics model from the problems that connected with linear equations with one variable (LEOV) - To solve mathematics model from the problems that connected with linear inequalities with one variable (LIOV)	Surya bought 2 books. He paid Rp. 10,000 and the restn Rp. 4,000. what is the price of one book? 3 years ago Pandu's age is less than 25. what is pandu's age now?	7 x 40′	Student Book & Worksheet
3.3 To use algebraic concept for solve the problems of		- Discuss the examples of selling – buying activities and describe the condition when get profit,	- To tell examples of selling – buying activities and describe the condition when get profit, loss or paid off.		7 x 40′	Student Book & Worksheet

simple social arithmetic		loss or paid off. - Determine the profit or loss if the selling price and the buying price given. - Determine selling price if percentage profit/loss and buying price is given. - Determine buying price if percentage profit/loss and selling price is given. - Determine the price if given discount or percentage of discount and the price before get discount. - Determine interest if percentage of interest, time of saving and amount of saving is given	- To calculate the whole value, each unit value and partial value. - To determine the profit or loss if the selling price and the buying price given. - To determine selling price if percentage profit/loss and buying price is given. - To determine buying price if percentage profit/loss and selling price is given. - To determine the price if given discount or percentage of discount and the price before get discount. - To determine interest if percentage of interest, time of saving and amount of saving is given	Pak Rifki sold ahis TV for Rp 1,650,000, and get 10% of profit. How much are the buying price? Ali save his money Rp. 347,000 at a simple interest rate of 16% a year. How much the amount of interest that Ali get at the second year?		
3.4. To use proportion for solve the problem		- Explain the definition of scale as a proportion. - Count gain and reduction factor in scale picture.	- To explain the definition of scale as a proportion. - To count gain and reduction factor in scale picture.	A road is 5 km of long and draw as long as 5 cm long. What is the drawing scale?	10 x 40′	Student Book & Worksheet

		- Tell examples in daily life that it is a direct proportion and an inverse proportion. - Solve the problems in daily life that it is a direct proportion and an inverse proportion.	- To tell examples in daily life that it is a direct proportion and an inverse proportion. - To solve the problems in daily life that it is a direct proportion and an inverse proportion.	A building built in 6 months if it is doing by 100 peoples. If it is doing by 50 peoples, how long does the building finished built?		

Acknowledgment
Principal of SMP AL-KHAWARIZMI

H.Muhammad Azis, S.Pd
NIK.148/PIA 133

Makassar, July 2O10
Mathematics Teacher

Bakry, S.Pd,M.Si

APPENDIX B

INFORMATION SHEET & CONSENT FORM

Curtin University

Curtin University
Science and Mathematics Education Centre
Students' and Parent's/Guardians' Information Sheet

Dear Students,

My name is Nurwati. I am currently completing a research project for my Doctoral degree at Curtin University. I would like to invite you to consider taking part in the action research on the Application of the Realistic Mathematics Education (RME) Approach with a Focus on Social Justice in Teaching and Learning Mathematics.

Purpose of Research
I will work with your teachers in trial a new way of teaching mathematics which employ real life problem solving including social justice issues.

Your Role
I am interested in finding out about your opinions regarding the application of the approach in the mathematics lesson. We will use a questionnaire and student task that will take 15 minutes to respond to and an interview within a group discussion that will take approximately 1 hour.

Consent to Participate
Your involvement in the research is entirely voluntary. You have the right to withdraw at any stage of the research. When you have signed the consent form, we will assume that you have agreed to participate and allow us to use your data in this research. Your parent/guardian has signed the consent form.

Confidentiality
The information you provide will be kept separate from your personal details, and only us and the supervisor will have access to this. The interview transcript will not have your name or any other identifying information on it.

Further Information
This research has been reviewed and given approval by Curtin University Human Research Ethics Committee (**SMEC XXXX**). If you would like further information about the study, please feel free to contact us. If you would like further information about the research, please feel free to contact me on 0433880566 or by email: nurwati_djaman@yahoo.co.id or nurwati.djaman@postgrad.curtin.edu.au. Alternatively, you can contact my supervisor, A/Professor Bill Atweh on +618 9266 7073 or b.atweh@curtin.edu.au

Thank you very much for your considerations on taking parts this research. Your participation is greatly appreciated.

Yours sincerely,

Nurwati

Curtin University

Curtin University
Science and Mathematics Education Centre

Teachers' Information Sheet

Dear Teacher,
My name is Nurwati and I am currently completing a research project for my Doctoral degree at Curtin University. My research title is *Application of the Realistic Mathematics Education (RME) Approach with a Focus on Social Justice in Teaching and Learning Mathematics.* I invite you to consider taking part in this research. This study will meet the requirements of The Research Ethics Committee.

Purpose of Research
The objectives of this research are: 1) to incorporate an innovative approach called PMRI in teaching mathematics for social justice within the Indonesian curriculum, 2) to investigate the effects of the approach on students' in term of mathematical learning, engagement, and knowledge about social justice issues, 3) to investigate the effects of socio-economic background on students' performance, 4) to investigate the professional growth of teacher as a trajectory of participation in the practices of the implementation of the approach, and 5) to examine the appropriateness of the approach in Indonesia.

Your Role
In participating in this research you will be ask to:
1. Attend 2 days workshop in week 1 of July 2012 to introduce and practice about the approach.
2. Develop some activity sheets for students related to social justice issues.
3. Allow me to observe your teaching practice in your mathematics classroom when implementing this approach in teaching integer, fraction, linear inequalities, and social arithmetic topics.
4. Attend focus group discussion, formal and informal meeting to report the experiences, feeling, and self analysis of conducting the approach.
5. Ask your students to fill in a questionnaire and student tasks approximately 15 minutes.
6. Allow me to interview some students and you separately within a focus group discussion that will take approximately 1 hour.
7. Attend a conference about 3 hour in week 2 of December 2012 to share the findings and the experiences of implementation of this approach in the end of this research.

Consent to Participate
Your involvement in the research is entirely voluntary. You have the right to withdraw at any stage without it affecting your rights or my responsibilities. When you have signed the consent form I will assume that you have agreed to participate and allow me to use your data in this research.

Confidentiality

The information you provide will be kept separate from your personal details, and only myself and my supervisor will only have access to this. The interview transcript will not have your name or any other identifying information on it and in adherence to university policy, the interview tapes, podcasts and transcribed information will be kept in a locked cabinet for at least five years, before a decision is made as to whether it should be destroyed.

Further Information

This research has been reviewed and given approval by Curtin University Human Research Ethics Committee **(SMEC XXX).** If you would like further information about the study, please feel free to contact us. If you would like further information about the research, please feel free to contact us on 0433880566 or by email: nurwati_djaman@yahoo.co.id or nurwati.djaman@postgrad.curtin.edu.au. Alternatively, you can contact my supervisor, A/Professor Bill Atweh on +618 9266 7073 or b.atweh@curtin.edu.au

Thank you very much for your considerations on taking parts this research. Your participation is greatly appreciated

Yours sincerely,

Nurwati

Curtin University

Curtin University
Science and Mathematics Education Centre

Principals' Information Sheet

Dear Principal,

My name is Nurwati and I am currently completing a research project for my Doctoral degree at Curtin University. My research title is *Application of the Realistic Mathematics Education (RME) Approach with a Focus on Social Justice in Teaching and Learning Mathematics.* I invite you to consider taking part in this research. This study will meet the requirements of The Research Ethics Committee.

Purpose of Research

The objectives of this research are: 1) to incorporate an innovative approach called PMRI in teaching mathematics for social justice within the Indonesian curriculum, 2) to investigate the effects of the approach on students' in term of mathematical learning, engagement, and knowledge about social justice issues, 3) to investigate the effects of socio-economic background on students' performance, 4) to investigate the professional growth of teacher as a trajectory of participation in the practices of the implementation of the approach, and 5) to examine the appropriateness of the approach in Indonesia.

Your Role

I am interested in:

1. Interviewing you about some information about the school background.
2. Negotiating the timeline with you to minimize the disruption in your school.
3. Employing 2 days workshop in week 1 of July 2012 to your mathematics teachers to introduce and practice about the approach.
4. Observing your teachers practice in mathematics classroom, especially in the implementation of this approach.
5. Conducting focus group discussion, formal and informal meeting with the teachers to report their experiences, feeling, and self analysis of conducting the approach.
6. Asking your students in grade 7 to fill in a questionnaire and student tasks approximately 15 minutes.
7. Interviewing some students and the teachers separately within a focus group discussion that will take approximately 1 hour.
8. Facilitating a conference in week 2 of December 2012 for the teachers to share the findings and the experiences in the end of this research that will take approximately 3 hour.

Consent to Participate

Your involvement in the research is entirely voluntary. You have the right to withdraw at any stage without it affecting your rights or my responsibilities. When you have signed the consent form I will assume that you have agreed to participate and allow me to use your data in this research.

Confidentiality

The information you provide will be kept separate from your personal details, and only myself and my supervisor will only have access to this. The interview transcript will not

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Thank you very much for your considerations on taking parts this research. Your participation is greatly appreciated

Yours sincerely,

Nurwati

Curtin University

PRINCIPAL'S CONSENT FORM

- I understand the purpose and procedures of the study.
- I have been provided with the participation information sheet.
- I understand that the procedure itself may not benefit me.
- I understand that my involvement is voluntary and I can withdraw at any time without problem.
- I understand that no personal identifying information like my name, address or school will be used in any published materials.
- I understand that all information will be securely stored for at least 5 years before a decision is made as to whether it should be destroyed.
- I understand that updates of the progress of the research will be provided to me.
- I have been given the opportunity to ask questions about this research.
- I agree to participate in the study outlined to me.

Name: _____

Signature: _____

Date: _____

STUDENTS' AND PARENTS'/GUARDIANS' CONSENT FORM

- I understand the purpose and procedures of the study.
- I have been provided with the participation information sheet.
- I understand that the procedure itself may not benefit me and my child.
- I understand that my child involvement is voluntary and he/she can withdraw at any time without problem.
- I understand that no personal identifying information like my child's name, address or school will be used in any published materials.
- I understand that all information will be securely stored for at least 5 years before a decision is made as to whether it should be destroyed.
- I understand that updates of the progress of the research will be provided to me and my child.
- I have been given the opportunity to ask questions about this research.
- I agree that my child to participate in the study.

Parent/Guardian	Student
Name:_____	Name:_____
Signature:_____	Signature:_____
Date:_____	Date:_____

STUDENT'S CONSENT FORM

- I understand the purpose and procedures of the study.
- I have been provided with the participation information sheet.
- I understand that the procedure itself may not benefit me.
- I understand that my involvement is voluntary and I can withdraw at any time without problem.
- I understand that no personal identifying information like my name, address or school will be used in any published materials.
- I understand that all information will be securely stored for at least 5 years before a decision is made as to whether it should be destroyed.
- I understand that updates of the progress of the research will be provided to me.
- I have been given the opportunity to ask questions about this research.
- I agree to participate in the study outlined to me.

Name: _____

Signature: _____

Date: _____

TEACHER'S CONSENT FORM

- I understand the purpose and procedures of the study.
- I have been provided with the participation information sheet.
- I understand that the procedure itself may not benefit me.
- I understand that my involvement is voluntary and I can withdraw at any time without problem.
- I understand that no personal identifying information like my name, address or school will be used in any published materials.
- I understand that all information will be securely stored for at least 5 years before a decision is made as to whether it should be destroyed.
- I understand that updates of the progress of the research will be provided to me.
- I have been given the opportunity to ask questions about this research.
- I agree to participate in the study outlined to me.

Name: _____

Signature: _____

Date: _____