Effective teacher professional development for the implementation of realistic mathematics education in Indonesia

Sutarto Hadi

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EFFECTIVE TEACHER PROFESSIONAL DEVELOPMENT FOR THE IMPLEMENTATION OF REALISTIC MATHEMATICS EDUCATION IN INDONESIA

PROEFSCHRIFT

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Promoters: Prof. dr. Tjeerd Plomp
Prof. dr. Jan de Lange

dedicated to Indonesian mathematics teachers

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GLOSSARY

BPS	Biro Pusat Statistik – Center of Statistic Bureau
CBSA	Cara Belajar Siswa Aktif – Student Active Learning
CP	Classroom practice
Depdikbud	Departemen Pendidikan dan Kebudayaan – Department of Education and Culture
DPR	Dewan Perwakilan Rakyat – House of Representative
Ebtanas	Evaluasi Belajar Tahap Akhir Nasional – National Leaving Examination
FI	Freudenthal Institute
FKIP	Fakultas Keguruan dan Ilmu Pendidikan – Faculty of Teacher Training and Educational Science
HLT	Hypothetical Learning Trajectory
HRD	Human Resources Development
ICT	Information and Communication Technology
IndoMath	In-service Education for Indonesian Mathematics Teachers
IKIP	Institut Keguruan dan Ilmu Pendidikan – Institute of Teacher Training and Educational Science
IMO	International Mathematics Olympiad
IPA	Ilmu Pengetahuan Alam – Natural Sciences
JHS	Junior High School
LKG	Latihan Kerja Guru – Workshop for Teachers of PKG project.
LKGI	Latihan Kerja Guru Inti – Workshop for Key Teachers of PKG project.
LKI	Latihan Kerja Instruktur – Workshop for Instructors of PKG project.
LKP	Latihan Kerja Pengawas – Workshop for Supervisors of PKG project.
LoU	Level of Use
LPTK	Lembaga Pendidikan Tenaga Kependidikan – Institute of Teacher Education
MGMP	Musyawarah Guru Mata Pelajaran – Weekly meeting of subject matter teachers.
MiC	Mathematics in Context.

MoEC	Ministry of Education and Culture.
NEM	Nilai Ebtanas Murni – Student's real score in national leaving examination
PKG	Pemantapan Kerja Guru – is a project to strengthen secondary school teachers competencies through in-service program.
PMRI	Pendidikan Matematika Realistik Indonesia (Indonesia Realistic Mathematics Education) – on August 20, 2001 some mathematics educator in Indonesia declared PMRI as the name of movement to reform mathematics school curriculum in line to RME theory.
PPPG Matematika	Pusat Pengembangan Penataran Guru Matematika – The National Development Training Center for Mathematics Teachers
Puskur	Pusat Kurikulum – The National Center for Curriculum Development
RCP-Test	Realistic Contextual Problems Test
Remesa	Realistic Mathematics Education in South Africa
RME	Realistic Mathematics Education
SD	Sekolah Dasar – Primary School
SGA	Sekolah Guru A – Senior High School for Primary School Teachers (A)
SGB	Sekolah Guru B – Senior High School for Primary Primary School Teachers (B)
SGO	Sekolah Guru Olahraga – Senior High School for Sport Teachers
SLTP	Sekolah Lanjutan Tingkat Pertama – Junior High School
SLTPN	Sekolah Lanjutan Tingkat Pertama Negeri – Public Junior High School
SMU	Sekolah Menengah Umum – General Senior High School
SoCQ	Stages of Concern Questionnaire
SPG	Sekolah Pendidikan Guru – Senior High School for Primary School Teachers
TLP	Teaching and learning process
UNDP	United Nation Development Program
USA	United States of America
TIMSS	Third International Mathematics and Sciences Study

PREFACE

The IndoMath Study had involved many people in its journey. Foremost I would like to express my gratitude to both my promotors Prof. Tj. Plomp and Prof. de Lange, who give me opportunity to study in the Netherlands under the framework of PGSM Project, Jakarta, Indonesia. Research workshop in mathematics education at ITB, Bandung on April 29 till May 9, 1998, where both of them gave lectures on educational technology and RME respectively, was very inspiring that influence the research for my PhD project. Having now been working with them for a few years, I deeply realized that for me, they are not only supervisors who always remind me to keep on the right track on my research, but also persons from whom I learn a lot of things about "working." Prof. Tj. Plomp gave example how to work in a productive way: "Come to the faculty earlier, you will have a long day." I really appreciate Prof. de Lange and staffs of Freudenthal Institute for allowing me use the library and resources they have. Thank you very much for such a meaningful contribution to my life.

I would like to thank Dr. O. Simbolon and Mr. Benny Karyadi from PGSM Project, for giving me opportunity to participate in research workshop in mathematics education at ITB, Bandung. To Mr. Pontas Hutagalung and Miss Anita I would like to thank for their helps for logistical matters in Indonesia. I would like to thank Indonesian co-supervisors Prof. Suryanto, Prof. R. Soedjadi, Prof. R.K. Sembiring, and Dr. Y. Marpaung for their constructive suggestions for my research in Indonesia.

I would like to thank the chairman and staffs of the International Education Office (IEO), the Faculty of Educational Science and Technology: Jan Nelissen, Dionysia Loman, Lidwien Mulder and Karin Brink for their immediate responses and helps for logistical matters during my stay in the Netherlands.

Further, I would like to appreciate the warm welcoming by the Junior High School (JHS) mathematics teachers in Yogyakarta. The beginning of the first fieldwork was stressful and uncertain because I had no idea of teachers who would be involved in the study. From the Yogyakarta Regional Office of Ministry of National Education, I received a list of five *guru-intis* (key-teacher) of *PKG* professional development project, namely Mrs. Rusindrayanti, Mr. Y. Sukamto, Mr. Y. Rudi Sudihardjo, Mrs. Widi Hastuti, and Mrs. Murni Kusumawati. They are experienced mathematics teachers who coordinated the *MGMP* weekly meeting for JHS mathematics teachers in the Yogyakarta Province. Through them I had an access to many other mathematics teachers, so that I could save the next stages to be a 'nightmare.' The teachers' commitment and support are highly appreciated, not only for their participation in the first tryout of in-service training, but especially also for their role as critical friends and assistant researchers. The help of Mrs. Surtiyati, the principal of SLTPN (JHS) 5 Yogyakarta, could conduct the first tryout of the IndoMath in-service training. I would like to thank for her kindness of allowing me to contact the teachers and students for conducted a research at her school.

The role of assistant researchers were important in the IndoMath study in order to avoid subjective views of the researcher in his mix roles in the study as a designer, a trainer, a teacher and an evaluator. Beside five experienced mathematics teachers mentioned above, the contribution of Mr. Sugiman (a mathematics teacher educator from State University of Yogyakarta) was important. He followed the IndoMath study from the preparation of the first fieldwork (September 1999) till the end of third fieldwork (February 2002). Having him as an assistant researcher I always had opportunity to discuss all issues not only from the research point of view but also the organizational matters. I owe him much for his constructive assistance.

The tryouts of the IndoMath in-service program in the second and third fieldwork were conducted at PPPG Matematika (The National Development Training Center for Mathematics Teachers). It was possible because of the permit from Mr. Mashari Subagiyana (Head of PPPG Matematika), and Mr. Herry Sukarman (Head, Division of Technical Service). I would like to thank for their support and cooperation, especially in allowing me to use facilities at PPPG Matematika. To Mrs. Ganung Anggraini and Mrs. Lusie, I also want to thank for their help to arrange the in-service course at PPPG Matematika.

During the first and second years of my study in the Netherlands I was struggling to find the right position between professional development for teachers and Realistic Mathematics Education. It was considered important to put emphasize on mathematics education as a central theme of my research. On the other hand I realized that educating teachers was crucial as a preliminary effort for implementation of innovation. Considering these two aspects I am fortunate to have Ellen van den Berg and Dick Slettenhaar as my mentors. From Ellen I learned about the effective strategies of teacher professional development and how to research this issue in relation to implementation of innovation in Indonesia. Moreover, with Dick I had extensive discussion about its implication to mathematics education research. He was not only assisting me at the University of Twente, but even had opportunity to come to schools in Yogyakarta as well as visited PPPG Matematika, gave lectures and talked with Indonesian JHS mathematics teachers.

My appreciation goes to Professor Jan van den Akker, the chairman of the Department of Curriculum, of the Faculty of Educational Science and Technology, for his support during my study at the University of Twente. I would like to express my thanks to Annette Thijs for her kindness and helps. She organized monthly meeting for international PhD students which is very constructive and useful for our study. To Sandra Schele I would like to thanks for the layout of this book. To staffs and friends at the Faculty of Educational Science and Technology, I would like to thanks for favorable environment during my study here. Zulkardi, Ahmad Fauzan, Dian Armanto, Melody Williams, Andemariam Tecle, Rijanto Purbojo, Irina Shostak, Fahoum Shalabi, and Muhammad (Abu Tariq), my very sincere go to all of you for your cooperation and friendship during my study at the University of Twente.

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Enschede, summer 2002

Sutarto Hadi

1

INTRODUCING THE INDOMATH STUDY

*This chapter introduces the IndoMath (**In**-service education for **Indo**nesian **Math**ematics Teachers) study. The study finds its basis in the needs for improving mathematics education in Indonesia that has for a long time had a lot of problems. The condition of mathematics education in Indonesia is outlined in the background of the study (Section 1.1) consisting of two aspects, namely the current situation of mathematics education in Indonesia, and RME as a promising theory to improve the situation. Having the issues of mathematics education in the country, the research question is then formulated as a guidance for the study conducted (Section 1.2). It is followed by the discussion of development research as an appropriate approach to answer the question (Section 1.3). This chapter concludes with the description of the following chapters of this book (Section 1.4).*

1.1 BACKGROUND OF THE STUDY

The study aims to investigate the characteristics of effective professional development to introduce *Realistic Mathematics Education* (RME) in Indonesian junior high schools. The central theme of the research is to develop and evaluate the in-service training program as an intervention to make mathematics teachers understand RME and prepare them for effective implementation of RME in their lessons. In this section, an introduction to the research is given; firstly mathematics education in Indonesia (1.1.1) followed by RME as a promising theory (1.1.2).

1.1.1 Mathematics education in Indonesia

The teaching of mathematics in Indonesian schools has been implemented since 1973 when the government replaced the teaching of arithmetic in the elementary school by the teaching of mathematics. Since then, mathematics has become a compulsory subject in the elementary, junior high, and senior high schools. However, the teaching of mathematics has always raised some problems. The query of the practice of mathematics teaching in schools may be suitably represented by the question: Do students learn mathematics during their six years of study at primary school, three years at junior high school, and three years at senior high school? If they do learn mathematics;

- Why has the students' achievement in mathematics in *Ebtanas* (national leaving examination) always low from year to year? (See *Informasi Ebtanas*, 2002).
- Why do Indonesian students fail in the International Mathematics Olympiad (IMO)? (See e.g. Supriyoko, 1997).
- Why do Indonesian students have low performance in the Third International Mathematics and Science Study (TIMSS)? (See Mullis et al., 2000).
- Why do Indonesian students get low achievement in mastering science and technology as compared to their South East Asian neighbors? (See "*Pengajaran Matematika Seharusnya Mengarah ke Logika*", 1999).

In fact, since the implementation of mathematics teaching in the elementary schools, many efforts have been done. Since 1977 the government has produced over 900 million copies of textbooks for students and teachers, has provided in-service training programs for most of the school teachers, and has provided teaching aids for schools (Moegiadi, 1994). The PKG (*Pemantapan Kerja Guru*) project is one of the efforts to improve high school teachers' competencies through in-service training program, although this project is not fully satisfactory. For instance, a diagnostic survey to study the PKG project' effects on mathematics teaching on junior high schools conducted by the Ministry of Education and Culture (MoEC) in 1996, revealed that many teachers were still using teaching techniques as telling method, and that students' performance in mathematics was poor (Suryanto, 1996; Somerset, 1997).

The aims of mathematics teaching in Indonesian junior high schools are twofold. First, it prepares students to be able to face the changing dynamic global world through practical works based upon logical reasoning, rational, critical, cautious, and honest attitude, efficient and effective skills. Second, it prepares students to be able to use mathematics and mathematical reasoning in everyday life and in studying other sciences (Depdikbud, 1994). However, it appears that the implementation of mathematics teaching in Indonesia is far from being successful at achieving its aims.

1.1.2 The promising theory: RME

Realistic Mathematics Education (RME) appears to be a promising approach in the teaching and learning of mathematics. Much literature mentions the potential of this approach in increasing students' understanding in mathematics (see e.g. Streefland, 1991; Gravemeijer, 1994, 1997) (It will be discussed in Chapter 3). The Netherlands is a pioneer of RME through the works of Freudenthal Institute (FI) and others. Later on, in the United States a number of schools started using the approach as a result of collaboration between FI and the University of Wisconsin in a project called Mathematics in Context (MiC). The data indicate that this international collaboration has been a worthwhile enterprise, in that 'the wisdom of practice' from many years in the Netherlands has been used as starting points for curriculum development in the United States (see, e.g., Clarke, 1993; Clarke, Clarke & Sullivan, 1996; de Lange, 1994). The MiC project has resulted in curriculum materials for Grades 5 – 9. After students in several school districts from different states used the materials, a preliminary research showed that the students' achievement on the national test highly increased (Romberg & de Lange, 1998). Furthermore, in the country where RME originally was developed, the Netherlands, there are also positive results that can be used as indicators for the success of RME in reforming mathematics education. The results of the Third International Mathematics and Science Study (TIMSS) show that students in the Netherlands gained high achievements in mathematics (Mullis, et al., 2000).

Another international collaboration of FI is with the University of the Western Cape in South Africa in a project called Remesa (Realistic Mathematics Education in South Africa). The Remesa project is aimed at developing and researching the impact of innovative mathematics learning and teaching materials based on the premise that '*reality is the basis of and the domain of application of mathematics*.' The materials developed by Remesa are intended to form a useful resource from which teachers, textbook authors and others can develop school mathematics learning programs relevant to the South African situation (see: www.fi.uu.nl/remesa). Besides the USA and South Africa, it appears that the theories of RME is in line with the trends of mathematics curriculum reform in other countries such as

Portugal, England, Germany, Spain, Brazil, Denmark, Japan and Malaysia (de Lange, 1996).

Much more important than the previous argument, namely that RME proved to be useful in other countries, is the concept of RME itself. In the concept of Freudenthal mathematics as a human activity should be connected to reality. The concept of RME is characterized by:

- students should be given the opportunity to reinvent mathematics under the guidance of an adult (Gravemeijer, 1994); and
- the reinvention of mathematics ideas and concepts should start from exposure to a variety of 'real-world' problems and situations (de Lange, 1995).

Next to these ideas, namely *guided reinvention* and *starting from exposure to variety of 'real-world' problems,* the process of learning is important. The learning route along which the student could be able to find the result by him/herself should be mapped out (Gravemeijer, 1997). The consequence of these principles is that teachers should develop highly interactive instruction and give students opportunities to actively contribute to their own learning process.

It is worth mentioning that the theory of RME is in line with the current thinking of learning, such as constructivism and pupil-centered learning. Indonesian mathematics curriculum of 1994 is also emphasized on student active learning, problem solving and application of mathematics. But whereas a constructivist approach represents a general theory of learning, RME is a theory of learning and instruction that has been evolved only for mathematics. Cobb (1994) states that constructivism and RME are compatible because, to a large extent, they have similar characteristics of mathematics and of mathematics learning. Both constructivism and RME contend that mathematics is a creative human activity, and that mathematics learning occurs as students develop effective ways to solve problems (de Lange, 1996; Streefland, 1991; Treffers, 1987).

1.2 RESEARCH QUESTION

The trend described above is in accordance with the needs for improvement of mathematics education in Indonesia that is dominated by the discussion on how to increase students' understanding of mathematics and develop students' reasoning (*Matematika yang Menumbuhkan Daya Pikir*, 1997). For instance, one of the reasons for revising the National Curriculum of 1994 by the Indonesian government is because there has been a lot of criticisms from educational professionals and within the society at large about the irrelevance and meaninglessness of the subject-matter content: "…. material content is too difficult because it is not relevant to the level of students' thinking and meaningless because it is not related to everyday life" (*Kurikulum 1994 Akhirnya Disempurnakan*, 1999).

It is a common phenomenon currently in Indonesia that the objective of teaching and learning mathematics is not to make students become mathematics expert, but to develop their reasoning and logical ability (*Pengajaran Matematika Rumit*, 1999). If we carefully listen to the messages from mathematics teachers in Indonesia, then one of their concerns is how to make mathematics teaching relevant for students in dealing with the daily life problems. It is also argued that mathematics should be mastered as a systematic pattern of reasoning (Nasution, 1996). The (re)construction of mathematical ideas and concepts goes hand in hand with the process of the development of the student's reasoning ability. This can be achieved in RME through students' exposure to contextual problems within the framework of an interactive teaching and learning process. Therefore, it is worthwhile to explore whether RME is a good approach to tackle the problems of mathematics education in Indonesia.

Since RME is so new for many people in Indonesia (teachers, teacher educators, curriculum developers, supervisors, and students) research is needed to investigate whether and how it can be translated and realized for the Indonesian context. Using the notion of 'think big start small' in education innovation efforts, it is important that a number of small experiments are carried out as a contribution to the curriculum reform in Indonesia. This research is needed to the reveal necessary components for a successful innovation on both curriculum and teachers level. Given the willingness of those who are involved in mathematics education as well as of the government to innovate mathematics education (see e.g. *Diusulkan, Guru Matematika dan IPA di SD*, 1996; *Matematika di SMU Perlu Direvisi*, 1997; *Matematika yang Menumbuhkan Daya Pikir*, 1997), we have reasons to expect a fruitful innovative curriculum for mathematics if we know how to adapt RME to the Indonesian context and know what implementation strategy is proper for the school level. According to Fullan (2001) a complex innovation is characterized by three dimensions, namely the changing of teachers' beliefs, introducing new teaching and learning methods, and introducing new curriculum materials. The innovation we are talking about here pertains to all the three dimensions. So, for Indonesia we are talking about a complex innovation if we want to introduce RME.

There is strong evidence from research at the University of Twente for the important role of exemplary curriculum materials in the implementation of educational innovations on teacher level (see e.g. van den Akker, 1988, 1998). Through exemplary curriculum materials, the new beliefs can be explained and operationalized, and serve as a vehicle in transferring new methods of teaching and learning. But, to introduce RME into Indonesia it is not sufficient to have only new curriculum materials. Because teachers are the key actors in education, they need to be well trained in order to understand the philosophy of RME as reflected by the new curriculum materials and have appropriate competencies to put this into practice. Based on this analysis, this research focuses on the development of in-service education and training for mathematics teachers on the basis of RME exemplary curriculum materials for junior high school mathematics to make teachers understand RME and prepare them for an effective introduction of RME in their classroom practice. For this purpose it is necessary to have some valid, practical, and effective exemplary curriculum materials. Exemplary curriculum materials have been developed in co-operation with other researchers. Concurrent with this study, other RME related projects were conducted in Indonesia. One of them involves an internet-based support system for RME training for student teachers and secondary school teachers (Zulkardi, in press). The development of RME-based modules for Indonesian primary education was also being carried out within the framework of two other projects (Armanto, in press; Fauzan, in press).

Within this analysis of problems related to the introduction of RME-based mathematics education the main research question can be formulated as follows:

> *What are the characteristics of in-service education that make Indonesian teachers understand RME and prepare them for effective implementation of RME in their classroom lessons?*

When we are talking about RME it is not as simple as saying that mathematics be viewed as human activities and should be connected to real life situations. There are some principles that are embedded within this belief and could be viewed as an abstraction of twenty years of RME movement in the Netherlands. Those principles have been elaborated into five tenets of RME, namely (1) the use of contextual problems, (2) bridging by vertical instruments, (3) pupil contribution, (4) interactivity, and (5) intertwining (see e.g. de Lange, 1987; Gravemeijer, 1994, 1997; Treffers, 1987). From these tenets we are aware of the consequences on mathematics teaching and learning if we want to introduce RME to Indonesian schools. These consequences are change in teaching and learning (such as class interaction and lack of authorities), change in content, and change in assessment. Within the analysis of these consequences, the professional development program should reflect the five tenets of RME in terms of how they work in reality. In order words, how to translate this 'philosophy' into the design and practice of professional development program. In accordance with the tenets of RME, the professional development program is intended also to address the changing of teaching and learning, of content as well as assessment (See Chapter 3).

1.3 RESEARCH APPROACH

To address the above question a development research approach has been chosen. According to Plomp (2002), in simple words, a development research can be defined as a research related to the development of a solution to an education problem. In a development research, the researcher has to account for the quality of analysis and the quality of the design. The design should reflect 'state of the art knowledge.' The researcher has also to explain the process of development, such as how it has been tested, evaluated, and revised. Finally, he or she has to make sure that the solution (whether it is the process or product) can be used (cf. Hadi, 2000).

Development research appears to be a promising approach in Indonesia where in most cases research does not emphasize the usability of its findings. Most researches conducted by teacher educators have not yet touched the educational needs or can be used as a guidance in innovation implementation. In many cases research results are poor in giving useful recommendations (Hadi, 2000).

Traditional research approaches (e.g. experiments, surveys, correlation analyses), with their focus on descriptive knowledge, hardly provide prescriptions with useful solutions for a variety of designs and development problems in education (van den Akker, 1999).

Contrary to this, a development research is performed to find a solution in education through formative evaluation activities and may be distinguished by two purposes (van den Akker & Plomp, 1993):

- Development of prototypical products by emphasizing the cyclic processes of design, evaluation, and revision;
- Generating methodological directions for the development of such products.

Given the problem central to this study, development research is considered to be the most appropriate.

1.4 OVERVIEW OF THE FOLLOWING CHAPTERS

The subsequent chapters of this book can be highlighted as follows. *Chapter 2* discusses the position of mathematics education in Indonesia within the overall education system. *Chapter 3* summarizes the results of a literature study to build a rational and strategies for the framework of developing an effective in-service education for the implementation of RME in the junior high schools in Indonesia. *Chapter 4* discusses the various aspects of development research activities in the IndoMath study. This study was developed along the lines of formative research: *orientation*, *development and evaluation* of intervention, and *semi-summative evaluation* of its effectiveness. The research was conducted during three field-works in Indonesia. In the first and second field works in Indonesia, the focus was mainly on the design and evaluation of adapted RME exemplary curriculum materials as well as in-service training program. In the third fieldwork, the focus was on the effectiveness of intervention to introduce RME to Indonesian mathematics teachers. At the end of Chapter 4 the various aspects of evaluation activities in the IndoMath study are summarized.

The first fieldwork in Indonesia was important as a preliminary step to explore the potential model for in-service education to introduce RME to mathematics teachers. In *Chapter 5* these efforts are discussed. *Chapter 6* discusses the results of design and evaluation of the IndoMath training program in the second fieldwork. As the development research approached its final stage, the focus of the research was on the impacts of the intervention on teachers' understanding of new strategies. In *Chapter 7* those aspects are discussed based on the results of the semi-summative evaluation on the effectiveness of the IndoMath training program. Finally, *Chapter 8* contains summary, discussion and recommendations.

❷

THE CONTEXT OF THE STUDY

This chapter discusses the position of mathematics education in Indonesia within the overall education system. It starts with the description of the country (Section 2.1). The character of Indonesia's system of education is outlined to give a general view of education in this archipelago nation (Section 2.2). The development of mathematics education in Indonesia is discussed in the subsequent sections of this chapter. Section 2.3 describes junior high school mathematics education. Section 2.4 outlines teacher education in Indonesia. Section 2.5 discusses mathematics teachers and curriculum development. Section 2.6 discusses the implications of the Indonesian context to the IndoMath study.

2.1 INDONESIA

Indonesia declared its independence from the Netherlands on August 17, 1945. Geographically the nation occupies archipelago of more than 17,000 islands, with nearly 1,000 of them inhabited. The islands spread across the seas south of continental Southeast Asia for 1,888 kilometers (1,180 miles) north to south and 5,110 kilometers (3,194 miles) east to west (see Figure 2.1). In 2000 the number of population is 206,264,595 (*BPS Statistics Indonesia*, 2002). Indonesia is the fourth most populous country in the world, after China, India, and the United States.

Figure 2.1
Indonesian Archipelago

Indonesian declared *Bahasa Indonesia* to be their unifying language, in the 1928 *Kongres Pemuda* (Youth Congress). Later, the language became the official language in the country. Yet, there are more than 350 indigenous languages existing today, and the most widely spoken is Javanese, whose ethnic group shares 39.4% of the population. Other ethnic groups are Sundanesse (15.8%), Malay (12.1%), Maduresse (4.5%), Minang (2.4%), and some other small ethnic groups, which share 26% of the total population.

2.2 SYSTEM OF EDUCATION

The character of Indonesia's educational system reflects its diverse ethnic and religious heritage, its struggle for a national identity, and the challenge of resource allocation in a developing archipelago nation with a young and rapidly growing population. Although a key government goal is to provide every Indonesian with at least nine years of basic education, the aim of universal education has not been reached, particularly among females – although great improvements had been made. Obstacles to meeting the government's goal include a high birth rate, a decline in infant mortality, and the shortage of schools and qualified teachers. In 1973 the government issued an order to set aside portions of oil revenues for the construction of new primary schools. This act resulted in the construction or repair of nearly 40,000 primary schools by the late 1980s, a move that greatly facilitated the goal of universal education.

The education system has its roots in the Indonesian culture based on *Pancasila* (five principles of the national ideology) and the 1945 Constitution. In the National Education Act No. 2 of 1989, the system aims at generating abilities and increasing the standard of living and dignity of the Indonesian people in order to achieve the national development goal.

In Indonesia the schools are operating under the auspices of several ministries. Public secular schools and non-Muslim private schools are under the responsibility of the Ministry of National Education, while Islamic schools are administrated under the Ministry of Religious Affairs. A small number of institutions designed for training specialized personnel are managed by several other ministries, such as the Ministry of Home Affairs and the Ministry of Defense and Security.

The system consists of seven types of education (see Figure 2.2), they are: (1) General education emphasizes the development of general knowledge and improvement of skills for the students. Specialization is also needed in the 12th grade; (2) Vocational education prepares students in mastering a number of specific vocational skills needed for employment; (3) Special education provides important skills and abilities for student with physical and/or mental disabilities; (4) Service-related education aims at increasing abilities required for certain government officials or prospective officials to implement a certain task; (5) Religious education prepares students to play a role which demands the mastery of specific knowledge about religion and related subjects; (6) Academic-oriented education focuses primarily on improving the mastery of science; and (7) Professional education prepares students primarily on mastering specialized or job-related knowledge and skills.

AGES OF STUDENTS																			
3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22^+

Ministry of National Education

Kindergarten	9-year basic education		3 or 4-year secondary education	Higher education
	6-year primary school	3-year junior secondary school		
			General	Universities
			Vocational	Institutes
			Religious	Academics
			Service related	Polytechnics
			Special	School of higher learning
			Professional	

Ministry of Religious Affair

Kindergarten	9-year basic education		3 or 4-year secondary education	Higher education
	6-year madrasah ibtidaiyah	3-year madrasah tsanawiyah		
			General	Universities
			Vocational	Institutes
			Religious	Academics
			Service related	
			Special	
			Professional	

Figure 2.2
Levels and types of Indonesian schools

The level of education that includes formal school system consists of: basic education, secondary education, and higher education. Apart from the levels of education mentioned above, pre-school education is also provided. Out-of-school education can be held at the outside schools and provided by governmental and non-governmental agencies of private sector and the community.

Following kindergarten, Indonesians of between six and fifteen years of age have to attend a six-year primary school and a three-year junior high school. They could choose between state-run, nonsectarian public schools supervised by the Ministry of National Education or private or semiprivate religious (usually Islamic and called Madrasah Ibtidaiyah and Madrasah Tsanawiyah) schools supervised and financed by the Ministry of Religious Affairs. Although 85 percents of the Indonesian population are registered as Muslims, less than 15 percents attend the religious schools. Enrolment was slightly higher for girls than boys and much higher in Java than in the rest of Indonesia.

A central goal of the national education system in the early 1990s was not merely to convey secular wisdom about the world, but also to instruct children in the principles of participation in the modern national-state, its bureaucracies, and its moral and ideological foundations. Since 1975, a key feature of the national curriculum – as in other parts of society – had been instruction in the *Pancasila* (The five principles of national identity of Indonesia). Children aged six and above learned the five principles – belief in one God, humanitarianism, national unity, democracy, and social justice – by rote and were instructed daily to apply the meanings of this key national symbol to their lives.

Inside the public school classroom of the early 1990s, a style of pedagogy prevailed that emphasized rote learning and respect to the authority of the teacher. Although the youngest children were sometimes allowed to use the local language, by the third year of primary school nearly all instruction was conducted in formal Indonesian. Instead of asking questions of the students, a standard teaching technique was to narrate a historical event or to describe a mathematical problem, pausing at key junctures to allow the students to fill in the blanks.

After completion of the nine-year basic education, senior secondary education is available. The paths of senior secondary education include general high school, vocational high school, religious high school, service related high school, special education, and professional secondary education. The length of study in secondary education is three years for general high school and three or four years for other senior high schools. In addition to the senior secondary education, there is also an Islamic general senior high school called *madrasah aliyah*, which is equivalent to general senior high school, but it is managed and run by the Ministry of Religious Affairs.

Higher education is an extension of secondary education consisting of academic and professional education. Academic education is mainly aimed at mastering science, technology, and research, whereas professional education is aimed more at developing practical skills. Institutions involved in higher education are of the following types: academies, polytechnics, schools of higher learning, institutes, and universities. The length of study in higher education is three years for diploma program and four years for graduate program. Upon completing a graduate program, students can continue to master program for two years, and finally to doctorate program for three years.

Table 2.1
School enrolment and educational attainment (http://www.bps.go.id)

Selected Indicators	1994	1995	1996	1997	1998 *Female*	1998 *Male*	1998 *F+M*
School Enrolment (%)							
Population aged 7-12 years	94.06	93.9	94.43	95.37	95.31	94.85	95.07
Population aged 13-15 years	72.38	73.2	75.84	77.51	77.17	77.44	77.31
Population aged 16-18 years	45.31	44.6	47.59	48.64	48.25	50.75	49.52
Educational attainment of population aged 10 years and over (%)							
No schooling	11.73	12.33	11.66	10.27	13.79	6.10	10.00
Some Elementary School	30.32	30.57	28.35	26.56	26.79	25.97	26.39
Elementary School	31.97	31.22	32.34	32.99	32.49	33.50	32.99
Junior High School	12.16	11.94	12.72	14.01	13.00	14.86	13.92
At least senior High School	13.83	13.94	14.92	16.16	13.93	19.56	16.70
Proportion of Population 5 years of age and over who were able to speak Indonesian	86.41	85.78	86.92	88.58	86.47	91.95	89.19
Proportion of population 10 years of age and over who were literate	87.26	86.26	87.36	89.07	85.54	93.41	89.42

In 1998, school enrolment for population aged 7-12 years and 13-15 years was 95.07 percents and 77.31 percents respectively, and only 49.52 percents of those aged 16-18 years went to schools. The national adult literacy rate was 89.42 percents in 1998 (93.41 percents for males and 85.54 percents for females) (Table 2.1).

2.3 MATHEMATICS TEACHING IN JUNIOR HIGH SCHOOL

Mathematics is considered as a basic science that is growing rapidly both in content and in applications. The teaching of mathematics in Indonesia becomes one of the priorities in educational development. It is stated that the improvement of mastery in science and technology at the higher education level is supported by the improvement of mastery in mathematics and science within the overall system of national education.

The content of school mathematics has been chosen among the body of mathematics knowledge that is perceived in line with the premise to develop students' ability in science and technology (Table 2.2). This means that beside its characteristic of having abstract objects and deductive pattern of reasoning, the school mathematics cannot be separated from the development of science and technology.

As mentioned in the introductory chapter of this book, the aims of mathematics teaching in junior high school are twofold:

- Preparing students to be able to face the changing dynamic global world through practical works based upon logical reasoning, rational, critical, cautious, and honest attitude, efficient and effective reasoning.
- Preparing student to be able to use mathematics and mathematical reasoning in everyday life and in studying other sciences.

Table 2.2
Contents of Mathematics Curriculum of 1994 for Junior High School (GBPP 1994)

Trimester	Grade 7 *(12-13 years)*	Grade 8 *(13-14 years)*	Grade 9 *(14-15 years)*
I	1. Sets (1)	1. Relation, mapping, and graph	1. Volume and the area of the 3D shape
	2. Whole Numbers	2. Square and root square of the number	2. Transformation
	3. Integers Numbers	3. Pythagorean theorem	3. Similarity
	4. Arithmetic operation on the algebraic expression	4. Parallel lines (deductive approach)	4. Congruent triangles
	5. Fraction	5. Parallelogram, rhombus, kites, and trapezoid	
	6. Sets (2)		
II	1. Economical arithmetic	1. Proportion	1. Circle (2)
	2. Equation and inequality in one variable	2. Time, distance, and velocity	2. Operation on the algebraic expression
	3. Cube and block shape	3. Locus	3. Quadratic Function and its graph
	4. Angle and direction	4. The (straight) line equation	
		5. Linear equation systems of two variables	
III	1. Tessellation	1. Circle (1)	1. Number patterns and sequence of the numbers
	2. Symmetry	2. Probability	2. Trigonometry
	3. Rectangular and square	3. Statistics	3. Logarithm (Optional)
	4. Triangle	4. The nondecimal numerals. (Optional)	4. Flowchart (Optional)
	5. Using Calculator (optional)		
	6. Clock arithmetic (optional)		

The aim we are talking about here is the emphasis on logical reasoning and the development of the students' attitude as well as skills in applying mathematics. Apparently, this aim aligns with the trend in other countries. Niss (1996) states that one of the fundamental reasons for mathematics education is providing individuals with prerequisites which may help them to cope with life in the various spheres in which they live: education or occupation; private life; social life; life as a citizen. More specifically the goals of mathematics teaching at junior high school are (Depdikbud, 1994):

- Students have transferable ability through mathematical activities;
- Students have mathematical knowledge as a prerequisite for their study in secondary schools;
- Students have mathematical skills as the improvement and broadening of their primary school mathematical skill that can be used in their everyday life;
- Students have broad views and have attitudes of logic, critical, cautious, discipline habit, and appreciation of the usefulness of mathematics.

2.4 TEACHERS EDUCATION IN INDONESIA

Teacher education in Indonesia was initially established by the Netherlands Indies through 'Zending' (Mission) in Ambon in 1834. It then continuously spread to other parts in Indonesia. The first 'Kweekschool' (Teacher Training Institution) was established in Java in 1852. The similar school, named Fort de Kock, was established in Bukit Tinggi in 1856 and in Tapanuli in 1864. In 1871 the government of the Netherlands Indies conducted evening courses in Batavia that operated until 1891.

During independence period teacher training program were varied, and gradually upgraded. For example, in the 1950s anyone completing a teacher-training program at the junior secondary level could obtain a teacher's certificate. Since the 1970s, Indonesia government established middle and senior high schools for teacher education like SGB (*Sekolah Guru B*), SGA (*Sekolah Guru A*), SPG (*Sekolah Pendidikan Guru*) and SGO (*Sekolah Guru Olahraga*). As a result, the teaching profession was restricted to graduates of senior high schools for teachers in primary schools, and to graduates of a university-level education course for teachers of higher grades. For teacher education at university level government established

FKIP (Faculty of Teacher Training and Educational Science) at leading universities in Indonesia, and IKIP (Institute of Teacher Training and Educational Science) in Padang, Bandung, Malang, Surabaya, Semarang, Manado, Jakarta, Yogyakarta, Makasar, and Medan. Currently these IKIPs have been converted to universities as a consequence of their wider mandate.

The result of teacher education can be seen from the favorable figure of student-to-teacher ratio. In 1997 the student-to-teacher ratio was 22 to 1 for primary schools, 15.7 to 1 for junior secondary schools, and 12.2 to 1 for senior secondary schools (Table 2.3).

Table 2.3
Numbers of schools, students and teachers in 1997 (MoEC)

	K	PS	JHS	SHS	HE
Number of school	40,215	173,898	30,424	15,744	1,667
Number of students	1,624,961	29,236,933	9,282,861	5,013,808	2,703,896
Number of teachers	93,962	1,327,218	588,788	409,812	180,471

Note: K = Kindergarten, PS = Primary School, JHS = Junior High School, SHS = Senior High School, HE = Higher Education.

Mathematics teacher education is the responsibility of LPTK (teachers training institution) as part of teacher education in FKIP and former IKIPs. Until 1985 the initial teacher training was emphasized on subject matter knowledge and pedagogical knowledge. Each student had to choose one subject as the major of study and another one as the minor of study. Therefore, every graduate could teach at least two subject matters whenever he or she served as a teacher at a school. This policy was important to overcome the shortcoming of qualified teachers. But later on there was growing awareness among people that most teachers' competency in mastering subject contents was low. From 1985 until 1990 LPTK did not obligate the student to take a minor of study. The LPTK emphasized only on one subject matter for the purpose to increase mastery of subject content of the teachers.

Teacher competency in mastering subject contents of the curriculum remains to be the central concern in the teacher professional development. The study in 1987 by Ministry of Education and Culture revealed that the mathematics teachers of junior high schools comprehended only 77% of the subject contents in the curriculum. Yet it is better than the science teachers do. The physics teachers comprehend only 55%, whereas the biology teachers comprehend 57% of the subject contents of the curriculum (MoEC, 1997). Some teachers who did not understand the content of the subjects prescribed in the syllabi postponed the teaching of the difficult concepts until the end of the academic term (semester). But due to the weakness in content mastery, teaching progress was often so slow that the postponed concepts were not covered at all (Hadi, 1990).

There is also a concern about the important of teacher's professional competency that must be grounded in different scientific domain, not only sciences of education and didactics of mathematics but also some other close related sciences, such as physics, chemistry, and biology. In the Curriculum of 1990 of the LPTKs, Mathematics, Physics, Chemistry, and Biology were compulsory courses for the first year students in the Department of Mathematics and Science Education. The courses for the first year consist of: Foundation of Mathematics and Sciences Education, Calculus I, Calculus II; Basic Chemistry I, Basic Chemistry II, Basic Physics I, Basic Physics II; General Biology; and Introduction of Ecology.

The didactics and method courses, such as The Foundation of Education, Educational Psychology, and Analysis of High School Curriculums, were offered in the second year. This policy reflects the importance of the orientation that mathematics teachers' competence must be grounded in different scientific domains. This policy at least has two purposes, first the mathematics teachers will be ready to teach science, second the mathematics teachers realize the relationship between mathematics and the other subjects, and realize the applications or usefulness of mathematics.

2.5 MATHEMATICS CURRICULUM DEVELOPMENT

In Indonesia a curriculum is designed on the basis of the aims and goals of the national educational system. In general the system is expected to develop the intellectual life of the nation and to develop the Indonesian people fully, i.e. as people who are devoted to God, have knowledge and skills, are in good physical and spiritual health, independent and fair, and responsible for their countryman and nation (http://www.pdk.go.id). It is commonly viewed that a curriculum is a written document that includes strategies for achieving these aims. In Indonesia a curriculum is divided into the core curriculum that is developed by the central government, and the local contents that vary from one province to another province. The core curriculum comprises the 80% of the total content of the curriculum. The remaining 20% are provided for the local contents. The local content is adjusted to the needs of the environment in which the educational activity takes place.

Mathematics curricula in Indonesia always follow the trends in other countries. When '*New Mathematics*' or '*Modern Mathematics*' became the dominant movement around the world, the government started to implement the Curriculum of 1975 that heavily relied on this new trend such as the use of set theory and logic to develop students' mathematical concept and reasoning. The current trend in mathematics education is toward a greater emphasis on problem solving, extended investigations, and on the recognizing and encouraging the reality of students' construction of their own understanding of mathematical concepts and ideas (Clarke, Clarke & Sullivan, 1996). This trend in Indonesia can be seen from the aim of mathematics teaching in Curriculum 1994 that emphasizes on logical reasoning and developing students' attitude as well as skills on mathematics applications.

A curriculum may be manifested in a concrete form. Based on Goodlad's conceptual work on various curriculum representations, van den Akker (1998) distinguishes curriculum representations as follows.

- The ideal curriculum reflects the visions and intentions of the developer which are laid down in a curriculum document;
- The formal curriculum reflects the concrete curriculum documents such as student books and teacher guides;
- The perceived curriculum represents the curriculum as interpreted by its users (especially teachers);
- The operational curriculum reflects the actual instructional process as realized in the classroom;
- The experienced curriculum reflects the curriculum as it is experienced by the learners or students;
- The attained curriculum represents the learning achievement of the students.

The discussion of curriculum development in Indonesia can be attributed to the above representations. It focuses largely on formal and operational representations. Most educators in Indonesia use the term *curriculum* to mean what teachers are expected to teach, with this expectation cast in a printed form called the *recommended curriculum* or *formal curriculum*. Other educators use the term curriculum to mean what classroom teachers actually do teach (*operational curriculum*) (Thomas, 1991). The junior high school curriculum is divided into general subject matter, academic subject matter, and skill (craft knowledge) subject matter. Mathematics is included in the academic subject matter. It is allocated 5 lesson hours per week or one eighth of the weekly school hours, the same with the allocated hours for *Bahasa Indonesia* (Indonesian), whereas other subject matters allocated one-tenth of the school week respectively.

Another component that strongly influences the operational curriculum is the system of examination. In Indonesia school examinations are conducted at the end of each school year, from primary to senior high schools. Each the examinations is called *Ebatnas*. *Ebtanas* is taken by every student enrolled at the last grade of every school (i.e., Grades 6, 9, and 12). This system has some potential to affect teachers' choice of content and ways of teaching.

The development of mathematics curriculum is usually accompanied by a syllabus or GBPP (*Garis-garis Besar Program Pengajaran* or the Guidelines of Instructional Program), student's book and teacher's guide. But as the curriculum materials are developed by the central government, the implementation in the classroom is rather troublesome, although the materials have been tried out and revised.

There is no clear description of teacher's role in the curriculum development in Indonesia. Curriculum development is done under the coordination of *Puskur* (Curriculum-Development Center of the Research and Development Bureau of the MoEC). This 'top-down' policy makes the implementation rather difficult for the teachers.

Basically the syllabus GBPP consists of minimal content that must be learned by all students in order to achieve instructional goals. However it is possible for teachers to give advanced topics to the gifted students in the class. For students of lower ability, there is a chance for receiving remedial teaching. The test items for evaluation at local, provincial, and national levels, are developed in accordance with the minimal content of the GBPP.

For the instructional practice the GBPP suggests that the teachers have to choose and use the strategies that involve students in active learning, mentally, physically and socially. In order to encourage the student-centered learning, the teachers are suggested to give divergent problems to their students, namely problems with different possible solutions. The teachers are also encouraged to build problem-solving activities during the instruction. Mathematics instruction should be in line with the specification of the mathematical concepts and the student's level of reasoning ability. It means that there should be an alignment between concept-mastery driven teaching and problem solving skills. The instruction must be started from concrete to abstract objects, easy matter to difficult one, and simple matter to a complex one. If it is necessary, the teacher can reteach the difficult topic to strengthen the students' mastery (Depdikbud, 1994).

In fact, what is stated in the GBPP is not fully implemented in the classroom. The observations by the Ministry of Education and Culture (MoEC) in 1996 revealed some problems in mathematics teaching (Suryanto, 1996; Somerset, 1997):

- Teachers asked questions quite frequently, but most of these were 'low demand' questions, requiring students no more than to carry out a routine number operation or to supply a mathematical term. High demand questions, checking on conceptual understanding, were rare.
- Only three of the 18 teachers observed made effective use of dialogue with their students to develop concepts or remedy misunderstanding.
- Many teachers, especially those with insecure mathematical knowledge were insecure, based their lessons heavily on the material in the textbook. In no fewer than four lessons, this led to teachers presenting their students with inaccurate mathematics, because the mathematics in the textbook was also inaccurate.

2.6 IMPLICATIONS FOR THE STUDY

Although the efforts to improve mathematics education in Indonesia have been conducted by using a well established program covering all parts in the country, the students' performance in mathematics remains low which is partly related to ineffectiveness of the mathematical instruction and an impact of the inadequacy of mathematical background of the teachers. Almost all mathematics teachers from secondary education (junior and senior high school) have experiences in participating in (at least) one mathematics in-service training within the framework of PKG project. The way this program was announced created high expectations among teachers, but the expectations were not met. Loucks-Horsley et al (1998) warn that "teachers' past experiences with professional development will influence how they view new initiatives, … if teachers have been 'in serviced to death' they may need to experience very different professional development strategies."

This issue has become the main question in this study that is how in-service education should be designed. The context of the study may suggest that the first attention must be paid to support teachers in improving their content and pedagogical content knowledge. Secondly, since RME is a new theory for Indonesian teachers, proper implementation of RME should be supported by high quality exemplary curriculum materials that help teachers to understand as well as promise to improve students' mathematical performance when they are implemented in an instruction.

Furthermore, due to the fact that many parties in Indonesia (especially teachers and teacher educators) regard a curriculum merely as a formal document and how teachers operationalize that document, we need to consider closing the gap between an ideal curriculum and its operational one, and narrowing the gap between the operational representation and its experienced one. The following illustrates the actions taken in this study (Figure 2.3).

Concern	Possible measure
Teachers perceive curriculum similar to what is intended by the developer.	Curriculum materials with procedural specification. Involving teachers in developing and/or revision curriculum materials.
Teachers optimally comprehend curriculum content.	Encouraging teachers to look in the content and work to the problems in the materials.
Teachers have competence to realize curriculum in their classes.	Teachers' opportunity to practice the curriculum materials in real situation.
Students find the lesson interesting and challenging for their own benefit.	Teachers' opportunity to reflect and discuss with colleagues, and get feedback from expert.

Figure 2.3
Possible measures for narrowing the gap among the various curriculum representations

First, teachers should perceive RME curriculum materials, to some extend, similar to what is intended by the developer. Developing curriculum materials with a procedural specification can do it. The procedural specification should give a clear description how the teaching being executed. Moreover, the teachers are involved in. the development. Second, the teachers should optimally comprehend the content of the RME curriculum materials. Giving them opportunity to look into and work on the curriculum materials can make it. Third, teachers should be competence to realize the new strategy in their classroom, which can be done through practice in real situation. Finally, students should have experience in taking the lesson and perceive the lesson as meaningful for their own mathematical learning. It can be realized through continuous support for the teachers during and after implementation process by giving them an opportunity to reflect their own interactions with the students.

Finally, it is good to mention that from the context of mathematics education in Indonesia there is a positive sign for a reform movement, because the policy makers (government and mathematics teacher educators) have a tendency to follow the trends around the world. The current movement appears to be directed to the contextual instruction and student's involvement in learning, which to some extent align to RME, the central theme of this research.

The following chapter discusses how the above issues, namely preparing mathematics teachers to understand RME and implement RME lesson in their mathematics classes by means of in-service education, are conceptualized based upon the results of literature study. It begins with the discussion of RME teaching and learning theory, followed by a summary of the nature and scope of the teacher in-service training in Indonesia, and then an elaboration of the principles of effective professional development.

❸

CONCEPTUAL FRAMEWORK

This chapter illustrates the results of literature study to build a rational and strategies for the framework of developing an effective in-service training for RME implementation in junior high school mathematics education in Indonesia. In Section 3.1 the general conceptual framework of IndoMath study is introduced. Section 3.2 discusses RME as a theory of teaching and learning. Section 3.3 gives an overview of the nature and scope of professional development in Indonesia. Section 3.4 discusses the principles of effective professional development.

3.1 INTRODUCTION

In doing research, we are standing on others' shoulders. A good research has a basis in theory. As it affects the network of previous findings, it is embedded in those ideas and shares in their implications and effects (Krathwohl, 1998). Van den Akker (1999) states this as one of the characteristics of development research of what he calls 'theoretical embedding': more systematic efforts are made to apply state-of-the-art knowledge in articulating the theoretical rational for design choices. The IndoMath program finds its conceptual basis in RME theory and the literature on professional development. The leading literature in RME includes among others those by de Lange (1991, 1994, 1996), Gravemeijer (1990, 1994), and Treffers (1991). To assess the effectiveness of the professional development, this researcher uses the criteria described in the literatures by Ball and Cohen (1996), Borko and Putnam (1996), Loucks-Horsley, Hewson, Love and Stiles (1998), Joyce and Shower (1988, 1995), and van den Akker (1988, 1998).

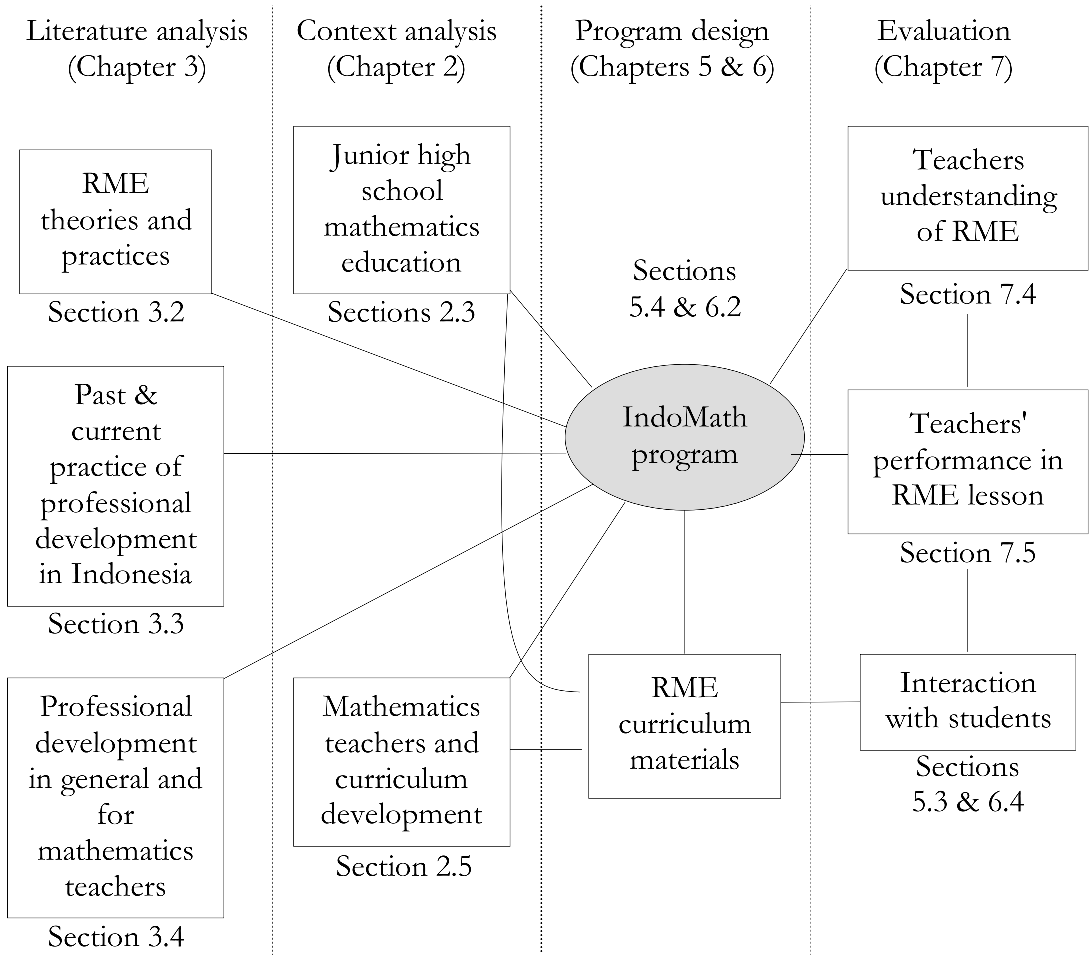


Figure 3.1
Conceptual framework of the IndoMath study

Figure 3.1 illustrates the major elements of the IndoMath Study: the development of the IndoMath in-service program took into account RME theories, past and current practice of professional development program in Indonesia, and the principles of effective professional development. The context analyses were mainly focused on junior high school (JHS) mathematics education, and curriculum development in Indonesia. These aspects influenced the decision of RME topics chosen for the in-service course on the assumption that they should be highly relevant to the current JHS mathematics curriculum content. Furthermore, as far as the impact of the program is concerned, two aspects were evaluated, namely the participants' understanding of RME and their performances in RME lessons. To evaluate RME understanding, Realistic Contextual Problem Test (RCP-Test) had been developed. Moreover, the performance of the participants after the program was evaluated by means of an innovation profile sheets (van den Akker & Voogt, 1994). The observation on the teachers' interaction with the students was carried out to obtain the teachers' performance and understanding of RME, and also to find out the usability of RME exemplary curriculum materials in the real classroom practice. Thereby it might contribute to the improvement of RME curriculum materials for subsequent implementation. By doing so, all aspects of the program design, evaluation, and implementation can be documented and analyzed.

In the subsequent sections of this chapter, RME is elaborated into several key concepts, namely the basic assumptions (its background and definitions), the conception of learner and learning, the conception of content, the conception of teacher and teaching, the conception of context, and the RME practices and its possible obstacles in school. The nature and scope of in-service training and its impact on mathematics education in Indonesia are summarized based mainly upon the results of the diagnostic survey conducted by MoEC (Suryanto, 1996; Somerset, 1997). The last section is devoted to the discussion of several aspects of effective professional development, which is apparently important as a basis for the design of the IndoMath program.

3.2 REALISTIC MATHEMATICS EDUCATION

3.2.1 Basic assumption

The concept of RME may not be known fully by the mathematics educators in Indonesia. The RME originally developed in the Netherlands. This approach is based on Freudenthal's concept of mathematics as a human activity. Freudenthal has a perception that students cannot be viewed as passive receivers of ready-made mathematics. Therefore, they should direct mathematics education to the use of a variety of situations and opportunities that enable students to reinvent mathematics. Many problems can be raised from learned situations. The problems are perceived relevant to become sources of learning (Gravemeijer, 1994).

Mathematical concepts are developed from a mathematization process. It seems that when Freudenthal rephrased 'mathematics as a human activity' he reflected the mathematicians' activity (he himself is a mathematician). In mathematical activities, one solves problem, looks for problems, and organizes or mathematizes a subject matter (Gravemeijer, 1990, 1994). It is the same way that we should naturally do in mathematics teaching and learning for children. Starting from context-linked solution, students gradually develop tools and understanding of mathematics to a more formal level. The models that appear in students' mathematical activities can trigger interactivity in the class from which students come to a higher level of mathematical thinking.

In RME, the *real world* is used as a starting point for the development of mathematical concept and ideas. Real world is the rest of the world outside mathematics, i.e., school or university subjects or disciplines different from mathematics, or everyday life and the world around us (Blum & Niss, 1989). Yet, we have to be careful because the real world here is the world that is concrete for students. A concept may be concrete for a mathematician, but is not necessarily concrete for children. De Lange (1996) defines a *concrete real world* as the world that comes across to children and students through mathematics in applications. It is a way to understand students' mathematical learning as it occurs in the real situation.

The process of developing mathematical concepts and ideas starting from the real world by de Lange (1996) is called 'Conceptual Mathematization'. A schematic model for this learning process is depicted in Figure 3.2.

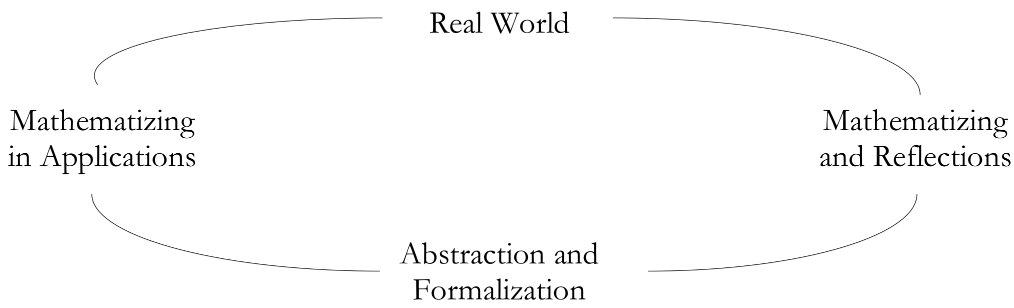


Figure 3.2
Conceptual mathematization (de Lange, 1996)

We see that there is no end in the cycle, which means that the emphasis is on the process as opposed to content or outcomes. It is assumed that knowledge is a transformation process, being continuously created and recreated, not an independent entity to be acquired or transmitted. The student's real world is adjusted continuously.

Applied problem solving is an initial approach to teaching mathematics in a real context. Blum and Niss (1989) define a *problem* as a situation, which carries with it certain open questions that intellectually challenge somebody who is not in immediate possession of direct methods sufficient to answer the question. Mathematical problems are divided into applied problems and purely mathematical problems. An applied problem refers to a problem where the situation and the questions defining it belong to some segment of the real world and allow some mathematical concept, method, and result, to become involved. In a purely mathematical problem, the defining situation is entirely embedded in some mathematical universe. Problem solving is the entire process of dealing with a problem – pure or applied – in attempting to solve it.

Applied problem solving goes through the following four steps (Blum & Niss, 1989):
#1 A real problem situation. This situation has to be simplified, idealized, structured, and made more precise by a problem solver, according to his or her interest. This leads to
#2 a real model of the original situation. This real model has to be
#3 mathematized, i.e., its data, concepts, relations, conditions, and assumptions, are to be translated into mathematics. This resulting in
#4 a mathematical model of original situation.

Mathematization is a process from the real model (#2) into mathematics (#3). Modeling or model building is the entire process from the original real situation (#1) to a mathematical model (#4) (Blum & Niss, 1989).

Treffers (1987, 1991) distinguishes two types of mathematization, i.e. vertical and horizontal, which are described by Gravemeijer (1990, 1994) as reinvention process (Figure 3.3).

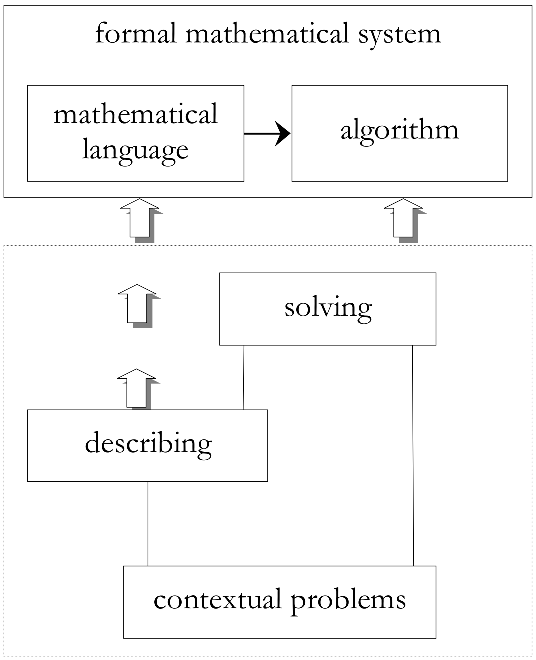


Figure 3.3
Horizontal and vertical mathematizations (Gravemeijer, 1990)

In a horizontal mathematization (depicted by a broken-line box) the learner starts from contextual problems, then tries to describe the problems using own language or symbols, and solves the problems. In this process it is possible that each learner has his or her own way which is different form others' solution. In vertical mathematization it is also started by contextual problems, but then in the long run, the learners can construct certain procedure that can be applied to the similar problems directly, not necessarily using a bridge of the context. Gravemeijer (1990, 1994) calls this as mathematization of mathematical matter, as distinghuized from horizontal mathematization, which is the mathematization of contextual problems.

RME can be distinguished from other theories in mathematics education such as mechanistic, empiristic, and structuralist according to the presence or absence of the components of horizontal and vertical mathematization (Treffers, 1991).

	Horizontal	Vertical
Mechanistic	-	-
Empiristic	+	-
Structuralist	-	+
Realistic	+	+

Figure 3.4
Mathematization and directions (Treffers, 1991)

Treffers (1991) perceives that both components of mathematizing are missing in machanistic education. This approach is algorithmic in nature and has a tendency to become the 'teaching as telling' and drill of rules and regulations. In empiristic education, horizontal mathematizing is clearly manifested using informal and context-bound as the basis of instruction, but without the support of intermediary models, schemes, and the like, the instruction does not tend toward the formal level. In structuralistic education operations, structures, and the like, are concretized with the aid of structured materials in order to represent the subject systems concretely and perceptibly. Vertical mathematizing takes place with this structural material. However, applications do not appear until learning how to operate with certain procedure takes place. As a consequence children cannot build on further their own natural and informal methods.

3.2.2 Conception of the learner and learning

According to van Hiele (cf. de Lange, 1996) the process of learning proceeds through three levels:

- A student reaches the first level of thinking as soon as he or she can manipulate the known characteristics of a pattern that are familiar to him or her.
- As soon as he or she learns to manipulate the interrelatedness of the characteristics he or she will have reached the second level.
- He or she will reach the third level of thinking when he or she starts manipulating the intrinsic characteristics of relations.

Traditional instruction is inclined to start at the second or third level. According to de Lange (1996) this should not be the case if we start in the real world. The researchers at the Freudenthal Institute notice that the significance of the level theory of van Hiele does not exist in its theoretical use, but it does in its practical implications. Firstly, mathematics has to start on a level at which the concepts used have a high degree of familiarity for the students, and secondly its aim has to be the creation of a relational framework (Gravemeijer, 1994).

Although RME and constructivism are not the same, to some extent they have some compatible characteristics, one of which is the similarity of the conceptions of learning and learners in both theories. As are the case to constructivism, the following conceptions are relevant to RME (Anderson et al., 1994; Louck-Horsley, et al., 1998; van den Berg, 1996):

- Each learner brings his or her preconceptions to the educational experience. These preconceptions are highly influential on subsequent learning. Learners possess a diverse set of alternative conceptions about mathematical ideas that influence their future learning;
- Each learner actively constructs meaning. Learners acquire new knowledge by constructing it for themselves;
- Each learner is ready to share his or her personal meaning with others, and based on this negotiation process, reconceptualizes the initial knowledge structures. The construction of knowledge is a process of change that includes addition, creation, modification, refinement, restructuring, and rejection;
- Each learner takes responsibility for his or her learning. The new knowledge learners construct for themselves has its origin in a diverse set of experiences;
- Each learner is convinced that success in learning with understanding is possible. In other words, all students regardless of race, culture, and gender are capable of understanding and doing mathematics.

The conception of learning in RME is in line with the conception of learners. The starting point in the learning process of the realistic approach is emphasized on the conception that the students are familiar with. Each learner has a preconception or a set of alternative conceptions about mathematical ideas. After a student is involved meaningfully in a learning process, the student develops the conceptions to a higher level. In this step, the student actively acquires new knowledge. The construction of knowledge is a process of change that proceeds slowly from the first to second and then to the third. In this process the student is responsible for his own learning.

3.2.3 Conception of the content

We can propose a framework for thinking about mathematical ideas through an exploration stage, a concept identification stage, and an application stage that triggers a new exploration stage that can be used to generate a mathematical concept. This is a cycle process without objective in advance. There is no intention to come to a certain end. The learning progress relies highly on the students' ability in acquiring new knowledge.

Gravemeijer (1994) argues that there is no place for a pre-program teaching-learning process, since the whole process will depend on the individual contribution of the students and has to be interactively constituted between the teacher and the students.

Based on Gravemeijer's argument, Clarke, Clarke, and Sullivan (1996), conclude that RME draws its basis from both the view of mathematics as a process of invention and a social constructivist's view of learning. Designers of curriculum support resources did not tend to have clear objectives or specific skills in mind and saw the classroom trial of materials as a vital component of development process. In developing RME, the working group in the Freudenthal Institute also formulated the standard for national assessment in schools. The assessment was emphasized more on the students' process of thinking. For example, a teacher could look at the way the students deal with a problem, such as how they determine the most efficient way to come to the solution.

However, applications and modeling should be part of mathematics curriculum in order to generate, develop, and qualify a critical potential in students towards the use and misuse of mathematics in extra-mathematical contexts (de Lange, 1996).

3.2.4 Conception of the teacher and teaching

Cobb (1994) states that the theory of RME constitutes a highly compatible, domain specific instructional theory that relies on real world application and modeling. The compatibility between constructivism and RME is due, in large part, to the similarity in the characterization of mathematics and mathematics learning. Both contend that mathematics is a creative human activity, and that mathematical learning occurs as students develop effective ways to solve problems (de Lange, 1996; Streefland, 1991; Treffers, 1987). Using the description by Cobb (1994), de Lange (1996) addresses the tenets of RME:

1. The starting points of instructional sequences should be experientially real to students so that they can immediately engage in personally meaningful mathematical activities.
2. In addition to taking into account the students' current mathematical ways of knowing, the starting points should also be justifiable in terms of the potential end points of the learning sequence.
3. Instructional sequences should involve activities in which students create and elaborate symbolic models of their informal mathematical activity.
4. The first three tenets can only be effective if they are realized in interactive instruction: explaining and justifying solutions, understanding other students' solutions, agreeing and disagreeing, questioning alternatives, reflecting.
5. Real phenomena in which mathematical structures and concepts manifest themselves lead to intertwining of learning strands.

The tenets of RME reflect the role of the teachers in mathematics teaching. Ideally, the teachers develop highly interactive instruction, give opportunities to the students to actively contribute to their own learning process, and actively assist the students in interpreting real problems.

De Lange (1991) describes RME teaching as *unteaching*. In order to be a successful RME teacher, one has to learn the 'art of unteaching' which is not easy to realize. Unlike traditional interpretation of teaching as an activity carried out mainly by the teacher, in RME the teaching is more complex than just a well organized sequence of introduction – explanation – exercise – conclusion (like PKG teaching model). In RME the teacher is not supposed to teach anymore. His or her role is emphasized on being an organizer and a facilitator of the students' reconstruction of mathematical ideas and concepts. He or she needs to make his or her own personal adaptation. Gravemeijer (1994) similarly describes that since students are no longer expected to simply produce correct answers quickly by following prescribed procedures, but have other obligations such as explaining and justifying solutions, trying to understand the solutions of others, and asking for explanations or justifications if necessary, the role of the teacher is changed. According to Gravemeijer (1994) the authority of the teacher as a validator is exchanged for an authority as a guide. He or she exercises this authority by way of selecting instructional activities, initiating and guiding discussions, and reformulating selected aspects of students' mathematical contributions.

3.2.5 Conception of the context

In RME a context plays an important role and distinguishes RME from other mathematics teaching approaches, such as the mechanistic and structuralist approaches. By using contextual problems the instruction is directed to the process of reinvention mathematical concepts through horizontal and vertical mathematization. The use of contextual problems as the starting point in mathematics teaching will engage students in meaningful mathematical activities. The problematic nature of RME contextual problems can also trigger interactivity among students. Students gain mathematics knowledge through comparing their answers to others', asking questions, justifying, and drawing conclusions.

The term context in RME refers primarily to the described situation in which the problem is placed, and from what students can produce mathematical activity as well as practice and apply their mathematical knowledge (Gravemeijer, 1981/1982). In RME, the context can also be a mathematical context, as long as the students see it as real. Contexts must be appealing, imaginable, and demanding mathematical organization, and they should be experienced 'real' and it must be possible to mathematize them (de Figueiredo, 1999).

Discussing RME contextual problems usually raises questions about its difference from story or word problems. In solving word problems students seem to follow rules and use symbols without reflecting the specific context where they are used. The students focus on the level of syntax of the problem, without paying enough attention to what the problems is really about (Wyndhamn & Saljo, 1997; de Figueiredo, 1999). While in RME, contextual problems have a number of functions (van den Heuvel-Panhuizen, 1996; de Lange, 1996; Treffers & Goffree, 1985):

- *Concept formation*: In the first phase of a course, they allow the students natural and motivating access to mathematics.
- *Model formation*: Contextual problems supply a firm basis for learning the formal operations, procedures, notations, and rules, in conjunction with other models that function as important supports for thinking.

- *Applicability*: Contextual problems utilize reality as a source and domain of applications.
- *Practice the exercise*: Contextual problems supply opportunities for developing specific abilities in applied situations.

Since the RME instruction depends heavily on the role of contextual problems, teachers have to be aware of the different answers that come up as consequences of these problems. Very often a teacher has to make judgement for his or her students' reactions or conclusion depending on the contexts. Treffers (cf. Gravemeijer, 1990) gives a nice example of problem, i.e. the division 26 : 4, that its answer *depends on* the contexts:

1. *One has to transport 26 persons by cars.*
   Each car takes 4 passengers.
   How many cars will be needed? *[7]*
2. *A rope of 26 meter is cut up in pieces of 4 meter.*
   How many pieces does one get? *[6]*
3. *If 26 bananas are to be fairly divided among 4 people*
   how many bananas will each of them get? *[6.5]*
4. *A walk of 26 km is divided in 4 equal stages.*
   How long is each of them? *[6.5]*
5. *A rectangular pattern of 26 trees with 4 trees a row,*
   How many rows will there be? *[?!!]*
6. *A rectangular terrace with a size of 26 square meters*
   has a width of 4 meter.
   How long is this terrace? *[6.5]*

3.2.6 RME and the reality of school life

As has been mentioned many times before, a realistic perspective implies that learning is embedded in real-life situations. These situations function as a source for content selection and as a context for knowledge construction and application. RME provides a visionary statement for a radical new conception of schooling, teaching, and learning in Indonesia. But the Netherlands experience shows us that changing from conventional to more realistic practice will be a long and difficult process (de Lange, 1996).

Yet the success story of the Netherlands – although it took more than 20 years – in implementing RME has attracted the National Science Foundation in the United States to provide funds for a series of major development initiatives. One of these, *Mathematics in Context* (Clarke, Clarke & Sullivan, 1996; Romberg et al., 1991) involved a collaboration between the Netherlands and the United States. The data indicate that this international collaboration has been a worthwhile enterprise, in that 'the wisdom of practice' for many years in the Netherlands has been used as the starting point for curriculum development in the United States (see e.g. Clarke, 1993; Clarke, Clarke & Sullivan, 1996; de Lange, 1994).

The implementation of realistic approach in Portugal revealed several difficulties such as too large classes, inadequate timetable, too content-centered, and too many topics to cover. But from this experience there are several examples which offer ideas and suggestions on how it can be developed with regular classes in normal schools, and it still leaves enough room for other kinds of mathematical activities (Abrantes, 1993; de Lange, 1996).

The implementation of RME could raise some potential obstacles. The following obstacles in mathematics problem solving, modeling, and applications, as addressed by Blum and Niss (1989, pp.11-12) must be considered:
(a). Obstacle from the point of view of instruction. Many mathematics teachers from school or university are afraid of not having enough time to deal with problem solving, modeling, and applications, in addition to the wealth of compulsory mathematics included in the curriculum. Furthermore, some teachers even doubt whether applications and connections to other subjects belong to mathematics instruction at all, because such components tend to distort the aesthetic purity, the beauty, and the context-free universality of mathematics.
(b). Obstacle from the learner's point of view. Problem solving, modeling, and applications to other disciplines, make the mathematics lesson unquestionably more demanding and less predictable for learners. Routine mathematical tasks such as calculations are more popular with many students, because they are much easier to grasp and can often be solved merely by following certain recipes.
(c). Obstacles from the teacher's point of view. Problem solving and references to the world outside mathematics make instruction more open and more demanding for teachers and make it more difficult to assess students' achievements. Moreover, many

teachers feel they are unable to deal with applied examples which are not taken from the subjects they have studied themselves. Very often teachers simply either do not know enough examples or they do not have enough time to adapt examples to their actual classes.

3.3 THE NATURE AND SCOPE OF PROFESSIONAL DEVELOPMENT IN INDONESIA

Indonesia has a long history on professional development programs for teachers through PKG project, that is a project of strengthening teachers' competencies. This project was initially supported by UNDP (United Nation Development Program) which ran from 1978 to 1984. This project has been continued after 1984 with support from the World Bank. It began with supporting secondary teacher improvement activities in Indonesia in 1984, through the First Secondary Education Project, and continued to do so from early 1990s through its successor, the Second Secondary Education and Management Project up to the present.

The PKG project has three training levels: national, provincial, and district/school levels (Figure 3.5). At the national level, there are training for *supervisor* (LKP) and for *instruktur* (LKI). At present, most supervisors are not specialists in a teaching subject, so the role they have played in teacher development activities has been managerial rather than professional.

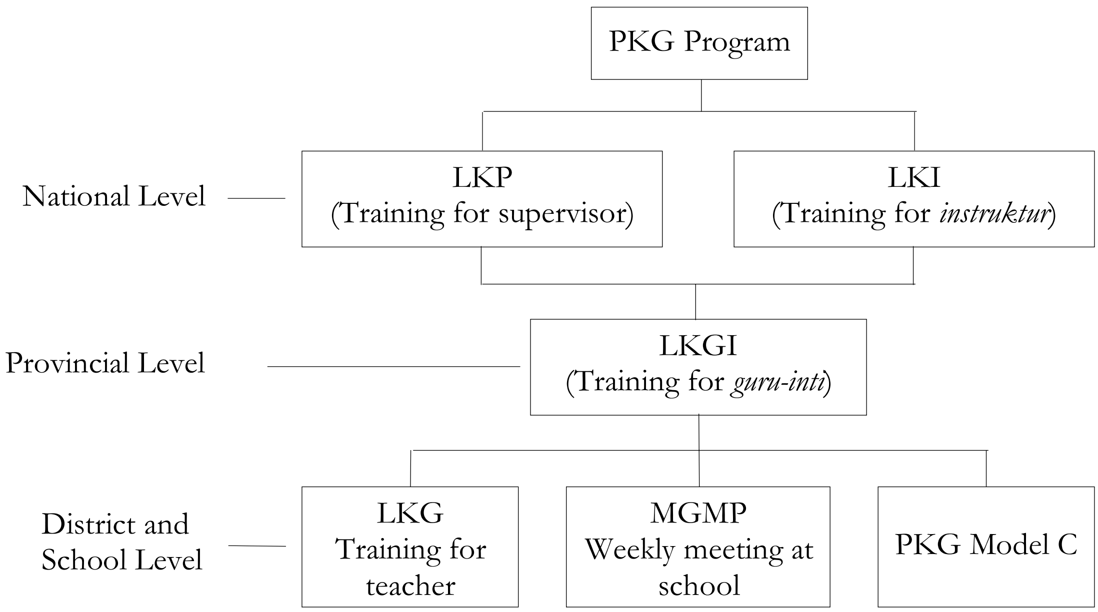


Figure 3.5
Diagram of training steps of PKG Project

Every *instruktur*, who works at the provincial level, is responsible for: (i) delivering PKG Model C program to the teachers from isolated schools, including regular visits to the participating schools; (ii) guru-inti training (LKGI); and (iii) monitoring the work of guru-inti through regular visits to MGMP activities. At provincial level there is training for guru-inti (LKGI). Guru-inti work at the district (*kabupaten*) and school cluster level. They are responsible for running MGMP teacher development activities, and for carrying out regular visits to all junior high schools in their cluster.

PKG has several defining features (Somerset, 1997):

- The trainers for this program mainly are practicing teachers, instructors and guru inti.
- The main emphasis of the program is on subject-specific and concept-specific pedagogy rather than on subject knowledge.
- There have been three stages in the development of the PKG delivery system, each of which is more decentralized than its predecessor:
  a. Phase 1 (late 1970s to mid 1980s). The PKG program was originally delivered through a rather complex model, combining in-service block, weekly meetings, and 'on-service' visits. This original program produced a substantial impact on student learning, but because it was run at the provincial level, it became prohibitively expensive when extended to schools located at any distance from the provincial capitals.
  b. Phase 2 (mid 1980s to early 1990s). Training was gradually decentralized to the *kabupaten* (district) level through the *Sanggar* PKG program.
  c. Phase 3 (since early 1990s). Training was further decentralized to the sub-district or school-cluster level, through the MGMP program. At about the same time a new program, PKG Model C, was introduced to serve teachers who were unable to attend weekly MGMP meetings, because their schools were too remote. Because in most places the numbers involved are relatively small, this program is run at the provincial level.

Somerset (1997) notes that despite PKG's long history, wide coverage (training teams are established in every district in the Republic), and many innovative features, the program remains badly under-documented. No comprehensive account of PKG has ever been published; while the few summary accounts that have been written are, for the most part, difficult to locate. Therefore a comprehensive study was conducted through three sets of activities during 1996, all funded by the Japan Grant Fund (Somerset, 1997). The results of these activities disclosed that students of junior secondary schools have poor performance in mathematics (Suryanto, 1996; Somerset, 1997). For example, only 17% of the students tested could solve the inequality $8p + 4 > 4p - 12$; and only 19% could express the three sets, $S = \{2,3,5,7,13\}$, $H = \{2,7\}$ and $K = \{2,5,7\}$ in one Venn diagram. Even in everyday number application problems, performance levels were low: only 16% could express a price rise from Rp 12,000 to Rp 15,000 as a percentage increase.

Many of the difficulties experienced by the junior high school students have their origins at the primary school (Suryanto, 1996; Somerset, 1997):

- Most students lacked understanding of decimal number values. Understanding of metric values also tended to be shaky.
- Skill in carrying out routine number operations was often lacking, and there were numerous systematic errors.
- In a set of six everyday number problems (involving time, money, proportion, perimeter, and area), the proportion of correct answers ranged from 65% down to below 20%. Most of the difficulties occurred during the early stages of problem solving: students either failed to read the given information correctly, or made faulty decisions as to which number operations were needed to reach the answer. Calculation errors, among those who managed the first two steps successfully, were relatively uncommon.
- In most questions, students in their third year of junior secondary education (Grade 9) performed only a little better than those in their first year (Grade 7); and in a few questions (e.g., the addition of fractions) their performance was actually poorer. It seems that in the schools visited, the junior secondary mathematics course does little to reinforce the mastery of basic number concepts and skills taught at the primary level.
- The performance of students in the four moderately isolated rural schools lagged well behind the performance of the students in schools located in provincial and district capitals. Overall, students in the rural schools gave only about half as many correct answers as students in the urban schools, but in the more difficult questions the performance gap was usually much wider.

3.4 PRINCIPLES OF EFFECTIVE PROFESSIONAL DEVELOPMENT

The implementation of RME in Indonesia could be a complex innovation process because it relates to the changing of teachers' beliefs, implementation of new methods, and use of new materials (Fullan, 2001). Therefore, the first plausible step is how to develop an instructional program that promises to make teachers understand RME. This step is important as a prerequisite before the teachers are ready to use it in their lesson.

When there is a problem regarding the introduction of a new material or approach in education, the natural question to answer is what strategies are effective to bring the teachers gradually come to understand, and become skillful and competent in the use of new ways. Appropriate interventions are needed to reduce obstacles in the introduction process. Even for a simple innovation effort, such as using a new curriculum, most teachers need some additional time and supports to understand and to be able to use it in practice (Hall & Hord, 2001). Sometimes the introduction of a new approach faces challenges from teachers who are already stable with his or her own approach.

In order to make teachers understand RME and prepare them for effective RME implementation, appropriate strategies are needed. An in-depth study of literature on professional development suggested that several principles be included in the intervention process (see e.g. Loucks-Horsley, et al., 1998; Ball & Cohen, 1996; Borko & Putnam, 1996; Joyce & Shower, 1988, 1995; van den Akker, 1988, 1998). An effective in-service program should give enough room to teachers to reflect their own experiences and beliefs. It should also give them an opportunity to practice the innovation in real setting. Moreover, in order to be effective teachers should be treated as learners consistent to the ideas behind the new way of teaching. Another important principle is that the intervention should benefit teachers to enhance their subject and pedagogical content knowledge. The professional development must support teachers for continues learning. Last but not least, the strategy chosen during professional development should be in line with the purpose of the intervention. These principles are elaborated further as follows (see also Hadi, 1999).

3.4.1 Addressing teacher's existing knowledge and beliefs

The successful professional development should give teachers an opportunity to do learning to learn. In order to be successful, efforts to support teachers' learning must recognize that teachers' knowledge and beliefs about teaching, learning, learners, and subject matter, will play a critical role in determining whether and how they implement new instructional ideas (Borko & Putnam, 1996). Loucks-Horsley, et al. (1998) similarly state that professional development should provide opportunities for teachers to build their own knowledge and skills. This principle advocates the importance of reflection of the teachers’ own experience in teaching.

We have to shift professional development programs from teachers as objects to teachers as the subjects of professional development.

Some other authors also share a common idea that reflection is one of the key components in professional development of teachers (Kruse, 1997; Cooney & Krainer, 1996; Comiti & Ball, 1996). In almost all works in the area of professional development, reflection is mentioned as a core component. For example, Cooney and Kramer (1996) strongly state the need for emphasizing a reflective component in any in-service training program. They give an argument that an in-service training is far more complex than simply increasing teachers' knowledge of mathematics. Through in-service program teachers explicitly consider the implication of their own learning experiences for their teaching and for creating contexts in which pedagogy and content are intertwined in a reform minded way. By including a reflective component, it shows that the teachers are treated not as 'objects' that will be 'filled' with new knowledge and skills, but rather as rational thinking beings that are not only capable of reflecting new 'things'. The teachers should be encouraged to do the reflection as part of the in-service training strategy to facilitate internalization of new approaches, knowledge and skills.

3.4.2 Grounding learning in classroom practice

Teachers must have the opportunity to learn and reflect about new instructional strategies and ideas in the context of their own classroom practice (Borko & Putnam, 1996). The importance of practice in training of teachers can be seen from its contribution to the development of the knowledge and skills of the teachers. The combinations of theory, demonstration, practice, and feedback, result in an effect to teachers' knowledge and skills (Joyce & Shower, 1995). The implication of this is that, according to Joyce and Shower, staff development should give the participants a sufficient opportunity to practice in classroom setting. Ball and Cohen (1996) also state the importance of classroom practice to enhance teachers' learning. Van den Akker (1988, 1998) proposes the creation of curricula that would help teachers to better enact in practice, particularly if they are given concrete structured materials with procedural specification. The idea of classroom practice is based upon the premise that curriculum enactment is jointly constructed by teachers, students, and materials in particular contexts.

3.4.3 Teachers as learners

According to Borko and Putnam (1996) each successful in-service project treats teachers as learners in ways that are consistent with the perspective on student learning. In this case the teachers should be given experiences with teaching approaches that are similar to those to be used in the classrooms. For example if the teachers are expected to use the realistic approach to teaching mathematics, then they should have experience and perceive how the approach does. So, the in-service training should not merely tell them what or how the 'RME approach' is, but it should let the teachers learn mathematics as they are expected to teach it. In the words of Loucks-Horsley, et al. (1998), it is called mirrored methods to be used with their students.

3.4.4 Learning subject and pedagogical content knowledge

Learning for teachers should be grounded in the teaching of particular subject matter domains and should provide opportunities for teachers to enhance their own subject matter knowledge and beliefs (Borko & Putnam, 1996). In order to be successful in teaching teachers should have deep and broad understanding of the subject. This is a potential way to reduce teacher anxiety in teaching. For a long time learning subject matter has become a central orientation in mathematics teacher education. The teacher must become more and more competent in mathematics: 'He who knows mathematics, knows how to teach it' (Boero, Dapueto & Parenti, 1996). More than just mastery the subject matter, the knowledge how to teach it, is also crucial. According to Loucks-Horsley, et al. (1998) teacher professional development should help teachers develop in-depth knowledge of their disciplines as well as pedagogical content knowledge.

3.4.5 Time and support

Teachers must be provided with sustained time and support for reflection, collaboration, and continued learning (Borko & Putnam, 1996). Swafford, Jones, Thornton, Stump, and Miller (1999) report the effects on instructional practice that result from enhancing teachers' content and pedagogical knowledge within an infrastructure that support collaborations and reflection. From an analysis of both qualitative and quantitative data, Swafford, et al. (1999) reveal that teachers' perceptions and approaches to curriculum became more balanced, their classrooms became more open, they used more problem-focused approach to instruction, and they developed more confidence and autonomy.

3.4.6 Conformity of purpose and strategy

Each in-service program has a specific purpose in line with the teachers' needs and educational demand. Loucks-Horsley, et al. (1998) identify some purposes of professional development in relation to the strategies practiced. The strategy should be chosen wisely according to the purpose of the in-service training, whether developing awareness, building knowledge, translating into practice, practicing teacher, or reflecting. Each strategy has a main purpose and some side-effect purposes. For example, the *immersion in inquiry* strategy has the main purpose to build knowledge, but at the same time can develop awareness of a new approach and content, and reflects of the teachers' experiences in the classroom.

Higgins and Leat (1997) propose what they called 'What' versus 'How', that is 'What changes' (subject knowledge, pedagogical knowledge, craft knowledge, images and self concept, and understanding goals of education) and 'How it can be changed' (instruction, modeling, induction, coaching, peer coaching, action research, and critical inquiry). When we talk about strategies it is not a matter of what strategy is better than others. Both Loucks-Horsley, et al. (1998), and Higgins and Leat (1997) agree that professional development could include combination of some strategies in order to enrich the professional learning of teachers.

In conclusion, this literature study has identified the principles of effective professional development. Principles are conceptual guidelines that inspire the program. The next step is how to translate these into practice. We need strategies to make these principles practically meaningful. This is a clear difference between a principle and a strategy. To be effective, the professional development effort should take into account the above principles. It is a sort of prerequisites for the effective professional development. The strategy is a kind of procedure that should be followed in practice. In the concept of Loucks-Horsley, et al. (1998) the principles are part of knowledge that support professional development, whereas a strategy is a sort of learning experience that has identifiable characteristics that make it recognizable when implemented.

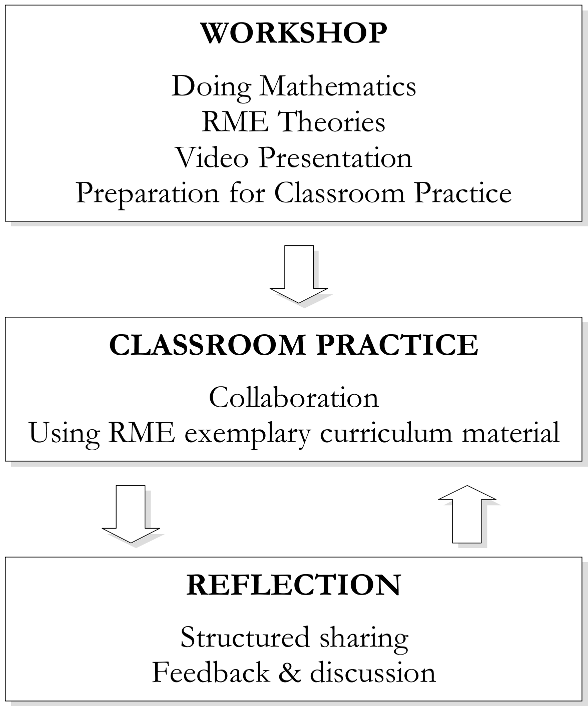


Figure 3.6
Teachers' development model of the IndoMath program

The strategy of the IndoMath program follows the model of the educational change depicted in Figure 3.6. In this model instructional practice is seen as being influenced by the teachers’ subject matter and pedagogical content knowledge, their opportunity to experience new practice in a real setting, with collaboration and reflection being mediating factors between enhanced teacher knowledge and the implementation of new practice (Swafford, et al., 1999). So, the strategy of intervention in the IndoMath study is a combination of workshop, classroom practice and reflection.

During the workshops, participants are directed to work in a way that helps them to understand RME exemplary curriculum materials as well as their pedagogical perspective. For these purposes the key elements in the **workshops** are the strategy that is called by Loucks-Horsley et al. (1998) as immersion in inquiry, i.e.:

- teachers are immersed in an intensive experience in which they focus on learning mathematics and are able to pursue content in-depth;
- the goal of these experiences is to engage the teachers in firsthand learning of

what they are expected to practice in their classroom – guiding students through exposure of contextual problems in order to be able to reconstruct mathematical ideas and concepts by themselves;
- one of the outcomes of the in-depth immersion in the exposure of contextual problems process is a change in the teachers' conception of the nature of mathematics teaching and learning.

The **classroom practice** is another component for improving teachers' knowledge and skill on the subject matter. The strength of this component is that it is supported by curriculum materials that enable the teachers to focus on the pedagogical aspect of the new curriculum. The teachers' time is devoted to learning the content necessary to teach the new curriculum, learning how to conduct the activities, learning how students can best learn new materials, and incorporating the new curriculum into their long-term instruction (Loucks-Horsley, et al., 1998).

Reflection appears in many aspects of human activities as Bengtsson (1995) states: it is something that occurs in action, it could be a cognitive activity, and it could be a sort of self-research as well. Literally, the word 'reflection' comes from Latin verb 'reflectere' which means 'turn back' (flectere = turn, re = back). The crucial issue in reflection is how its process is performed. In the IndoMath program teachers' reflection process was performed through three aspects as described by Kruse (1997):
- Viewing one's self as a resource;
- Relationships with other teachers as resources; and
- Ability to identify multiple sources of knowledge.

Viewing one's self as a resource includes an acknowledgement of one's own skills and abilities. Experienced teachers could get more benefit from self-reflection because of the strong understanding and skills they have. However, self-reflection is limited. Bengtsson (1995) does not suggest that, by reflecting, a teacher can learn everything about him or herself and his or her professional activities, or that reflection is the only way to get knowledge about oneself. In this matter the relation with colleagues is important. As teachers build relationships with others, they must focus on improving their ability to seek other ideas and opinions concerning expert practice. This can be achieved in school community. As they selectively sought information and ideas from their colleagues they were involved in an ongoing process of scrutiny – considering all aspects of situation – including the quality of the information they received, their ability to employ these new ideas in their current situations, and identification of what class situation might need further attention following these changes (Kruse, 1997).

3.5 Summary of Conceptual Framework

Following the line of reasoning in this chapter, there are three main ideas that build the rational for the IndoMath study. First, RME is the central theme of this research. The IndoMath in-service program is designed with the purpose to introduce this innovation in Indonesia, and can be regarded as a preliminary step for the reform movement in mathematics education. RME is considered relevant to the current thinking among people (the government and teacher educators) in Indonesia about the need for improving the mathematics education toward problem solving oriented instruction, contextual and student-centered learning. Second, it is realized that Indonesia has taught mathematics at schools since 1973, and many efforts have been done to support the teaching. One of these efforts is the in-service training for the teachers. The new initiative of professional development apparently can take advantage from this experience. For instance what is the weakness of the previous measure that makes the teaching of mathematics in Indonesia remain unsatisfactory. Third, the literature in the field of professional development gives the reference of the principles of effective teachers change model. These principles build the basis for the development of the IndoMath program.

Moreover, the development of the IndoMath program also takes into account the RME theory and its practices from other countries. The Mathematics in Context (MiC) curriculum materials (which is developed in the USA) has been adapted as the model of the Indonesian version of RME exemplary curriculum materials. The IndoMath program cannot be separated from the availability of RME curriculum materials with the Indonesian context. Fortunately, the development of the IndoMath program is conducted in cyclic nature (design, evaluation and revision). One of these cycles is the evaluation of teachers' performance in classroom lessons. Teachers' interactions with students provide insight about the applicability and usability of the Indonesian version of RME exemplary curriculum materials, which subsequently contribute to the improvement of the curriculum materials.

❹

General Research Design of IndoMath Study

This chapter discusses the various aspects of development research activities in the IndoMath Study. This study was developed along the lines of formative research: orientation, design and evaluation of intervention, and evaluation of its effectiveness (Section 4.3). The research has been conducted during the three fieldworks in Indonesia. In the first and second fieldwork, the focus was mainly on the design and evaluation of adapted RME exemplary curriculum materials as well as in-service education program (Section 4.4). In the third fieldwork, the focus was on the effectiveness of intervention to introduce RME to Indonesian mathematics teachers (Section 4.5). At the end of this chapter the various aspects of evaluation activities in the IndoMath Study are summarized.

4.1 Introduction

The IndoMath study focuses on designing and evaluating an instructional program to introduce RME to Indonesian junior high school (JHS) mathematics teachers. The aims of the study are twofold, namely to make teachers understand RME and prepare them for effective implementation of RME in their classes. The overall research question in the IndoMath study was formulated as:

> *What are the characteristics of the in-service education that make Indonesian teachers understand RME and prepare them for effective implementation of RME in their classes?*

The study was conducted through the stages of orientation, development, and evaluation. In the orientation stage, it analyzed the literature on RME and the RME lesson material that was relevant to the current JHS mathematics curriculum and promised to be adapted to the Indonesian context (see Chapter 3). This analysis resulted in tentative adapted RME exemplary lesson material in Indonesian (a student material and teacher guide), and the preliminary design guidelines for the development of the in-service education program. Subsequently, in the development stage, the adapted RME curriculum material and the preliminary model of in-service education program were formatively evaluated in the first fieldwork in Indonesia. After the first fieldwork in Indonesia, the activities focused on the reflective analysis of the process and outcomes of the formative evaluation of the adapted curriculum material and the in-service education model. This reflective analysis resulted in new adapted RME exemplary lesson materials for several other topics, and the revised model of the in-service education program, which subsequently were formatively evaluated in the second fieldwork in Indonesia. Finally, in the evaluation stage (the third fieldwork in Indonesia), it evaluated the effectiveness of the IndoMath program in achieving its goals, namely to make teachers understand and effectively capable of using RME lesson material in the classroom.

The above processes of orientation, development and evaluation highly reflected the nature of development research. How and why this approach was considered as an appropriate approach for the IndoMath study is elaborated in the following section.

4.2 DEVELOPMENT RESEARCH

The implementation of RME to Indonesian schools seems to be a complex process for two reasons. First, there is no single curriculum material in the country (in Indonesian) that is developed intentionally starting from RME theories. Second, the RME is a new theory for many people in Indonesia (especially teachers, teacher educators, and students). According to Fullan (2001) educational innovation is a complex endeavor because it is related to the change in a teachers' belief, introduction of new curriculum materials and a change in teaching methods. Because of this complex situation, under uncertain circumstances (e.g. the government is in the process of developing a new curriculum for schools, no exception for the mathematics subject matter), timely and adequate information is required for the designer to make the right choice in such a dynamic situation.

Development research could be an appropriate approach in a complex situation where the effectiveness of the intervention is unknown beforehand and its success depends on the implementation process within the wide variety of the contexts (van den Akker, 1999).

Development research is a systematic study of designing, developing and evaluating instructional programs, processes, and products that must meet the criteria of validity, practicality, and effectiveness (Seels & Richey, 1994; van den Akker & Plomp, 1993; van den Akker, 1999). Development research can be distinguished into two types depending on its purpose and the time the development process takes place (van den Akker, 1999):

- *Formative research.* In formative research the activities are conducted during the whole development process of a specific intervention aiming at the improvement of the quality of intervention or product.
- *Reconstructive studies.* In reconstructive studies the activities are conducted sometimes during, but often after the development process of several interventions aiming at articulating and specifying the design principles.

Van den Akker's typology of development research is similar to the types of development research distinguished by Richey and Nelson (1996). The latter distinguish two types of research or study. Type 1 is the research related to the development of an instructional program (or concrete lesson materials) and generating an empirical basis for the direction of design and evaluation of such a product. Type 2 is the study related to the analysis of the previously developed research project that results in the methodological direction of the effective processes.

The IndoMath study can be categorized as *formative research* (type 1). The purpose of the research is to document the entire development process of an in-service education program for mathematics teachers in Indonesia (from orientation, development, and evaluation), and to learn the conditions that support the program implementation. The expected results of the IndoMath study are: insights into the high-quality adapted RME lesson materials for the Indonesian context, and lessons learned about the characteristics of effective in-service programs to introduce RME to mathematics teachers in Indonesia.

The formative evaluation in the IndoMath Study is summarized in Table 4.1 and will be discussed in the remainder of this chapter.

Table 4.1
Focus of the formative evaluation of the IndoMath Study

		Prelim. design (Net. period)	**First version (Indonesia 1st field work)**		**Second version (Indonesia 2nd field work)**	**Third version (Indonesia 3rd field work)**
		Experts (n = 2)	*Experts (n = 3)*	*Target learners (n = 10)*	*Target learners (n = 18)*	*Target learners (n = 16)*
Validity	RME exemplary lesson materials	Expert appraisal		Classroom observa-tion		
	Inservice program components	Expert appraisal	Expert appraisal			
Practicality	RME exem-plary lesson materials			Small-scale tryout	Classroom observa-tion	
	Inservice program components			Program tryout	Program tryout	
Effectiveness	Entire program					- Pre and posttest - Program implemen-tation - Classroom observa-tion

Note: Prelim. design (Net. Period) = Preliminary design (the Netherlands period);
▭ = Primary attention of formative (semi-summative) evaluation.

In an effort to develop a valid and practical in-service education program as a prerequisite for an effective program to make teachers understand and able to use RME ideas in their classes, the validity, practicality and effectiveness of the IndoMath program were defined as follows.

- Validity: The IndoMath program should be developed based upon theories of RME as well as professional development in order to meet the 'state-of-the-art-knowledge.'
- Practicality: The IndoMath program should meet the local Indonesian constraint, such as that it could be performed in the circumstance of high time schedule of mathematics teachers, that RME exemplary lesson materials should be relevant to the current curriculum, and that the target learners perceived the program relevant and could meet their expectation.
- Effectiveness: The IndoMath program should impact the teachers into acquiring both its theoretical innovation and its practical implication.

Several research projects have been conducted at the University of Twente using the formative research approach, such as those done by van den Berg (1996), Thijs (1999), and Ottevanger (2001). Van den Berg (1996) examines the design of in-service education for the purpose of the implementation of constructivist learning for primary science education. Thijs (1999) explores the potential of peer coaching in the implementation of learner-centered approach in the context of a developing country in Botswana. Ottevanger (2001) studies the role of exemplary curriculum materials as a catalyst in the science curriculum reform in the context of a developing country.

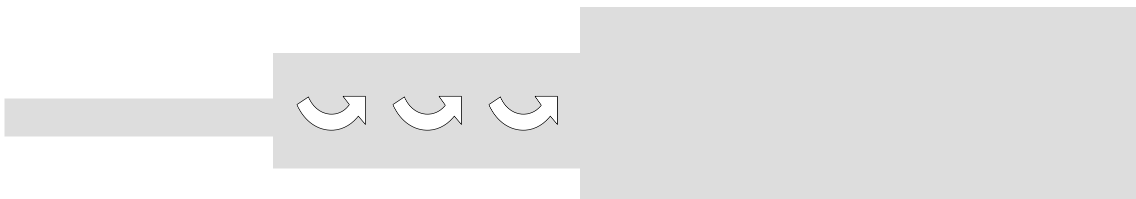
Most development research studies have been performed by using a combination of loose prescribed research design in the orientation and development stages and become more structured when they approach the final stages (Miles & Huberman, 1994). Apparently they are constrained by the dynamic nature of the context where the designs are implemented. Many research designs take this emergent model (Thijs, 1999; Ottevanger, 2001). The design of the study was evolved during the development processes. Sometimes adjustments are made to meet the local context. It depends on the time available, how much has been known about the phenomena under study, the instruments available, and the analysis that will be done (Miles & Huberman, 1994, p. 17).

In the following section the development research in the context of IndoMath study is further discussed.

4.3 DEVELOPING THE INDOMATH STUDY

The formative research in the IndoMath study is characterized by a mix of development and research, as suggested by van den Akker (1999). Its cyclic nature (design, evaluation and revision) and the formative evaluation activities are important to establish evidence of high quality intervention and to generate guidelines for product improvement. In general there are three stages in development research in the IndoMath study, namely orientation, development & evaluation*, and semi-summative evaluation (Figure 4.1).

Orientation	Development & Evaluation	Semi-summative evaluation	
	Fieldwork 1 10 teachers	Fieldwork 2 18 teachers	Fieldwork 3 16 teachers
Sep 98- Aug 99	Sep 99-Feb 00	Sep 00-Feb 01	Sep 01-Feb 02



Literature study on professional development, the RME theory, and curriculum materials	Program tryouts: Workshop Classroom practice with peer collaboration Reflection	Program implementation

Notes: 1. Curved arrows indicate cyclical character of development process; 2. Increasing gray area means gradual up-scaling of project

Figure 4.1
General research design of IndoMath study

* Because of the prominent place of (formative) evaluation in the development process and because most of research activities have evaluative characteristic this stage is labeled development & evaluation.

The above stages are elaborated further as follows.

Almost all development research studies begin with the preliminary investigation on the problems, tasks and relevance literature, as well as the context analysis in which the program being implemented (van den Akker, 1999). Various terms are used for this preliminary activity, such as *front-end analysis* (Nieveen, 1997; Ottevanger, 2001), *needs and content analysis* (McKenney, 2001), and *in-depth orientation* (Thijs, 1999).

The preliminary investigation in the IndoMath study is called *orientation*. In the orientation stage, an analysis of RME literature and RME exemplary curriculum materials was done. The purpose of analyzing the RME curriculum material is to find the topic that is relevant to the current JHS curriculum content adaptable to Indonesian context. In addition, an in-depth review of literature on professional development was done. To assure the quality of the program, 'the state of the art knowledge' was incorporated. (See Section 3.4). A product or program is valid if it reflects state of the art knowledge (van den Akker & Plomp, 1993). This is the content validity. To ensure the construct validity, the components of the product or program should also be consistent with each other..

For the purpose of understanding the context where the program was to be implemented, an analysis of the context had been done as part of the first fieldwork in Indonesia. Based upon the results of this orientation stage, the procedural specifications were formulated. These specifications generated the methodological directions for the design and evaluation of the program.

After the phase of problem and context analysis and the review of literature, the next phase consisted of activities to articulate the design ideas into the empirical development stage. In this stage the clear empirical evidence was sought for the validity and practicality of the program for the target groups in the real setting, as suggested by van den Akker (1999). In this study we use several terms that were used by some researchers for this stage, such as *prototyping phase* (Nieveen, 1997) and *design, development and evaluation* stage (McKenney, 2001). The intended results of this activity were the evidences of the validity and practicality of the first product, and the improved effectiveness of the subsequent products.

In the IndoMath study this stage is called the *development and evaluation* stage. The activities were mainly focused on the formative evaluation of the adapted RME curriculum material and the in-service education program. In this development stage, two fieldwork studies had been conducted in Yogyakarta. In the first fieldwork, the activities were to validate the adapted RME curriculum material. The curriculum material was then used in the in-service education program, which was also tried out and evaluated.

The program evaluation was performed in an integrated form during the development processes. Based upon the result of the first trial-out some revisions were made to the program components, RME exemplary curriculum materials, and program organization. Furthermore, in the second trial-out (as part of the second fieldwork) the evaluation was focused on the usability of RME curriculum material and the practicality of the in-service program. During the second fieldwork some instruments (such as 'Realistic Contextual Problem Test or RCP-test' and 'innovation profile') to be used in the evaluation stage (the third fieldwork) were also field-tested.

The last stage of the development research project is usually devoted to the analysis of the effectiveness of the intervention. Nieveen (1997) uses the term *assessment phase* for this stage in her CASCADE study, while McKenney (2001) calls this stage the *semi-summative evaluation* stage. The activities in this stage were mainly focused on the program's effects on the target learners or the organizational level.

In the *semi-summative evaluation* stage, the IndoMath study (the third fieldwork) was focused on the impact of the IndoMath program to the teachers' understanding of RME and on their performance in carrying out an RME instruction at their own schools. To assess the teachers' understanding of RME, an RCP-test was administrated at the beginning and at the end of the IndoMath in-service program. Classroom observations were conducted daily to collect information on the teachers' performance in RME instruction at their own schools. The observations were conducted three months after the end of the in-service training. An '*innovation profile*' sheet was used for the classroom observations.

In summary, the development research in the IndoMath study proceeded in the following three stages:

1. The orientation stage consisted of the activities during the preliminary phases of the study that was focused mainly on the problems and context analysis, as well as in-depth review of the literature on RME and professional development for mathematics teachers.
2. The development and evaluation stage consisted of the activities during the first and second fieldworks in Indonesia which were concentrated mainly on the formative evaluation of the adapted RME exemplary lesson materials and in-service training.
3. The semi-summative evaluation stage consisted of the activities during the third fieldwork in Indonesian which were devoted to field-testing the effectiveness of the in-service training to evaluate whether it was potential for achieving the program goals. The goals were to make the mathematics teachers understand RME and to enable the teachers teach mathematics using the RME approach.

The results of the orientation stage are discussed in Chapter 3 of this book. In the following section, the development and evaluation stage is discussed. In Section 4.5 the semi-summative evaluation of the IndoMath is discussed.

4.4 PROCEDURE OF PROGRAM DEVELOPMENT AND EVALUATION IN THE FIRST AND SECOND FIELDWORK

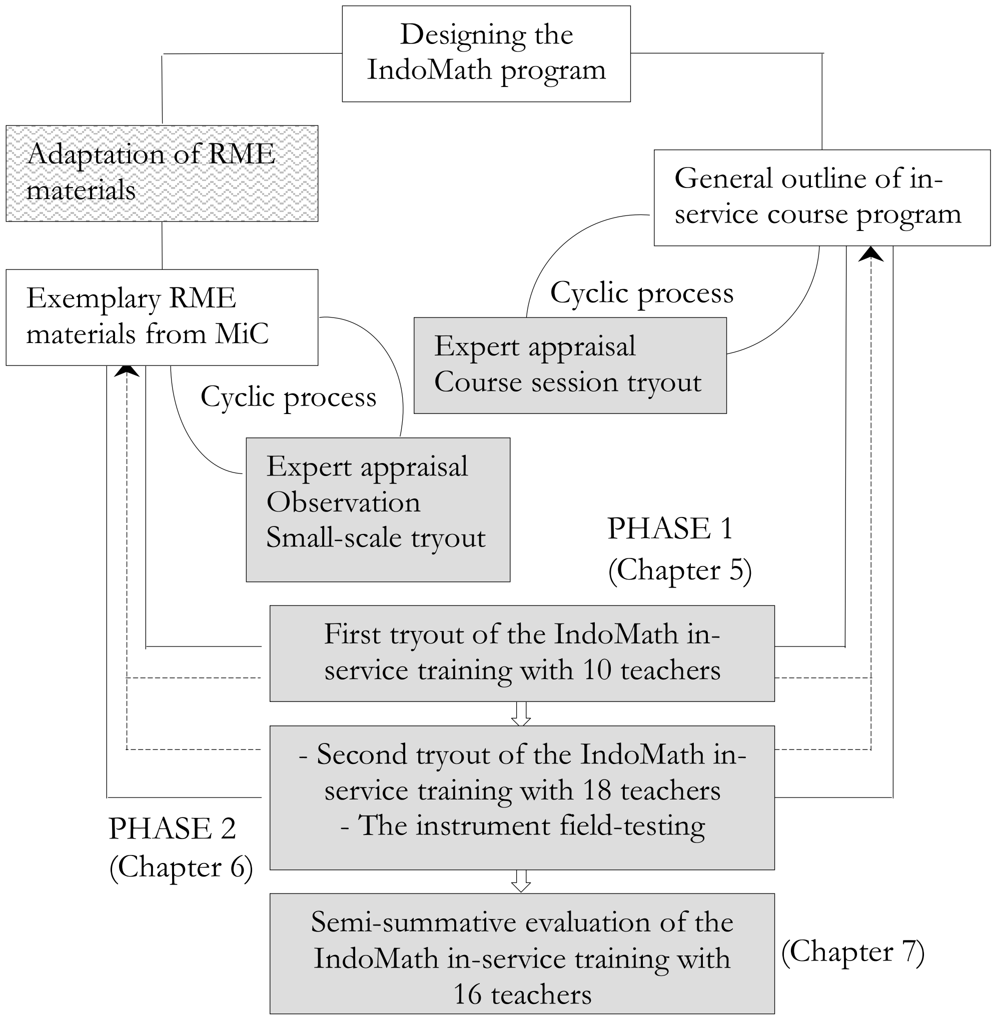
As mentioned earlier, one of the problems in developing the program for this study is that RME curriculum materials that are relevant to the current junior high school curriculum in Indonesia are not available. Therefore, the research question in the development and evaluation stages (in the first fieldwork) was as follow:

How can RME curriculum material be adapted to the Indonesian context?

The next problem in developing this study is the difficulty of organizing an in-service training program for introducing RME to mathematics teachers. Hence, the second question of the first fieldwork of this study was as follow:

What are the characteristics of a valid and practical in-service education that can be used as a vehicle to introduce RME to Indonesian mathematics teachers?

The sequence of activities in designing the study to answer the above research questions, is depicted in the following figure.



Note: = preparation the first adapted RME lesson material;
= draft (versions) of program and lesson material;
= evaluation activities.

Figure 4.2
Procedure of program development and evaluation

To design the in-service program for this study, the researcher examined the principles of an effective professional development program. From the characteristics of effective professional development, the researcher concluded that there were three main components that could be expected to facilitate the researcher in achieving the goals of this study. Those three components were workshop, classroom practice with peer collaboration, and reflection.. These components were formulated into a general outline of the in-service course program and were elaborated into some activities in order to make it clear when to be executed. The elaboration was aimed at supporting the achievement of the goals of this program, that is to make teachers understand RME and prepare them for effective implementation of RME in their instruction at their own schools.

As described in Figure 4.2 the *general outline of in-service course program* was given to the experts to get an *expert appraisal*. The experts who were in charge were a Dutch expert on professional development and on RME respectively, an Indonesian teacher educator, and two Indonesian experienced JHS mathematics teachers. The in-service course sessions were also tried out separately. The results of the expert appraisal and tryout of the course sessions were applied in the revision of the general outline of in-service program. These activities were conducted in a cyclic process: designing, evaluation, and revision. At the same time, the adaptation of RME curriculum materials was performed. The result was some exemplary RME materials from the MiC. The translation of the materials took place in the Netherlands, but the tryout, validation, evaluation of the materials at the classroom level were conducted in Indonesia, in a small-scale tryout. These activities were also conducted in a cyclic process, to assess the adaptability of the materials in the Indonesian context. Both results of the cyclic processes were then integrated for the first integrated tryout with 10 participating teachers. Those processes altogether comprised Phase 1 of the formative evaluation. Research design for the first fieldwork is elaborated in Section 5.2.

Phase 2 of the formative evaluation consisted of the cyclic processes of designing in-service program and adaptation of exemplary RME materials, that was similar to those activities in Phase 1, with addition of the results of the first integrated tryout. The results of the first integrated tryout were evaluated. The findings of the evaluation then were used for the revision of the program. This program was then tried out and evaluated in Phase 2, with 18 participating teachers. The research design for the second fieldwork is discussed in details in Section 6.1.

4.5 THE EVALUATION PROCEDURE IN THE THIRD FIELDWORK

In the final implementation of the IndoMath program (the third fieldwork), the evaluation activities were focused on the impact of the in-service training on the teachers' understanding of RME and their performance in RME lesson. According to Guskey (2000) true professional development is the learning experience gleaned by the teachers. It is a critical component in evaluating an in-service training program on new knowledge and skill. The third fieldwork was focused on the acquisition of the new knowledge and skill by the participating teachers. Based on the above consideration, the research question for the third fieldwork was formulated as follow:

> *To what extent does the in-service training effectively contribute to the teachers understanding of RME?*

For evaluating a teacher in-service training, Guskey (2000) develops five levels of effectiveness: (1) the participants' reactions; (2) the participants' learning; (3) the organization support and change; (4) the participants' use of the new knowledge and skills; and (5) the outcomes of the participants' students. Those levels are hierarchically arranged from simple to more complex, and each higher level is built on its predecessor. In other words, the success at one level is a necessary condition for the success at the next level. (p. 78).

Three levels of professional development effect, namely participants' reaction, participants' learning, and participants' use of new knowledge and skill, were evaluated to study the effectiveness of the IndoMath program.

If we compare the levels of effectiveness evaluated in the IndoMath study and the levels of effectiveness developed by Guskey, we see that there is a jump from Guskey's second level (participants' learning) to Guskey's forth level (participants' use of new knowledge and skill). The difference or jump exists because the focus of the current stage of the IndoMath program is on the mathematics teachers as the target learners, that is to investigate whether or not the teachers can be supported to understand RME by using the in-service training and the RME exemplary lesson materials. This is the central theme of the research. Hence it was apparently not necessary to include the evaluation of the organization support and change.

Moreover, during the first and second fieldwork in Indonesia it was understood that the mathematics teachers have the authority and responsibility to decide the materials and method for teaching as long as the two elements are within the boundary of the state compulsory curriculum.

The fifth effectiveness level of Guskey's model was not included in the IndoMath study, because the effect of the in-service training on the learning outcomes of the students seem to be not relevant for a short time in-service training. In other words, it cannot be determined whether or not the new method and materials affect the students' achievement. In fact, some people argue that one cannot improve the learning achievement of a group of students without first improving the learning and instructional practices of their teacher (Fullan, 1996, cf. Guskey, 2000). Based on this reason, the IndoMath study was focused on the collection and analysis of the information about the teachers' use of the new knowledge and the RME exemplary materials in mathematics instruction. According to Guskey (2000) these are the essential activities in evaluating a professional development program. He mentions three major aspects to be considered in addressing this issue:

- The first regards the concerns that teachers experience as they go through the process of change (see also Hall & Hord, 2001);
- The second aspect focuses on the various degrees or levels of use involved in implementing new practices or techniques (see also Hall & Hord, 2001);
- The third aspect comes from research linking professional development improvement in student learning. It involves determining whether the new practices are really different from what participants used in the past or from what other teachers are using at the present time.

The evaluation of the effectiveness of this program was used to improve the program for the subsequent implementation. Therefore, this stage of evaluation is called the semi-summative evaluation. The evaluation was conducted during and after the implementation of the program. The research design for the third fieldwork is discussed in details in Section 7.1.

The above aspects of various activities in IndoMath study are summarized in Table 4.2.

Table 4.2
Summary of the IndoMath Study

Period	Stage in the study	General description of activities carried out in this stage	Specific evaluation activities	Focus on quality aspects	Outcomes
The Netherlands period	Orientation	- Literature study on RME; - Analysis of available RME curriculum material in the Netherlands that is relevant to Indonesian context and current curriculum content; - Literature study on professional development in general and for mathematics teachers; - The determination of the design specification of in-service education program.	Expert appraisal	Validity	- Design specification of in-service program; - The first adapted RME exemplary lesson material; - The first design of in-service program.
First Fieldwork in Indonesia	Development and evaluation	1. Formative evaluation of the adapted RME exemplary curriculum material on *probability* (*What's the chance*?)	1a. Three instructional tryouts by three JHS teachers, using the lesson material in their classes; 1b. A small scale tryout involving 5 JHS students, where the trainer acted as the teacher; 1c. Analysis of the students' works.	Validity and practicality	Lesson learned about a valid and practical RME exemplary lesson material for Indonesian setting

To be continued

Table 4.2 (*Continued*)

Period	Stage in the study	General description of activities carried out in this stage	Specific evaluation activities	Focus on quality aspects	Outcomes
		2. Formative evaluation of the in-service education program	2a. Expert appraisal; 2b. Two tryouts of course session ('*Doing mathematics*' and 'Instruction on RME theory'); 2c. Tryout in-service program involving 10 JHS mathematics teachers.	Validity and practicality	- Teachers initial experience of RME and its practices; - Lesson learned to improve program design and delivery.
The Nether-lands	Reflection on process and outcomes	1. Adaptation of RME exemplary curriculum materials on several other topics. 2. Revision of the in-service program.		Validity	- Adapted RME lesson materials; - The second design of in-service program.
Second fieldwork in Indonesia	Development and evaluation	1. Formative evaluation of the in-service program 2. Formative evaluation of the adapted RME curriculum materials on '*System of Linear Equations*,' '*Number Pattern*,' and '*Comparison*.' 3. Design and evaluation of '*RCP-test*' and '*innovation profile*.' Sheet.	1. Tryout of the in-service training that involved 18 JHS mathematics teachers 2. Classroom observation 3. Field-test	Validity and practicality	- Teachers experience of RME and its practices; - Lesson learned to improve program design and delivery. - Valid and practical evaluation instruments.
Third fieldwork in Indonesia	Evaluating effectiveness of in-service education program	1. Semi-summative evaluation of in-service program	- Tryout in-service program involving 16 JHS mathematics teachers; - Teacher test; - Classroom observation.	Effectiveness	- Teachers experience of RME and its practices; - Data on the impacts of the program on tea-chers' understanding of RME and its practices.

5

DEVELOPING INDOMATH PROGRAM IN THE EARLY STAGE

The first fieldwork in Indonesian was important as preliminary step to explore the potential model of in-service education to introduce RME to mathematics teachers. In this chapter these efforts are discussed. The discussion starts with the goal of the fieldwork in Indonesia and the research questions (Section 5.1). The design of the study is discussed in Section 5.2. The development of RME exemplary lesson material is addressed in Section 5.3. In this section the results of small-scale tryout are given (Section 5.3.1), followed by the analysis of students' works (Section 5.3.2). It closes with the students' responses on the lesson (Section 5.3.3). The development of in-service program is elaborated in Section 5.4. In this section design guidelines are given (Section 5.4.1), followed by the summaries of the results of expert appraisal to the program design (Section 5.4.2), and results of the first tryout of IndoMath in-service program involving 10 mathematics teachers (Sections 5.4.3 and 5.4.4). It closes with the comments and suggestion to improve program design and execution by an independent observer and participants (Section 5.4.5). Finally, in Section 5.5 discusses the lesson learned from the results of analysis of students' works.

5.1 INTRODUCTION

As the IndoMath study evolved its shape in the early stage, the development activities focused on how to develop the program in the right direction. This was highly important because RME are new for the target learners. The focus of research in the first fieldwork was to assess the first design or model of the instructional program to introduce RME to Indonesian mathematics teachers. Moreover, the RME exemplary curriculum material as part of the program should be appraised as well. In several development research projects within the framework of University of Twente, it has been proven that exemplary curriculum materials demonstrate important role in the professional development program (van den Berg, 1996; Thijs, 1999; Ottevanger, 2001). So, the first fieldwork in Indonesia focused mainly on the evaluation to judge of the strengths and weakness of the instruction and the lesson material in its developing stages.

The preliminary design of the IndoMath program had been developed in the Netherlands and appraised by two experts in professional development and RME respectively. The tryout in Indonesia was conducted to find out the validity and practicality of in-service program (with the support of adapted RME lesson material) whether it could be an appropriate model to introduce RME to mathematics teachers.

Within the above analysis the focus of the research in the first fieldwork was directed toward three aspects:

- The possibility to adapt RME curriculum material into Indonesian context;
- The validity and practicality of the first design of the IndoMath in-service program; and
- The validity and practicality of the adapted RME curriculum material as a vehicle to support teachers understand RME.

It is commonly understood that the evaluation questions should be formulated highly related to the evaluation purpose (Brinkerhoff, Brethower, Hluchyj & Nowakowski, 1983). In order to avoid insignificant questions the research questions were formulated highly related to the above aspects.

The first attention was focused on the preparation of the RME exemplary lesson material to be used in the training program. The first adapted RME material had also been prepared in the Netherlands. In Indonesia the material was field tested to find its tune in local situation. So, the operational research questions for the first aspect were:

1a. How valid is the RME curriculum material adapted?

1b. How do teachers perceive the adapted RME exemplary curriculum material?

As far as the validity and practicality of the IndoMath in-service program was concerned, the activities in the first fieldwork in Indonesia was concentrated to improve the program components, i.e. workshops, classroom practices, and reflection meetings. The IndoMath program tryout in the first fieldwork can be seen as the beginning of the development process. Tessmer (1998) says that it is like children as they are in their developing years and are pertinent to growth. In this sense, the evaluation activities in the first fieldwork were expected benefiting the developer for the improvement of the effectiveness of instructional program and materials. According to Tessmer (1998) formative evaluation could be used to obtain criticisms and suggestions on the interest of the instruction to its users (p. 12). Brinkerhoff, et al. (1983) specify formative evaluation as one of evaluation designs and distinct it to summative evaluation based on their purpose: formative evaluation is used to glean information to help improvement, while summative evaluation is designed to make judgments about the worth a program.

The validity and practicality aspects of in-service program were measured by consulting an independent observer who followed the program from the beginning till the end, and participants' perception of the program in term of their satisfaction to the program's activities and management. The operational research questions then were formulated as follows.

2a. How the participants perceive the IndoMath in-service program?
2b. What suggestions the participants give to improve the IndoMath in-service program?
2c. How the observer perceives the IndoMath program?
2d. What suggestions the observer gives to improve the IndoMath in-service program?

As part of the study it was apparently important to gain insight about teachers and students' reaction to the RME-based lesson. The operational research questions were focused around this issue.

3a. How do teachers react to the RME-based mathematics lesson?
3b. How do students react to the RME-based mathematics lesson?

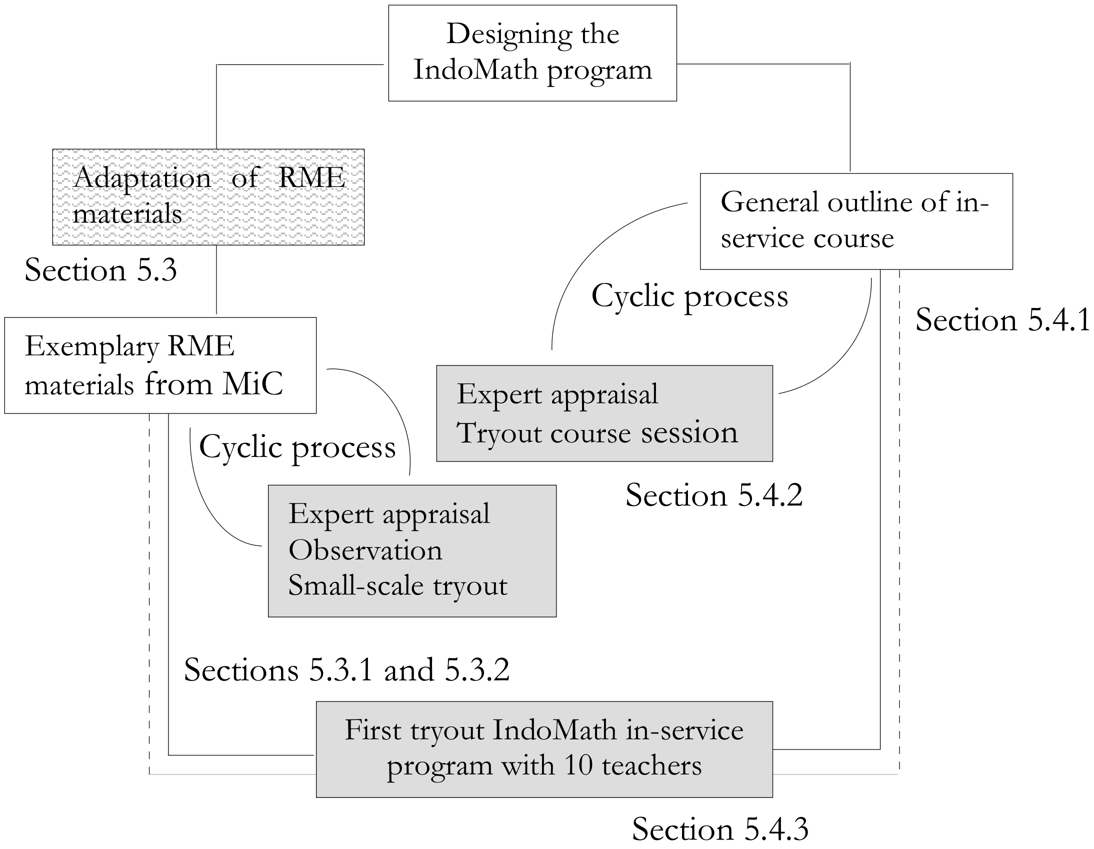
In the following section the research design of the IndoMath Study in the first fieldwork is discussed.

5.2 DESIGN OF THE STUDY

As mentioned in the beginning of this chapter, the main focus of the research in the first fieldwork is how the in-service program and of the adapted RME material being developed. The first design of IndoMath in-service program and the first draft of the adapted RME lesson material were developed simultaneously as they cannot be viewed as separated entities. The in-service program should highly relevant to RME theories, while the RME lesson material was integral part of the in-service program. In short, without RME lesson material the in-service program could not take its form.

The first fieldwork in Indonesia was conducted from September 1999 until February 2001. To explore the potential model of in-service education, formative evaluation was conducted by means of expert appraisal, and tryout of courses sessions. For the purpose to find out the adaptability of RME curriculum material to Indonesian context formative evaluation was performed by means of tryout of RME exemplary curriculum material by several JHS mathematics teachers, small scale tryout, and classroom observation to one of participants of the in-service program. The results of students' work during this lesson were also analyzed.

Along with the program design, the RME exemplary curriculum material to be used in the in-service program was introduced. Because the main goal of the in-service program is to introduce RME to teachers and give them opportunity to practice RME lesson. Development process of the adapted RME exemplary lesson material was conducted through expert appraisal, validation and small-scale tryout (Section 5.3). As described in Figure 5.1 the guidelines were elaborated into program design as an initial version (Section 5.4.1). An expert on RME appraised this first design. It then brought to Indonesia where the discussion was performed with a mathematics teacher educator and two experienced Junior High School mathematics teachers (Section 5.4.2). A result of this deliberation process was the first version of IndoMath in-service model. This first version was tried out fully involving 10 JHS mathematics teachers (Section 5.4.3).



Note: ▩ = preparation the first adapted RME lesson material;
□ = draft (versions) of program and lesson material;
■ = evaluation activities.

Figure 5.1
Procedure of program development and evaluation in the first field work

The first fieldwork studies in Indonesia was rather informal impressionistic in nature. According to Plomp (2002) during the early stage the formative evaluation can be quite informal but will increasingly formal and having more 'rigid' design. Information collection plan during the first fieldwork is summarized in table 5.1. As indicated in the table, data collection plan provided an overall picture of the evaluation activities related to evaluation questions (Brinkerhoff, et al., 1983). In the following each evaluation procedure is discussed briefly.

Table 5.1
Information collection plan in the first fieldwork

	Information Collection Procedures									
Evaluation Questions	*OQ*	*EA*	*ST*	*SST*	*PPT*	*O*	*SW*	*PT*	*I*	*RR*
How valid was the design of the IndoMath inservice program?		√							√	
Was the IndoMath inservice program sessions practical?			√							
What are characteristics of participants?	√									
Was workshop implemented as planned?								√		
Was classroom practice implemented as planned?								√		
Was reflection meeting implemented as planned?								√		
How valid was the RME curriculum material adapted?		√								
How did teachers perceive the adapted RME exemplary curriculum material?									√	√
Was RME exemplary lesson material practical?				√	√	√	√		√	√
How did the participants perceive the IndoMath inservice program?								√		√
What suggestions did the participants give to improve the IndoMath inservice program?								√		√
How did the observer perceive the IndoMath program?						√		√		√
What suggestions did the observer give to improve the IndoMath inservice program?										√
How did teachers react to RME-based mathematics lesson?									√	√
How did students react to the RME-based mathematics lesson?						√			√	√

Notes: OQ = Orientation Questionnaire; EA = Expert Appraisal; ST = Session Tryout; SST = Small-scale Tryout; PPT = Pre and Posttest; O = Observation; SW = Students' Works; PT = Program Tryout; I = Interview; RR = Reflective Report.

Orientation questionnaire was delivered to participants at the beginning of the program and it consisted of questions about participants' background and expectation in following the program.

Expert appraisal: an expert on RME appraised the first design of in-service program. A mathematics teacher educator in Indonesia was also asked to comment on the program design. This Indonesian expert has 19 years experiences as a mathematics teacher educator at State University of Yogyakarta. He has a master degree in education and head of department of mathematics education. Other Indonesian experts are two experienced JHS mathematics teachers who have 33 and 22 years of experiences as mathematics teachers respectively. They also were key teachers (*guru inti*) of PKG professional development project.

The expert appraisal in Indonesia was performed by means of *structured interviews* (Tessmer, 1998). The experts were asked to comment on the program design such as program goal, usefulness for the participants, and whether or not it is necessary to put prerequisite for teacher to join the program (see figure 5.2). At the end of the interview the experts were asked to write down their comments/suggestion on the open questions related to several issues such as the relevance of the program to participants, program contents, media used, and program organization[*)].

*) Before the interview the Indonesian experts got the in-service program protocol and oral explanation from the researcher. The interview was then focused on the program components and their contents. But, again it was rather informal.

Interview Scheme

1. Is the program general goal clearly stated?
2. Is the program specific goal clearly stated?
3. To what extend is the program goal relevant to the needs of mathematics teachers in Indonesia?
4. What do you think about the participants of this program (JHS mathematics teachers)?
5. Do you agree JHS mathematics teachers, as participants of the program are relevant?
6. To what extend JHS mathematics teachers are commit to follow the program?
7. What do you think about the program components that consist of lecture, demonstration, micro-teaching, preparation for classroom practice, observation skill; is it strong enough to achieve program goal as a whole?
8. Do you agree that the advantage of the program is teachers are given opportunity to perform classroom practice?
9. Do you agree that pair collaboration and reflection will give useful lesson for the participants to know their strength and weakness in using the intended innovation?
10. Do you agree that time allocation for each session is enough?
11. Do you agree that certificate will be given to participants at the end of the program is motivate them to follow the program fully?
12. If you are invited to participate in the program, are you enthusiastic?
13. For the purpose of the improvement of the program, if you have any suggestion please write down, especially to aspects below:
    a. the relevance of the program to participants' needs;
    b. participants' requirement;
    c. program content;
    d. media used:
    e. program management;
    f. teachers' participation;
    g. management quality;
    h. the usefulness of the program;
    i. program effect to participants' skill and knowledge on mathematics instruction;
    j. others.

Figure 5.2
Interview scheme in evaluating IndoMath in-service program

Tryout of course sessions[*)]: there were two course sessions that were tried out, namely sessions of 'doing mathematics' and 'instruction on the theory of RME.' These

*) The tryout was (also) intended as a practice for the trainer in delivering the materials before the 'real' in-service program performed. The lesson learned by doing so was the experience the trainer obtained and he became more eloquent.

sessions were tried out two times, first in Bantul district, and second on Sleman district, attended by 20 Junior High School mathematics teachers respectively. In the 'doing mathematics' session teachers were given a problem – the last card problem – that forced them to find mathematics idea by themselves. They worked in pairs and in small group. On the other hand, in the session of 'instruction of the RME theory' teachers were given lecture on the aspects of RME such as five tenets of RME, change in teaching and learning as well as in content and assessment.

Observation and interview[**)]: in order to find the adaptability of RME exemplary curriculum material, it was validated in two JHSs in Banjarmasin. In this phase a teacher from SLTPN 19 and two teachers from SLTPN 24 used the RME exemplary curriculum material of *Apakah Peluang Itu?* (What is the Chance?) in their classroom lesson. Their lessons were observed and afterward teachers and several students were interviewed separately to know their reactions to the material and the teaching-learning process. The classroom observations were intended to find the practicality of the material in general, such as how teachers delivered the problems, how students deal with the problems which is quite different from the usual one. Also, to what extent it facilitates the discussion among students as well as between teacher and students. The interview with the teachers focused on the preparation before the lesson (how long they read the *Teacher Guide*), and how are their feelings in using the new curriculum material. In interview with students, their feelings and responses about the lesson were asked.

Small-scale tryout of RME exemplary curriculum material: the exemplary curriculum material was also tried out with five students in Yogyakarta. The small-scale tryout was considered important to get a more in-depth understanding of Indonesian students' way of thinking while dealing with the contextual problems that were definitely new for them. This small-scale tryout was also used to find out adaptability of the material to the Indonesian schools in term of time used for the lesson, texts and figure clearness, interaction and students' achievement. Each student received a *Student Material* and *Student Work Sheet*. They learned using the material under guidance of a teacher – in this case the researcher acted as a teacher.

**) For the first time Indonesian teachers used RME exemplary curriculum material in mathematics instruction. The data collected were rather informal which mainly intended to give the researcher the first impression about RME lesson.

The lesson went as proposed in the exemplary material with emphasis on student learning. They solved the problems alone and worked in a group.

Program tryout: after the above steps of formative evaluation activities over some aspects of IndoMath in-service program had been conducted, the next step was to tryout the program fully, comprising all components of the in-service program that consisted of workshop, classroom practice, and reflection meeting.

Reflective report: after the program tryout was fully conducted the participants (10 teachers) and an independent observer were invited to come to evaluation meeting. In the meeting the participants and an observer reported their comment and reaction to the whole program activities. They were also asked to give suggestions for the improvement of the program.

The development of RME lesson materials and the tryout the in-service program are elaborated in the remainder of this chapter.

5.3 DEVELOPMENT OF RME MATERIALS

As mentioned earlier, curriculum materials have an important role in the implementation of innovation in education. The development of professional development program to make teachers understand RME and prepare them for effective implementation in their classroom practice was started by preparing RME exemplary curriculum material for the Indonesian context. The exemplary curriculum material was an integral part of the professional development program itself.

In preparing RME exemplary curriculum materials the first step was the adaptation from MiC materials. In this process, the researcher was interested in finding out whether and how the tenets of RME can be realized in the materials for the Indonesian context. There are five tenets of RME (see e.g. De Lange, 1987; Gravemeijer, 1994, 1997; Treffers, 1987): (1) the use of context, (2) bridging by vertical instruments, (3) student contribution, (4) interactivity, and (5) intertwining (see Section 3.2.4).

Moreover, the realization was not only reflected by the exemplary materials themselves but also indicated by the way the participating teachers use the materials within local situation that is characterized by 40-45 class-size with classroom practice: teaching as telling, passive nature of learners, and students' activities of note-taking.

The development of exemplary RME curriculum materials for the Indonesian context was performed through:

1. Adapting the RME materials from MiC of the topic Probability (What's the chance) for the Indonesian context and culture. This process was done through translating and redesigning.
2. By assuming that the exemplary material has reflected RME tenets in itself, the validation and evaluation of the materials in classroom level was conducted to find out its adaptability in Indonesian context. In this part a series of tryout in some junior high schools was held as part of the first fieldwork in Indonesia.
3. A small-scale tryout was conducted to gain insight in how Indonesian JHS students deal with the contextual problems in the lesson material.
4. As part of in-service program, the RME exemplary lesson material was used by the ten participants of the in-service program in their classroom lesson practices. The observation was conducted in the participants' lesson, and students' works resulted from this practice was analyzed.

5.3.1 Results of the small-scale tryout

The small-scale tryout was aimed at finding out the practicality of the adapted RME exemplary curriculum material when the students use the material in their learning process. The practicality aspect consisted of aspects: time, texts and figures clearness, interaction, and students' achievement (Tessmer, 1998).

The purpose of this small-scale tryout was giving the researcher (developer) the real experience in using the RME approach in instruction. As proposed by a Dutch RME expert that for the novice in RME the first experience with RME should be an appealing and motivating one. Tryout with a small number of children (no more than five) was recommended.

Five students of grade 8 (JHS students grade 2) were selected based on their level in the class: two students from upper group, one from middle group, and two from lower group (Tessmer, 1998). Each student received a 'student book' and a 'student work sheets.' They learned from the materials under the guidance of the teacher (in this case the researcher acted as a teacher). The lesson went as arranged in the exemplary material that emphasized on students learning. They solved the problems either individually or in a group.

Students were given pre and posttest (see Figure 5.3). The purpose of the test was to measure students' performance in learning so that the developer could have a greater degree of confidence about instructional strengths and weaknesses (Tessmer, 1998). According to Tessmer (1998) the evaluation also need to reveal what aspects of the instruction seem to be successful, although the primary purpose is to *improve* the instruction and not to *prove* that it works! (p. 102).

The items on the test were picked up from the compulsory textbook used in Indonesian JHS and of the same topic with the adapted RME exemplary lesson material. The reason for this selection was if the students learn mathematics from the lesson, then whatever the questions or problems from whatever textbook they should be able to find the solutions.

After the result of pre and posttest was examined, the researcher came back to the students for interview about their reactions to RME material and the lesson. The interview was recorded and transcript was made for analysis. The objective was to get descriptive information on the material in term of students' reaction on the contexts, figures and language used. Also, their impression on the lesson, and to check if the increasing of their scores from pretest to posttest due to their process of learning using the material.

1. Test Items for Pre and Posttest

1. A number is randomly selected from the natural number less than 11. If each has the same chance to be selected, then determine the chance that it is:
   a. an even number
   b. a prime
   c. less than 5.
2. A letter is randomly selected from the word 'REPELITA'. What is the chance that it is:
   a. E
   b. R
   c. P
   d. A
3. In a box there are 50 balls that consist of 18 red balls, 13 white balls, and 19 blue balls. One ball is randomly picked out. If each ball has the same chance to be selected, what is the chance that it is:
   a. White ball
   b. Blue ball
   c. Red ball
4. There are 20 cards which are numbered 1, 2, 3, …, 20. If one card is randomly picked, then what is the chance that the numbered card is:
   a. less than 10
   b. multiplication of 3
   c. more than 14
   d. prime less than 12
5. In a class which consist of 25 males and 23 females, each student has the same chance to get a prize. What is the chance that the student who get the prize is
   a. a male
   b. a female
6. The chance of a child is infected a disease is 0.25. What is the chance that he will not infected?
7. The chance that tomorrow will rain is 6/11. What is the chance that tomorrow will not rain?
8. In clipping two coins, what is the chance that will appear
   a. Both heads
   b. One head and one tail

Figure 5.3
Questions in pre and posttest in the small-scale tryout

The results of small-scale tryout are summarized as follows.

- In the original MiC version the lesson was planned for 3 or 4 hours lesson. In the tryout it can be performed in 2 hours lesson (2 time 45 minutes), excluding 30 minutes for pre and posttest. The shorter time needed than approximately 3 or 4 time 45 minutes as proposed by the book was understandable because this tryout only involving 5 students. For the real class setting with 40 to 45 students, the duration must be more than 90 minutes because more time is needed for distributing 'student book' at the beginning of the lesson, and 'student work sheets,' and of course for discussion with students since more students involved.
- During the lesson showed that the content of material (texts and figures) were understandable. For the students there was no confusing on the texts, figures and sentences.
- On almost all of the problems students worked alone. The interaction appeared when teacher ask for their reasoning for each answer they made. Direct interaction among them hardly occurred if teacher did not confront their different answers.
- After the lesson students expressed their feelings about the lesson that:
  - they enjoyed the lesson and were not boring (because there are some figures and stories that make it attractive). They had a feeling that they were playing, but then realized they learned from it;
  - the lesson was easy to understand because it helped by figures and stories, the problems were arranged step by step begin with easy problem and increased the difficulty bit by bit;
  - they learned from it because they knew the process their own learning and concluded by themselves;
  - the lesson was different from their current mathematics lesson which is difficult, burdening and boring.
- The increase in students' scores from pre to posttest (Table 5.2) gave indication that the lesson contributes to their process of learning to understand the concept of chance (probability) meaningfully.

Table 5.2
Students' scores in pretest and posttest (in 100 scale)

Student	Level in group*)	Pretest	Posttest	Increasing
A	Upper	62.5	100	37.5
B	Upper	75.0	100	25.0
C	Middle	37.5	87.5	50.0
D	Lower	37.5	75.0	37.5
E	Lower	25.0	62.5	37.5

Note: *) Level refers to students' score in primary school national leaving examination.

All of students had not learned yet the topic before. They had no prior idea of the notion of chance. Two of them had good scores in pretest. When the researcher asked if they know the concept beforehand, they said they already know the concept of fraction and think that these two things (chance and fraction) are similar. These two students were lucky because some of their guessed answers were correct. The fact that they knew the concept of fraction can be seen from variation of their answers in the pre test as described in table 5.3.

Table 5.3
Sample of students' answer on pretest

	Student				
Question*)	*A*	*B*	*C*	*D*	*E*
3a	13/50	13/50	3/13	No answer	30.3%
3b	19/50	19/50	2/19	No answer	30.3%
3c	18/50	18/50	5/18	No answer	30.3%
5a	25/48	25/48	10/25	1/25	No answer
5b	23/48	23/48	8/23	1/23	No answer
8a	1/4	1/3	1/2	1/2	No answer
8b	2/4	1/3	1	1/3	No answer

Note: *) Question number refers to figure 5.3.

Students' misconception of the notion of chance can be seen from sample of their answers as described in table 5.3. For instance, for questions 3a, b and c about the chance to get a white, a blue and a red ball respectively from a box that contains 18 red balls, 13 white balls and 19 blue balls. Student C answered that the chance is 3/13 for a white ball, 2/19 for a blue ball and 5/18 for a red ball. This seems clear that the numbers of 13, 19 and 18 come from the numbers of white, blue and red balls in the box, but we never know from where he got 3, 2 and 5. Student E answered that the chance is the same, 30.3% for each white, blue and red ball to be selected. We understand that this student thought that because there are three different colors of balls in the box, so the chance must be one third, the same for each ball. Students apparently mixed the concept of fraction and the concept of chance. As indicated by the result of posttest the RME exemplary lesson material succeeded in improving students' misconception about the chance (probability) concept.

The results of validation and small-scale tryout to RME exemplary lesson material indicated that no significant change was needed. This material (see Appendix M for the complete RME exemplary lesson material of this topic) was then used in the IndoMath in-service program, and used by the participants in their classroom practices. The result of teachers' classroom practice is discussed in the following Section 5.3.2 focused on students' works.

5.3.2 Analysis of students' works*)

The book from which RME exemplary lesson material to be adapted is intended for students of Grade 5/6 in the USA, a developed country where their students have different characteristics from Indonesian students. Given these contexts as the roots for the development of problems in the module, the questions that need to be answered is whether or not they (the contexts) are 'working', that is to what extent they contribute to the process of concept building of Indonesian students in their learning activities. If the contexts are working, then we can conclude that they are adaptable from the USA contexts. The structure of MiC curriculum materials can be explained as follows.

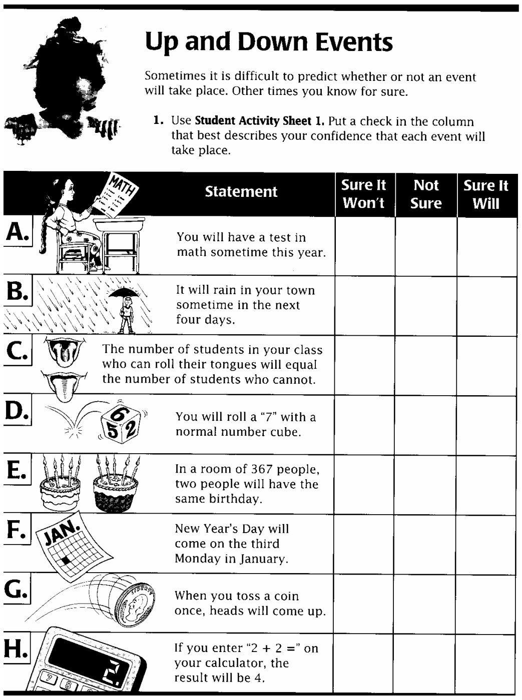
*) This section is based on Hadi (2002). Complete analysis of students' works is given in Appendix N.

There are two parts in MiC curriculum materials, that is Student Materials and the Teacher Guide. Basically, the Teacher Guide consist of the same content as the Student Materials with addition of:

- Logistical preparation of lesson;
- Explanation about mathematics concept to be addressed in the lesson;
- The materials or media needed in the lesson. For instance: 'Student Activity Sheet', 'black crayons', 'cube'.
- Solutions and samples of student works;
- Explanation of how to execute the lesson for each problem. For instance: 'Students may work in pairs or small groups on the problems. Discuss problem with whole class'; 'You may assign problem 10 for homework'.
- Comments about problems. For instance: 'Discuss students' explanation to this problem'; 'Students do not need have to compute the exact percents'.
- (Informal) assessment during and after the lesson.

Students' works analyzed here are taken from the results of classroom practice of a participant of IndoMath in-service program using RME exemplary lesson material at junior high school in Yogyakarta, Indonesia. Grade 8 students worked individually as well as in small group of four. In the learning process the teacher gave students opportunity to interpret and solve the contextual problems in the lesson material distributed to each of them.

The topic of *What is the Chance* (the Indonesian version of this material is given in Appendix M) from MiC curriculum materials starts with the problem in which students should decide among three possibilities: 'sure it won't', 'not sure', and 'sure it will' over eight statement of events (Figure 5.4).



Up and Down Events

Sometimes it is difficult to predict whether or not an event will take place. Other times you know for sure.

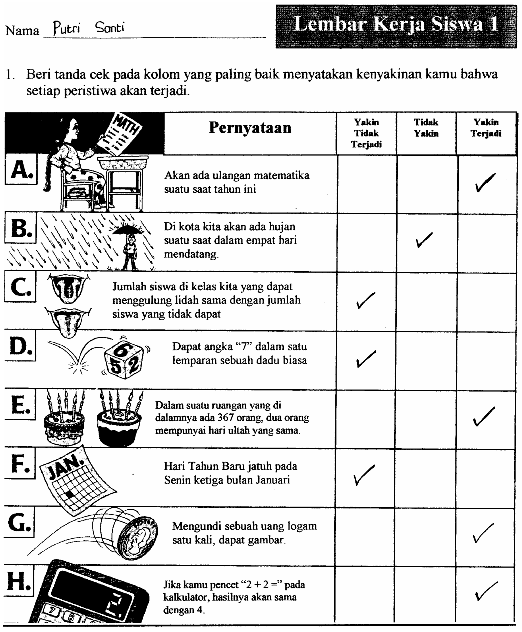
1. Use **Student Activity Sheet 1.** Put a check in the column that best describes your confidence that each event will take place.

	Statement	Sure It Won't	Not Sure	Sure It Will
A.	You will have a test in math sometime this year.			
B.	It will rain in your town sometime in the next four days.			
C.	The number of students in your class who can roll their tongues will equal the number of students who cannot.			
D.	You will roll a "7" with a normal number cube.			
E.	In a room of 367 people, two people will have the same birthday.			
F.	New Year's Day will come on the third Monday in January.			
G.	When you toss a coin once, heads will come up.			
H.	If you enter "2 + 2 =" on your calculator, the result will be 4.			

Figure 5.4
Up and down events (reprinted from *Mathematics in Context*, 1997)

Using the above problem students gain a basic understanding of the concept of chance by estimating chances before describing exact chances using percents, fractions, or ratios. Students base their chance estimates on the general idea that some events are sure to happen, some are sure not to happen, and all other possibilities are between these two extremes. This problem reflects the first tenet of RME that is to give students a problem in which they can immediately engage in a meaningful mathematical activity.

On figure 5.5, students' works on 'Up and Down Events' Problem are given, Putri and Dhomas's answers. From their work we know how – in some statements – the different answer come up that reflect the various perceptions about the possibility of an event to happen or not to happen, whereas for some other statements they come up to the same idea.



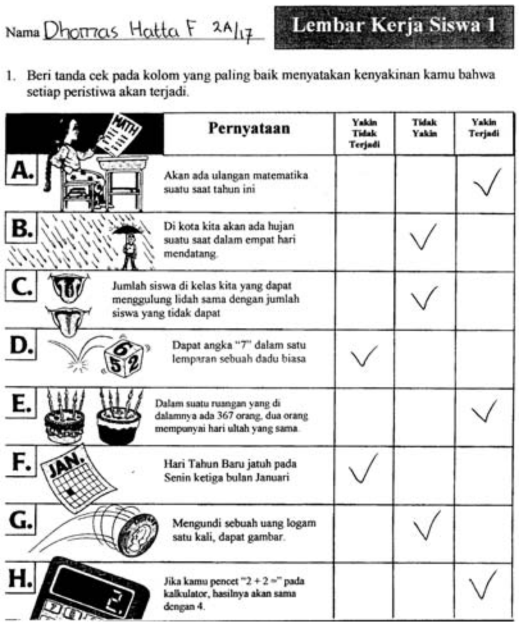
Nama Putri Santi

Lembar Kerja Siswa 1

1. Beri tanda cek pada kolom yang paling baik menyatakan kenyakinan kamu bahwa setiap peristiwa akan terjadi.

	Pernyataan	Yakin Tidak Terjadi	Tidak Yakin	Yakin Terjadi
A.	Akan ada ulangan matematika suatu saat tahun ini			✓
B.	Di kota kita akan ada hujan suatu saat dalam empat hari mendatang.		✓	
C.	Jumlah siswa di kelas kita yang dapat menggulung lidah sama dengan jumlah siswa yang tidak dapat	✓		
D.	Dapat angka "7" dalam satu lemparan sebuah dadu biasa	✓		
E.	Dalam suatu ruangan yang di dalamnya ada 367 orang, dua orang mempunyai hari ultah yang sama.			✓
F.	Hari Tahun Baru jatuh pada Senin ketiga bulan Januari	✓		
G.	Mengundi sebuah uang logam satu kali, dapat gambar.			✓
H.	Jika kamu pencet "2 + 2 =" pada kalkulator, hasilnya akan sama dengan 4.			✓

Putri's answer



Nama Dhomas Hatta F 2A/17

Lembar Kerja Siswa 1

1. Beri tanda cek pada kolom yang paling baik menyatakan kenyakinan kamu bahwa setiap peristiwa akan terjadi.

	Pernyataan	Yakin Tidak Terjadi	Tidak Yakin	Yakin Terjadi
A.	Akan ada ulangan matematika suatu saat tahun ini			✓
B.	Di kota kita akan ada hujan suatu saat dalam empat hari mendatang.		✓	
C.	Jumlah siswa di kelas kita yang dapat menggulung lidah sama dengan jumlah siswa yang tidak dapat		✓	
D.	Dapat angka "7" dalam satu lemparan sebuah dadu biasa	✓		
E.	Dalam suatu ruangan yang di dalamnya ada 367 orang, dua orang mempunyai hari ultah yang sama.			✓
F.	Hari Tahun Baru jatuh pada Senin ketiga bulan Januari	✓		
G.	Mengundi sebuah uang logam satu kali, dapat gambar.		✓	
H.	Jika kamu pencet "2 + 2 =" pada kalkulator, hasilnya akan sama dengan 4.			✓

Dhomas's answer

Figure 5.5
Deciding the chance of events: 'sure it won't,' 'not sure' or 'sure it will'

Problem 'Put the statements on a ladder' (Figure 5.6) corresponds to Problem 'Up and Down Events' in which students are asked to put the statements on a ladder. In this problem students estimated the chances of events by placing each event in an appropriate position on a chance ladder. The ladder shows that the chance that an event will occur is between 0% and 100%.

Sekarang kembali ke tabel di halaman 2 dan letakkan pernyataan pada tabel tersebut pada sebuah tangga. Jelaskan jawaban kamu.	Now go back to the table on page 2 and put the statements from the table on one ladder. Explain why you put the statements where you did.

Figure 5.6
'Put the statements on a ladder'

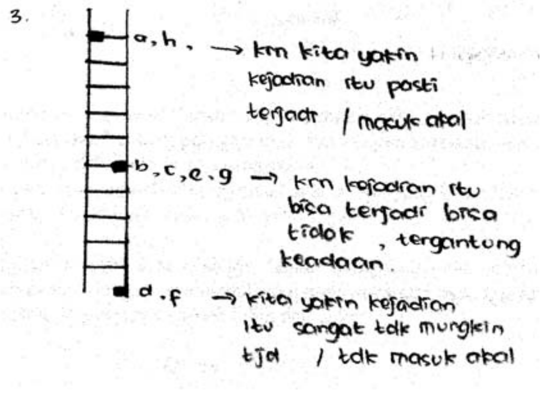
Students estimate the chances of events occurrence by placing each event in an appropriate position on a chance ladder. The ladder shows that the chance of the occurrence of an event is between 0% and 100%, inclusive.

In the following we find how Indonesian grade 8 students deal with the problem 'put the statements on a ladder.' The data showed the various approaches were applied. In the end they could be categorized in three model answers, namely

1. Students put the statements on three places on the ladder: on the top (100% = sure to happen), on the middle (50% = not sure) and on the ground (0% = sure not to happen);
2. Students put the statements on different places on the ladder without indication of exact percentage;
3. Students put the statements on different places on the ladder with indication of certain percentage.

As representative of those models we give here some of their answers (Figure 5.7). It is interesting to notice here how Erika gave reason for her answer: for statements A and H where she put on the top, she indicated that those events were sure to happen and logic as she wrote '*karena kita yakin kejadian itu pasti terjadi/masuk akal*' (because we are sure that those events will happen/logic). For statements B, C, E and G she put on the middle with the reason '*karena kejadian itu bisa terjadi bisa tidak, tergantung keadaan*' (because those events may or may not to happen, depend on the situation). For statements D and F she put on the ground with reason '*kita yakin kejadian tersebut sangat tidak mungkin terjadi/tidak masuk akal*' (we are sure that those events very unlikely to happen/not logic).

Put statements on the Top, Middle and Ground (35%).



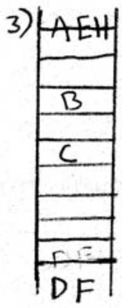
a, h, -> Because we are confident that those events sure to happen / logic.

b, c, e, g -> Because those events may or may not to happen, depend on the situation.

d, f -> We are confident that those event very unlikely to happen / not logic

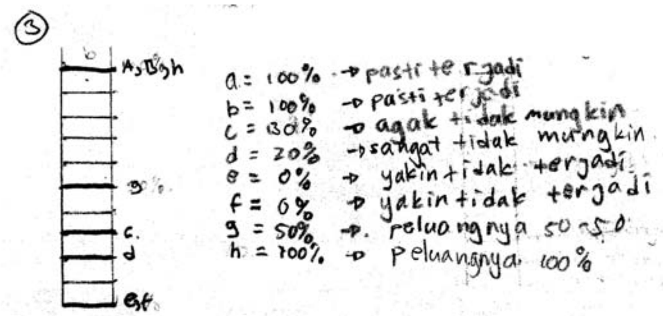
Erika

Put statements on different places without certain percentage (20%).



Tezar

Put statements on different places with certain percentage (37.5%).



a=100% -> sure to happen
b=100% -> sure to happen
c=30% -> seems unlikely
d=20% -> very unlikely
e=0% -> sure not to happen
f=0% -> sure not to happen
g=50% -> the chance is 50-50
h=100% -> the chance is 100%

Atria

Figure 5.7
Answer models for Problem of 'Put the statements on a ladder'

Fourteen out of 40 students (35%) had the same answer as Erika. Some of them put the percentages (100%, 50% and 0%) on the ladder like Dhomas's answer as shown on Figure 5.8.

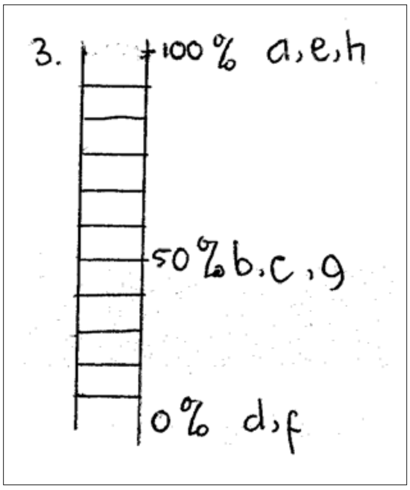


Figure 5.8
Dhomas's answer to Problem 'Put the statements on a ladder'

If we compare Dhomas's answers to Problem #1 and Problem #3 we find a consistency. The decision that he took for each statement among three possibilities: 'sure to happen', 'not sure' and 'sure not to happen' (Figure 5.5) were consistent with the place he chose on the ladder for each statement (Figure 5.8).
The differences in the students' reaction on that problem can facilitate the discussion among them – except for statement A (you will have a test in math sometime this year) where all students (100%) had the same answer, that is 'sure it will.'

For the rest, the responses varied among three possibilities. From the above description we understand that teacher can use this situation as starting point to motivate the students to engage in the learning process. In this regard, the contextual problem will lose its meaning if teacher let the atmosphere that created by that problem go without any effort to build students' interest. It is particularly important in Indonesia where teaching and learning process is usually dominated by passive nature of students.

Indonesian teachers who participated in the tryout of IndoMath program and who used the exemplary materials in their classroom practice seemed to be aware of the nature of the realistic approach as this was discussed in the IndoMath in-service course. Therefore, they did not have many problems in realizing in their lesson the expected situation, namely engaging their students in meaningful mathematical activities. This seems simple, but how strong this starting point influences the next step of learning process: students start to become very attentive if at any moment teacher ask their comment and reaction. This appears to be promising to shift the learning process from teacher centered to students centered. Also, students becoming aware of their role, that they were not only 'object' that should be filled with information or knowledge, but they had the right to deliver their thoughts.

The use of chance ladders builds a basic understanding that chances range between 0% and 100%. Students first learn to describe chance informally by placing statements on a chance ladder at a height that represents the chance in percent. The above example illustrates how the context is used to facilitate students learning as first tenet says. It also reflects the tenet of 'bridging by vertical instrument.' The chance ladder is only a model that can help students to bridge gap between the intuitive level and the level of subject matter systematic.

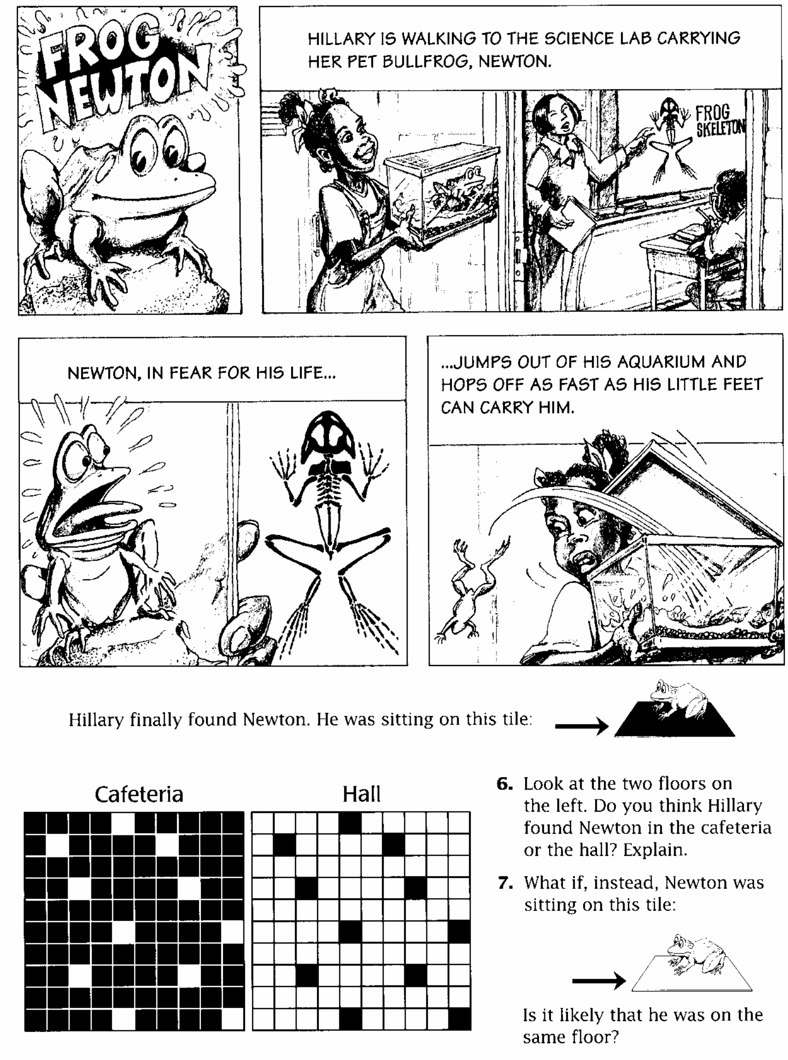


Figure 5.9
Frog Newton (reprinted from *Mathematics in Context*, 1997)

From 'Frog Newton' Problems (Problems #6 and #7) on figure 5.9 it is known how the context of a frog that jumps on a black-white tile floor leads to the idea of chance by comparing the numbers of black and white tiles. The floors with black and white tiles give students visual support for estimating chances. This context prepares students to use informal ratio terminology, such as 'one out of four.'

The story of 'Frog Newton' in the form of a comic is a reflection of a model situation. This story is designed to prepare students toward Problems #6 and #7. By reading this story beforehand students will engage in the situation that helps them to interpret the problems. This again is a good example of the tenet of 'bridging by vertical instrument.' The story also can trigger a discussion among students. This facilitates interactivity as the fourth tenet says.

There were three answers appear for Problem #6: [*)]

1. In the hall: Ira found Frog Newton in the hall (27.5%);
2. Both in the hall and cafeteria is possible: It is possible for Ira to find Frog Newton in the cafeteria as well as in the hall (10%); and
3. In the cafeteria: Ira found Frog Newton in the cafeteria (60%).

For Problem #6, Isaac answered 'Di Aula' (in the hall). The explanation of his answer was '*karena katak berada di ubin hitam jadi tidak mungkin ia lompat bolak-balik*' (because the frog is on a black tile, so it is unlikely he jumps back and forth). For this problem Lidya wrote '*bisa di Kafetaria dan Aula, karena dua-duanya mempunyai warna lantai yang sama*' (it is possible [to find the frog] either in the cafeteria as well as in the hall, because both [floors] have the same color.

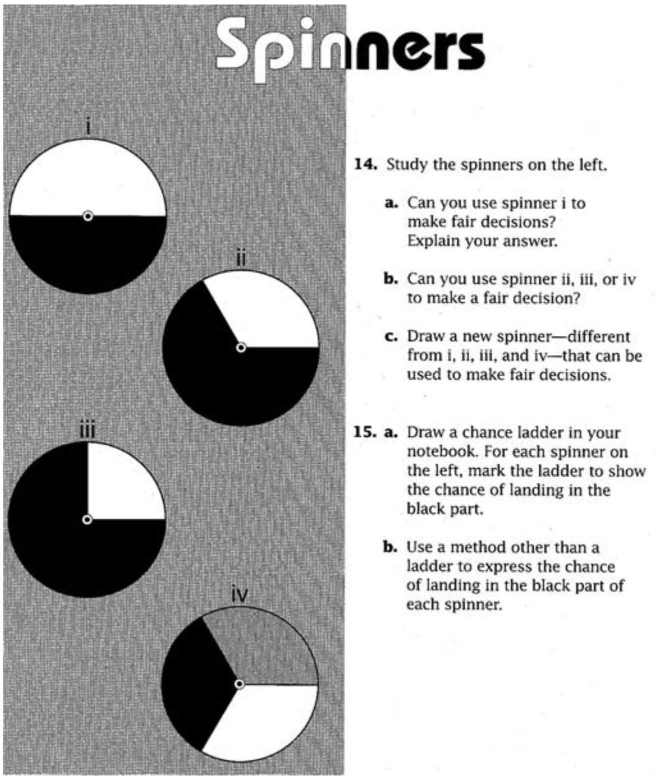
From both Isaac and Lidya's answers we understand that in giving the answer and the reason for its they had not yet touch the logic of the problems to compare the number of black and white tiles on each floor. The idea of giving the context of floor with black and white tiles is to give students visual support for estimating chances. This context prepares students to use informal ratio terminology, such as eleven out of one hundred. However, their answers were not wrong. It is logic to say that the frog may land on cafeteria as well as hall because both have white and black tile as well. Some students gave this sort of argument in their answer.

*) A pupil (2.5%) had no answer for this problem.

In the hall (27.5%) 6 Di Aula → krn katak beradi di Ubin hitam jadi tdk mungkin ia lompat bolak - balik In the hall ➔ Because the frog is in a black tile, so it is unlikely he jumps back and forth Isaac
In the hall and cafeteria is possible (10%) 6. bisa di kafetaria dan Aula. karena dua - duanya mempunyai warna lantai yang sama it could be in the cafeteria as well as in the hall, because both have the same color Lidya
In the cafeteria (60%) 6. Kafetaria, karena peluang frog newton mendarat di ubin hitam lebih banyak Cafeteria, because the chance of Frog Newton to land on the black tile is bigger. Dhomas

Figure 5.10
Students' answer for 'Frog Newton' (Problem # 6)

For Problem #6 Dhomas wrote '*Kafetaria, karena peluang frog newton mendarat di ubin hitam lebih banyak*' (Cafeteria, because the chance of frog newton to land on black tile is bigger [than white tile]) (Figure 5.10). The sample of Dhomas's answer tells us that he knows how to compare the number of black and white tiles. It is interesting to notice that 60% students have the same answer as Dhomas's.



Spinners

i

ii

iii

iv

14. Study the spinners on the left.

a. Can you use spinner i to make fair decisions? Explain your answer.

b. Can you use spinner ii, iii, or iv to make a fair decision?

c. Draw a new spinner—different from i, ii, iii, and iv—that can be used to make fair decisions.

15. a. Draw a chance ladder in your notebook. For each spinner on the left, mark the ladder to show the chance of landing in the black part.

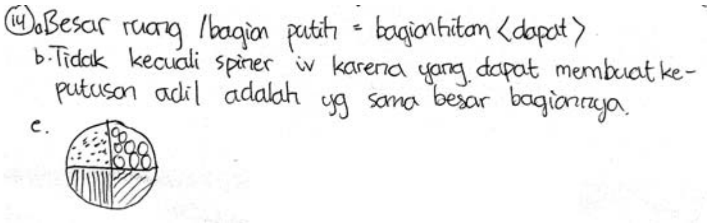
b. Use a method other than a ladder to express the chance of landing in the black part of each spinner.

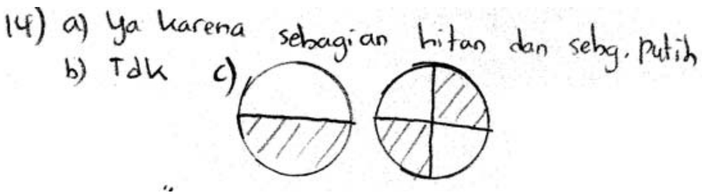
Figure 5.11
Spinners (reprinted from *Mathematics in Context*, 1997)

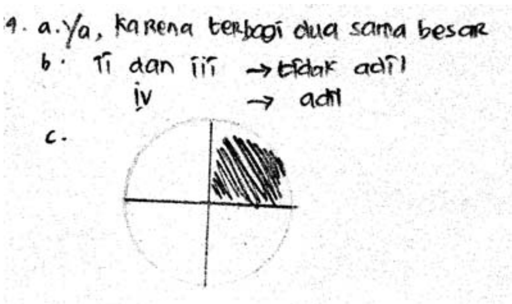
Using the context of spinner, students learn how to make fair decisions (Figure 5.11). They represent the chance for landing on the black part of each spinner with a chance ladder and express the chance as a percent, a fraction, or a ratio.

The way to express the chances in percents, fractions or ratios reflects the cross-connection between mathematical concepts. Percents, fractions and ratios are used in various problems in arithmetic strand. So, the tenet of 'intertwining' may be best reflected from the above spinners problems (Problem #14 and #15).

In figure 5.12 are samples of Indonesian grade 8 students' answers to 'Spinners Problem.'

<table>
<tr>
<td>Fully Correct


a. Space area of white part = black part (it can)
b. No, except spinner iv because the spinner that can make fair decision is one which is divided by the same part
Dhomas</td>
<td>Eight out of 40 students (20%) had this perfect answer as represented by Dhomas's answer on the left.</td>
</tr>
<tr>
<td>Correct


a. Yes because part of it is black and part of it white
b. No
Tezar</td>
<td>Nineteen out of 40 students (47.5%) had correct answer. The only thing that make their answer is not fully correct is b, they did not realize that spinner iv can be used to make fair decision among three people.</td>
</tr>
<tr>
<td>Partly Correct


a. Yes, because it is divided by two equally
b. ii and iii -> not fair
iv -> fair
Lidya</td>
<td>Thirteen out of 40 students (32.5%) had the answer of partly correct. Among this group 2 students had no answer for question c; 4 students had wrong answer for c like Lidya's answer on the left; 3 students had wrong answer for a and b; and 4 students have wrong answer for b and c.</td>
</tr>
</table>

Figure 5.12
Model answer for Spinners Problems (Problem #14)

5.3.3 Students' responses on the lesson

As mentioned earlier, the tryout of IndoMath program was conducted based on three main components, namely workshop, classroom practice and reflection meeting. In the classroom practice, the participating teacher used RME exemplary materials in their lesson in the real setting. The purpose of this classroom practice was to give teachers opportunity to understand RME approach and later on able to use it in their lesson. For this purpose, namely to gain understanding about RME, each of them noted his/her perception before, during, and after the lesson as well as his/her students' reaction about the lesson. This note was especially needed in the discussion with others participant in the reflection meeting.

In the following we find students' responses on the lesson as a result of classroom practice of a participant in a junior high school in Yogyakarta. After students finished the lesson the teacher ordered her students to write down on their papers their comment about the lesson at that day. Students freed to comment whatever they like.

Basically, their responses can be divided into four: positive, negative, neutral (between positive and negative), and no comment. The following are summaries of their responses (Table 5.4).

Table 5.4
Students' response on teaching-learning process using RME exemplary material (N = 40)

Positive	42.5 %
Negative	5 %
Neutral	12.5 %
No comment	40 %

Sample of students' response on the lesson is given in Figure 5.13 in order to give an idea how they react on the learning process using the RME exemplary material.

Positive (42.5%, N=40)	
Mengasyikan karena dilengkapi gambar-gambar yang menarik (Dhomas).	Enjoyable, because it was equipped by interesting pictures.
Lebih enak ini, kalau diterangkan terus-menerus mungkin akan lupa dan bosan (Gunawan).	It is more enjoyable. If teacher was always explaining I may forget and boring.
Cukup mudah dan agak menyenangkan (Fatmawati).	Quite easy and a bit enjoyable.
Lebih menyenangkan daripada pelajaran fisik dan menghitung matematika, pokoknya lebih santai dan menyenangkan dan pelajaran begini dapat menambah pengetahuan dalam peluang (Yonatan).	More enjoyable than physic and arithmetic subject-matter. The main thing was more relax and leisure, and this lesson could add our knowledge about chance.
Negative (5%, N=40)	
Pelajaran mengenai peluang ini tidak menarik karena tidak diterangkan oleh guru dan siswa disuruh mengerjakan sendiri/diskusi (Rachmat).	This lesson about chance was not interesting, because teacher did not explain, and students were asked to work alone/ discussion.
Menurut saya pelajaran ini mungkin agak membosankan (Carter).	In my opinion this lesson was a bit boring, maybe.
Neutral (12.5%, N=40)	
Sangat membosankan, karena siswa tidak diberi kesempatan tanya jawab dengan guru, waktu terlalu dihemat, lebih mementingkan selesai pekerjaannya daripada mengerti. Seharusnya dikerjakan secara bertahap, karena soal ini sungguh menarik kalau dikerjakan secara bertahap, tidak asal tubruk saja (Daud).	Very boring, because students were not given an opportunity to conduct questions and answers with the teacher, the time was too thrifty, more emphasized to finish the work rather than understanding. It must be done step by step, because this problem was really interesting if done step by step, not just slammed into.

Figure 5.13
Students' response about the lesson

From the students' comments, we understand that shifting from teacher-centered learning to student-centered learning was for some of them difficult and frustrating. As can be seen in like Rachmat's response: "This lesson … was not interesting, because the teacher does not explain," and Daud's response: "Very boring, because the students are not given an opportunity to conduct questions and answers with the teacher." In contrast, some students had an opposite opinion like Gunawan: "It was more enjoyable, if it [lesson] was always explained [by the teacher] I may forget and boring." Almost half (42.5%) of the students had a positive perception (such as easier, enjoyable, and interesting) about the material as well as the teaching-learning process. Only 5% of the students had negative response (not interesting and boring) about the lesson. Twelve and half percent (12.5%) of the students had neutral position that is they thought that the material was interesting. However, the way that teacher used it in the teaching that was emphasizing on student own learning rather than explaining was difficult for them who used to for a long time with teacher-centered approach.

It is rather significant that 40% students had no comment on the lesson that they had just followed. It is unclear whether this group has positive or negative response. However, from the report of the teacher who conduct the lesson it seemed that students enjoyed the lesson as she said, "Students and I enjoyed the lesson. I didn't need to prepare the materials [because it is already available]. The material was really help me to conduct the lesson, and my students could learn from it."

5.4 Development of In-service Program

The development of IndoMath program in its preliminary stages proceeding two steps of what are called the Netherlands and Indonesia periods (the first fieldwork).

5.4.1 Design guidelines

The Netherlands period focused mainly on literature review on professional development for teachers that resulted in the insight of the principles of effective strategies for professional development for teachers (Section 3.4). In Indonesia, the focus was devoted to the current practice of in-service education for teachers (Section 3.3). By combining the result of literature analysis on professional development and insight from the context analysis, the design guidelines were formulated as outlined below.

1. Although the efforts to improve mathematics education in Indonesia has been conducted using a well established program covering all parts in the country, the students' performance in mathematics is remain low which is partly related to ineffectiveness of mathematical instruction and an impact of lack mathematical

background of the teachers. It may suggest that the first attention on the IndoMath program must be paid to *support teachers in improving their content and pedagogical content knowledge*.

2. Since RME is a new theory for Indonesian teachers the introduction of RME should be supported by *high quality RME exemplary curriculum materials* that help them to understand as well as promising to improve students' mathematical performance when being implemented in instruction.
3. Due to the fact that many parties in Indonesia (especially teachers and teachers educators) value curriculum merely as a formal document and how teachers operationalize that document, it is needed to consider to closing the gap between ideal curriculum and its operational, and narrowing the gap between the operational representation to its experienced one. It may suggest that the development of RME exemplary curriculum material should *involving teachers from the very beginning*, and teachers' opportunity to practice the material in real situation as well as to reflect and discuss with their colleagues and get feedback from expert.
4. Based on the above arguments, to support teachers understanding and ability to implementing RME in the classroom lesson, the IndoMath in-service program consist of components of Workshops, Classroom practices, and Reflection. The in-service course itself should *reflect the approach that teachers could use with their students in classroom setting* (see point 6 in the Design Guidelines**)**.
5. Moreover, e*xemplary curriculum materials for teachers are integrated in the in-service course* to provide clear description of RME method in practice. The materials should contain the following information:
   - General information (logistical preparation of the lesson);
   - The contextual problems;
   - Solutions and samples of students work;
   - Hints and comments.
6. The flow of instruction should *reflect the flow of learning and teaching activities in classroom*, that is meaningful RME mathematics instruction. This should help teachers see and feel what new practice look like in action.
7. The participating schools on the IndoMath program are Junior High Schools from rural, urban, and suburban area. Each participating school should be *represented by two mathematics teachers in order to give opportunity for collaboration* in classroom practices.

The operationalization of design guidelines into in-service program design is discussed in Section 5.4.3 in which formative evaluation played important role during development process. In this phase, the first design model of in-service program appraised by a Dutch RME expert, an Indonesian teacher educator and two Indonesian experienced mathematics teachers, tried out of course sessions, and field-test involving 10 mathematics teachers. Another teacher educator was also asked to become an observer (independent evaluator) to assess the whole aspects of in-service program activities when being performed.

5.4.2 Results of experts appraisal

The preliminary design of the IndoMath in-service program has been examined by an expert on RME in the Netherlands. His suggestions and comments are summarized as follows.

- Teachers' reflection is important. However, it is not necessary involving the materials (content of the lesson) as a component to be reflected. Teachers' ideas about the materials can be developed later after they have experience using the given materials in the in-service education program. They can focus on the instruction (lesson flow), interaction, and students' work. For the purpose to obtain teachers' reflection on classroom practice it is useful to give the teachers diaries to write down what happens in the learning process. It could be a combination of empty sheets and structured sheets, so they can choose the appropriate ones for the likely situation that happened in the classroom. The diaries should be filled in immediately after the class. A lot of useful data and information come from teachers' diaries.
- The topic of training about Probability is appropriate. It is a good topic to explore the ideas of RME. The topic is small in coverage so that we can explore it in depth. The exemplary materials for the training and classroom practice should be well formulated, i.e. the developer should choose the situation (problem) which is very well addressing the concept. Participating teachers should be given broad materials on this topic. So, they can select which one that they like for classroom practice. Give teachers booklet on the background information for home reading.
- It is important to know which ideas and concept teachers do have. Teachers can not involve themselves immediately in the lesson if they don't have ample background information of the mathematics topics to be trained. Firstly give

them easy example ideas or possible problem cases.

- Start in-service education program with 'doing mathematics'. It is useful to increase teachers' curiosity of the topic being taught. Discussion will grow up after they involve in the interesting start. Give teachers opportunity to address their own experiences. The trainer can put the theory of RME on the discussion.
- Time allocation for teachers' self reflection (3 hours) seems too long.
- On the first phase, the organization of training divided into three sets is okay. It is appropriate to gain the basic ideas of the learning process in the training, for the purpose of improvement. But, the next phase of training program, self and group reflection sessions can be integrated with didactic and instruction/demonstration sessions in one day.
- The information and data for the purpose of improvement of the program can be obtained from teachers' diaries, classroom observation, presentations, discussion (in the course), and students' work. If possible it is a good idea to tape teachers' presentation in reflection sessions (in the second, fourth and sixth meeting of the in-service program). The purpose of this tape is to see the growing of teachers' product and process of thinking.

Indonesian experts (a teacher educator and two experienced mathematics teachers) were interviewed about the design of the in-service program. In the following are summary of the results of expert appraisal in Indonesia.

- They agreed that the program goals (general and specific goals) are clearly stated and relevance to current needs of mathematics teachers in Indonesia.
- They agreed that the participants of the program are JHS mathematics teachers who willing to participate in the program in pair in order to give them opportunity to collaborate and support each other.
- They stated that the combination of workshop, classroom practice and reflection meeting make the program possible to achieve its goal. Collaboration in pair and reflection will give them worthy experience to understand the strength and weakness in implementing the intended approach.
- They thought that the content of the workshop that consists of lecture, demonstration, micro teaching, preparation for classroom practice, and observation skill will determine the success of the program in a whole.
- They perceived that one of the advantages of this program is the teachers are given opportunity to conduct classroom practice in their real setting.
- They proposed that time allocation for each session should be calculated

properly in order to avoid the organizational misleading.

In spite of the above comments of the program design, Indonesia experts gave several suggestions to improve the program:

- Prior to the program it is necessary to conduct 'polling' of what are the mathematics topics that teachers really need.
- The participants should have at least five years of experiences in mathematics teaching in JHS. Give priority to the member of MGMP weekly meeting. They should commit to fulfill their obligation during the program.
- There must be alignment between the program content and evaluation. The program may be conducted step by step. The participants should commit to implement the results of the program in their school, and for this purpose there should be a monitoring and evaluation.
- It may use videotape as media in instruction. Give each participant 'student material' and 'teacher guide.'

5.4.3 The first tryout of IndoMath program

As mentioned in Section 3.4 the strategy of IndoMath Program applied the model of educational change in which the instructional practice is considered influences by teachers' mastery of subject matter and its pedagogical content knowledge, teachers opportunity to experience new practice in their classroom setting, and with collaboration and reflection being mediating factors between enhanced teacher knowledge and the use of innovation (Swafford, et al., 1999). So, the strategy of intervention in the IndoMath Study was a combination of workshop, classroom practice, and reflection.

During the workshop the participants were facilitated to work in a way that support them to understand RME exemplary lesson materials as well as their pedagogical perspective. For this purpose the 'doing mathematics' session provided them opportunity to learn about problem solving and its approaches. This key element of the workshop similarly reflects the strategy which is known as immersion in inquiry (Loucks-Horsley, et al., 1998). Teachers are immersed in intensive experience in which they focus on learning mathematics and are able to pursue content in-depth.

The goal of these experience is to engage teachers in firsthand learning as they are expected to practice in their classroom in which they guide the students through exposure contextual problems in order to be able reconstruct mathematics ideas and concept by themselves. In fact, the principle of effective professional development proposes that the participants must be provided with opportunity to learn and reflect about instructional ideas in the context of their own classroom practice (Borko & Putnam, 1996). The strength of the classroom practice in the IndoMath Program that it is supported by curriculum materials that enable teachers to focus on the content as well as pedagogical aspect of the new curriculum.

The first tryout of IndoMath in-service program was conducted from December 30, 1999 till January 27, 2000. The main concerned in this program was the fact that RME is a new theory for mathematics teachers in Indonesia. So, the implementation of IndoMath program focused on giving the participants experiences on this new strategy of teaching and learning. The program was aimed at helping mathematics teachers to know, understand and develop competency in implementing RME in their mathematics lesson for a certain topic (see Table 5.5 for IndoMath program components).

Table 5.5
The IndoMath in-service program components

Program components	Content and procedure
Workshop	
▪ Doing mathematics (45 min.)	First, teachers worked in a group to solve 'the last card problem'. Second, they learned how to approach a problem using '4-steps toward problem solving'. Third, discussion of their findings.
▪ RME Theory (30 min.)	Instruction on the theory of RME
▪ Audio session (30 min.)	Teachers listened to an audio of lesson with RME approach is used. The topic of lesson was similar with the topic for classroom practice.
▪ Micro-teaching (30 min.)	Two teachers voluntarily taught (supposedly) a certain part of the exemplary curriculum material to other participants.
▪ Observing skill (30 min.)	Teachers learned the classroom observation form under the guidance of trainer, and by the help of some photographs of the realistic approach lesson the get feeling how to interpret the lesson process and class activities.
▪ Preparation of Classroom practice (30 min.)	Discussion of aspects of realistic approach lesson and the possible approach for the topic to be practiced.
Classroom practice	
▪ (2 days 2 x 45 min. each, for each teacher participant)	The following days after the workshop teachers planned with their peer to conduct classroom practice. They performed peer collaboration by stressing on mutual observation (both teachers observe each other in classroom practice).
Reflection Meeting	
▪ Collaboration report (50 min.)	Each pair addressed to other participants the result of their collaboration in classroom practice.
▪ Feedback and discussion (60 min.)	The trainer gave comments on the reports by paying special attention on the common issue raise in the classroom practice and asked participants to share their experiences.

5.4.4 Participants of the tryout

Ten JHS mathematics teachers from three districts, Yogyakarta, Bantul and Sleman in the Yogyakarta Special Region Province, were participated in the program (see

Table 5.6 for characteristic of participants). Five of them are experienced teachers who officially selected by Department of National Education Office in Yogyakarta to participate in the IndoMath study. From the beginning of the first fieldwork in Yogyakarta these five teachers were being critical friends of the researcher in discussion of the program design and RME exemplary curriculum material. Each of these teachers then invited a teacher from his/her school respectively to participate in the IndoMath program that made all participants of the program became 10.

Table 5.6
Characteristic of participants of tryout IndoMath program

Teacher	**Sex**	**Age**	**Education**	**Experience in year**	**School location**
A*	Female	39	S1	18 (5)**	Urban
B	Male	30	S1	4 (4)	Urban
C*	Female	35	S1	15 (15)	Rural
D	Male	27	S1	2 (2)	Rural
E*	Male	42	S1	22 (18)	Sub-urban
F	Male	38	D3	16 (12)	Sub-urban
G	Female	37	S1	3 (3)	Urban
H*	Female	35	S1	13 (13)	Urban
I*	Male	58	D3	32 (32)	Rural
J	Female	36	D3	15 (15)	Rural
		Mean = 37.7 S.d. = 8.33		Mean = 14 (11.9) S.d. = 9.29 (9.12)	

Note: * Experienced mathematics teachers (key teachers of PKG professional development project);
** In bracket is teaching experience in current school;
S1 = Bachelor degree in mathematics education;
D3 = Three years diploma in mathematics education.

As mentioned in the design guidelines the participants of the in-service course were JHS mathematics teachers representing urban, sub-urban and rural schools. It was expected that each school represented by two teachers, but because of the limited number of mathematics teachers in the rural area a pair (teachers C and D) came from two neighborhood schools. However, they did not have difficulty in collaboration in term of observing each other classes during classroom practices.

5.4.5 Comments and suggestions on IndoMath program

During the IndoMath in-service program a mathematics teacher educator from State University of Yogyakarta acted as an assistant researcher (observer) to evaluate all the program activities. At the end of the in-service program, the assistant researcher and all the participants of the program were asked to comment on the program components and suggest for the improvement of the program. Their comments are summarized in table 5.7.

About the 'doing mathematics' session, the observer commented that the trainer (in this case the researcher acted as a trainer) had showed a good role model for RME teaching. However, the observer was rather uncertain whether the participants had grasped this idea (RME teaching model). He observed also that the trainer too fast moving to other activity before the problem in the session was fully completed by participants. On the other hand, three participants (teachers C, D and G) perceived this session as the most interesting session, while a participant (teacher I) perceived as the most useful session.

About the 'RME theory' session, the observer thought that the participants usually were not interested in 'theoretical matter.' He said that the teachers have a tendency to appreciate 'practical matter' which they can observe to and work on. However, a participant (teacher I) perceived that this session as the most interesting one.

About the 'audio session' the observer commented that in general participants' attention was good. However, in the beginning of the session some participants did not look at the pages on *Student Book* which match to audio recording. Teacher G commented this session: "After audio session I got impression on how to conduct the teaching-learning process."

The 'micro teaching' session was failed to be conducted. According to the observer the participants hesitated to perform because they were not ready yet. The observer thought this session was important because could give the participants a clear view on how and what RME lesson could be performed.

Table 5.7
Comments on the IndoMath program components

Program component	An observer (a teacher educator)	Participants
Doing mathematics	Trainer, actually, has showed how to teach using RME approach. However, whether or not this already has been grasped by participants need to further examine. Besides, trainer too fast moving to other activity before the problem was fully answered.	The most interesting session (C, D, G). The most useful session (I).
RME theory	Commonly teachers (participants) were not interest in 'theoretical matter'. They tended prefer 'practical matter' which they can observe to and work on.	The most interesting session (I).
Audio session	In general, participants' attention was good. However, in the beginning some of them didn't look at the pages on Student Book which match to audio recording.	After audio session I got impression how to conduct the teaching-learning process (C).
Micro teaching	This session failed to be conducted, because participants hesitated to perform. Actually, it could give them a clear view on how and what RME is. The way trainer used to handle this situation was correct by replacing with other activity of looking at photographs of RME lesson.	
Observing skills	[No comment, but give some suggestions for improvement.]	This session and audio session is the most useful (D).
Preparation of classroom practice	This session is the right moment to see participants' perception on the RA, whether or not they already understand. For them who are not understood yet can be given 'remedial'.	The most useful session (C, G). This session is not enough (I).

To be continued

Table 5.7 *(Continued)*

Program component	**An observer (a teacher educator)**	**Participant**
Classroom practice	Is the RME remains work for the schools with very poor students' intake?	The materials really help me to conduct the lesson, and students can learn from it. Students and I enjoy the lesson very much (A). Comparing my students to other participants' I doubt if I can finish the lesson in 4 hour-lessons. But then everything was going well. My students were very enthusiastic and active in learning (C). RME is a new approach for teacher, therefore classroom practice is important to give them experience. I think teacher can use the approach for other topics if materials available (E). My students enjoy very much the lesson. Their perception on mathematics has changed. They pay more attention on me (G). Classroom practice with collaboration has many advantages. I learn from other teacher whose teaching I observed. I got impression that students get pleasure from the lesson (I).
Reflection meeting		Collaboration and reflection is the most useful session. I know what other teachers did, and I can improve my lesson (A).

Furthermore, the observer stated that the way the trainer used to handle the situation was correct by replacing with other activity of looking at some photographs on RME lesson.

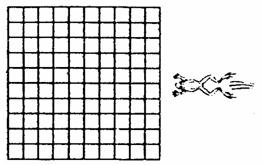
About the 'preparation of classroom practice' session, the observer though that this is the right moment to see participants' readiness to perform the RME lesson. Teachers C and G perceived this session as the most useful session.

About the RME exemplary lesson material used in classroom practice after the workshop Teacher A said: "*The material really helped me to conduct the lesson, and students can learn from it. Students and I enjoyed the lesson very much*." The same comment came from Teacher E: "*I think teachers can use the approach for other topics if RME curriculum material are available*."

About the lesson itself Teacher C commented: "*Comparing my students to other participants' I doubt if I can finish the lesson in 4 hour-lessons. But then everything was going well. My students were very enthusiastic and active in learning*." The observation to teacher C's classroom practice was resemble what she said (see Figure 5.14). The same as Teacher's C comment, Teacher G said: "*My students enjoyed very much the lesson. Their perception on mathematics has changed. They pay more attention on me*."

About the collaboration during the classroom practice Teacher I said: "*Classroom practice with collaboration had many advantages. I learned from other teacher whose teaching I observed.*

Pupils worked on Problem #12b of Student Book:
Now color the third floor on Student Activity Sheet 2 with any pattern of black and white tiles. What is the chance that Newton will land on a black tile on the floor you made?



[Pupils worked in pair. Then teacher asked 2 students to write down their answers on the blackboard].

Daru wrote: 50%, 1: 2, ½
Eka wrote: 10/100 x 100% = 10%
10/100 = 1/10 or 1 out of 10

Teacher C: I observe other answers as well. However we discuss these two only. First, Daru's answer. Why 50 percent?
Daru: Because I colored half.
Teacher C: How many half is?
Daru: 50 tiles.
Teacher C: So, where does 50 percent come from?
Daru: 100 divided by 2.
Teacher C: Is it, 100 divided by 2?
Daru: [confusing] 100 divided by 50 time 100 eh ….. [other students are laughing].
Teacher C: I want Firman to explain, because they discuss each other.
Firman: 50 over 100 time 100.
Teacher C: Why 50 over 100? Where does 50 come from?
Firman: Because the colored tiles are 50.
Teacher C: Where does 100 come from?
Firman: From all tiles.
Teacher C: Now Eka's answer. Why 10 percent?
Eka: The number of colored tiles is 10. All the tiles are 100.
Therefore, the chance is 10 over 100 time 100 percent which is equal to 10 percent.

Figure 5.14
Sample of interaction between Teacher C and students

Beside the comments he gave to the sessions in the workshop, the observer also commented the IndoMath program in general as follows.

1. Besides giving a workshop, the trainer (in this case the researcher acted as a trainer) also used a personal approach to introduce the matters of RME to the participants. This, in fact, gave significant impact on participants' understanding on RME. The problem is whether this still can be done if the participants double. It should be examined carefully.

2. Some participants had a weak preparation in teaching using RME approach (classroom practice). This wouldn't happen if the participants were given an appropriate opportunity to study the method and materials.

In addition to the comments about the program the observer and participants were also asked to give suggestions for the improvement of the IndoMath program. Their suggestions are summarized in table 5.8.

Table 5.8
Suggestions for improvement of the IndoMath program

Program component	The observer (a teacher educator)	Participants
Doing mathematics	Seeing participants' enthusiasm in Doing Mathematics, it is better to give them more than one problem, and those should be solved completely.	Develop other examples (B, I). Add more other games (C). Add other problems which have different ways but come up to the same answer (D).
RME theory	Emphasizing on the strength of RME compare to others approach could be interesting for participants. Show that RME is a good alternative in mathematics teaching in order to raise their beliefs which implies to their confident to use it in practice.	Give some other topics (C). Too brief, give some other examples (D).
Audio session	Trainer's comments on the events on the audio could be done on or after the recording. It is better to developed to be audio-visual session.	Use audio-visual (C, D, I).
Micro-teaching	It is better to appoint participant who will perform the microteaching beforehand. It could help if there is no 'volunteer' come up. Before audio playing ask participants to open the pages on Student Book that match to the events in the recording.	Appoint the participants beforehand (A). It is very useful session, so that it is better to deliver the schedule before the workshop which enable participants preparing themselves for microteaching (C, E, I). The trainer could be a role model in microteaching (D).

To be continued

Table 5.8 *(Continued)*

Program component	The observer (a teacher educator)	Participants
Observing skills	This session should be emphasized into two things. First, common perception on the aspects to be observed. Second, familiarity on the observation tools. Participants can practice to fill in the observation sheets while watching audio-visual presentation.	Participants' perception on the aspects being observed should be the same (E).
Prepara-tion of classroom practice	Use this session for activity of composing 'Instructional Planning' for 45/90 minutes pacing time by the participants. Based on this instructional planning, the trainer can assess whether or not they understand RME which has been introduced to them. If there is any obstacle can be handled immediately before classroom practice.	It is better to give a correct sample of teaching using the approach (A).
Classroom practice		Develop exemplary materials for other topics, such as: Proportion; Time, distance and velocity; Locus; and The (straight) line equation.

After the first tryout of IndoMath in-service program several revisions were made to program design.

1. The duration of the in-service program are added that consisted of two one-day workshops, two time classroom practices and two half-day reflection meeting in the time range of two weeks. The adjustment was also made to time allocation for each session. More time apparently was needed for doing mathematics session to give the participants enough time to solve all the problems in the session. Time allocation for doing mathematics was added 45 minutes to become 90 minutes.

2. A video of RME lesson was made that used in the next training program. So, the 'audio session' was skipped in the new design. Also, 'observing skill' session was removed from the program to be part of 'video presentation' session. It seemed useful to merge video presentation and observing skill in one session, because while teachers are watching the video they learn the aspects of RME lesson mentioned in the observation form.
3. Several other RME exemplary lesson materials were developed to give teachers more insight about the innovation. These exemplary materials were used for in the next in-service course. The topics chosen to be adapted are highly considered the need of teachers in their mathematics instruction and relevant to the current JHS mathematics curriculum. It was also the reason that the duration of the in-service program was longer as mentioned in point 1, because more topics were covered in the training program.

5.5 IN RETROSPECT

In Realistic Mathematics Education, the instruction is aimed at narrowing the gap between mathematics concepts and students' real experiences. The instruction should give students opportunity to experience the meaning and usefulness of mathematics that give them the ability to reconstruct mathematics ideas and concepts based on their own experiences of their environment. It is in the relation between mathematics and the students' experiential world that the use of contexts plays an important role. The context is a situation in which the problem is placed, and from which students can produce mathematical activity as well as practice and apply their mathematical knowledge (Gravemeijer, 1981/1982 cf. de Figueiredo, 1999).

Context can also be a model or representation of a real thing that can be used to facilitate learner understand mathematics idea and concept in the learning process. The ladder, floor and spinner that is being used in various problems in the module of *Apakah Peluang Itu?* may be categorized as this kind of context. The important thing in using the context is that students are able to imagine something and also can make use of their own experiences and knowledge.

In this chapter students' works that resulted from the tryout of RME exemplary curriculum material in an Indonesian Junior High School are analyzed. The exemplary curriculum material uses the contexts of chance ladder, black-and-white floor, and spinner to facilitate students learning process about the concept of chance or probability. The various problems are embedded in those contexts.

From this analysis we would like to understand how RME curriculum material is adapted to the Indonesian schools whose situation are different from the original one where the material is intended to, the United States.

The following are the points that can be derived from the result of the tryout of RME exemplary curriculum material in Indonesian Junior High School.

5.5.1 Students' familiarity of the contexts should be taken as first consideration in the adaptation of RME curriculum materials

It seems that Indonesian students quite familiar with the contexts of ladder, floor, and spinner. The familiarity of the contexts is the main requirement of the successful adaptation of the RME curriculum material (see also de Figueiredo, 1999). As an example, we may have a look at the Problems #6 and #7 about Frog Newton. Indonesian students were familiar with the contexts of black-and-white floor of 'cafeteria' and 'hall,' and of course, they had no difficulty to imagine a 'frog.' This allowed them to easily understand the story of Ira's frog, and interpret correctly the questions from the story. Moreover, because of high degree of familiarity of Indonesian students about the contexts of 'cafeteria,' 'hall,' and 'frog,' the story was recognizable and was more likely to be seen by them as relevance and interesting.

However, regarding the familiarity of the contexts, the adaptation of the RME curriculum material from MiC (the United States) to the Indonesian version is not easy to realize. The RME curriculum material has the nature that it is arranged as unity. A module or section of RME curriculum material contains some contexts and story problems that embedded in those contexts. It is quite difficult to find a module or section with which context all Indonesian students are familiar with. They may be familiar with some of the contexts but are not familiar with the others. The story problems that are embedded in the contexts that the students are not familiar with should be skipped from the module. This implies to the discontinuity of the sequence of the content of the module because it should be followed step by step. This damages the unity of the module. To some extent such a defect module (if it is forced to be adapted) affects students' learning process and their reconstruction of mathematical ideas and concepts.

In the case of the module of *Apakah Peluang Itu?* the developer assessed the familiarity of Indonesian students to the contexts in the beginning of adaptation process. As can be seen from Indonesian students' works in dealing with the problems, the process of adaptation was going well. In order to become an effective assessor, the foremost requirement is that the developer must have wide knowledge and experiences about the Indonesian students' life.

5.5.2 The translation of the texts into Indonesian should reflect their original message in order to avoid different interpretation

In the case that Indonesian students are familiar with the contexts, the next process of adaptation is translation. The translation of the texts in the module, especially in the problems should reflects its original meaning in order to avoid ambiguity. For example, in Problem #1 in the module of *Apakah Peluang Itu?* 'birthday' is translated as 'hari ultah.' Some students referred 'hari ultah' as days in a week, namely Monday, Tuesday, …, Sunday. Another example is in Problem #10c: *Adakah cara lain untuk mengatakan: 'Peluangnya adalah 50%'?* as translation of *What is another way of saying: 'The chance is 50%'?* Twenty three out of 40 students had no answer. It is quite a lot. Apparently the translation was confusing. Because for that question the answer can be as simple as 'yes' or 'not' which is not intended by the original one.

5.5.3 The context should as much as possible explain itself without explanation

Some contexts in the module were not easy to understand by students. This brought them to the difficulty to solve the problem. The context needed to be explained orally by the teacher. In other words it was not understood without saying (see also de Figueiredo, 1999). For example, in the context of *Cocokkan* (Problem #5) only 3 out of 40 students had correct answer. Concerning the difficulty faced by some students in dealing with the problems, in adapting the

RME curriculum material we should aware that the context should as much as possible explain itself without explanation. It is particularly important in Indonesia where the class size is big (40 – 45 students). Otherwise, the teacher should explain again and again to every group of students in the class before they are ready to work with the problem.

5.5.4 Students' experiences about the context influences their approach to the problem

In the tryout of RME curriculum material of *Apakah Peluang Itu?* we found that students' experiences of their environment related to the context affected their approach to the problem. For example, in Problem #2c students had to decide the chance that their fingernails will grow at that day. Fifteen out of 40 students were not sure. The growing of fingernail that is not visible in daily observation can be considered as students' factual knowledge that affected their decision. Another example is Problem #6. Students' factual knowledge of the contexts of 'cafeteria' and 'hall' brought them to the incorrect reasons for their answers such as Frog Newton was founded in the hall, because *hall is less crowded than cafeteria*. The answer could be correct but the reason is incorrect. They used the reference of '*less crowded*' instead of *comparing* the number of black and white tiles in the hall and cafeteria.

5.5.5 Picture can mislead students *(see also de Figueiredo, 1999)*

Some students made use of the picture to understand the question. It happened, for example, when students answered Problem #8. They measured using a ruler the distance of frog's jump. Using the result of that measurement they decided where the frog will land. This led them to the answer that the frog will land between black and white tiles. They did not care about the number of black and white tiles as intended by the problems.

5.5.6 Teaching-learning process

Regarding the teaching-learning process using the module of *Apakah Peluang Itu?* we can conclude that majority of the students enjoy the lesson. The teaching-learning process that give students opportunity to learn with less intervention form the teacher made them easily to reconstruction their own knowledge about mathematics idea and concepts. To some other students this approach was difficult and frustrating.

If we go back to the philosophy of RME that students' reconstruction of mathematics idea and concepts may be guided by teachers, the role of teachers is still crucial in implementation of RME curriculum material in Indonesian schools in term of bringing students to the new way of mathematics learning process. This is important to avoid students' frustration that can make them hate mathematics subject as the experience of the implementation of *modern mathematics* to replace *arithmetic* in the early 70's.

The role of Indonesian teachers in the teaching-learning process can be learned from the tryout of the module. Most of the problems in the module resulted in different students' answers. Teachers can use students' different answers to motivate them to engage in the learning process. The contextual problems will loose their role if teacher let the atmosphere that created by those problems go without any effort to build students' interest. It is particularly important in Indonesia as teaching-learning process is dominated by passive nature of students.

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EXAMINING VALIDITY AND PRACTICALITY OF INDOMATH PROGRAM

This chapter discusses the results of design and evaluation of IndoMath program in the second fieldwork. This chapter starts with the design of the study (Section 6.1), and overview of the implementation of IndoMath program (Section 6.2). The aims of the fieldwork is to study teachers' perception about the aspects in the program and its validity upon the effects of training to teachers' perception of possible implementation of RME in their classroom instruction (Section 6.3). In addition to teachers' perception of IndoMath program, the design and evaluation of the adapted RME lesson materials are also examined. This results in the revised versions of those materials (Section 6.4). Section 6.5 discusses the design and evaluation of the RCP-test. Section 6.6 gives summary and discussion of this chapter.

6.1 DESIGN OF THE STUDY

6.1.1 Research approach

The evaluation of the implementation of IndoMath program in the second fieldwork aimed at evaluating all aspects of program components, i.e. workshop, classroom practice, and reflection, including curriculum materials which have been adapted from MiC. The outcomes of the evaluation were used to make revision of in-service activities as well as adjustment to the curriculum materials for the purpose of subsequent implementation.

In order to achieve those goals, the first level of professional development effects on participants was assigned to evaluate the program activities that is teachers' perception of the in-service education program. Participants' perceive relevance of course program can be regarded as an important factor influencing the potential impact of the program on classroom practice (Kirkpatrick, 1987, cf. Thijs, 1999). Measuring participants' initial satisfaction with the experience provides information that can help improve the design and delivery of program in valid ways (Guskey, 2000, p. 82).

As far as a tension between development and research was concerned – since both aspects were held by the same person – the evaluation of the IndoMath program was done by the researcher with three assistant researchers who follow the program from the preparation until the end.

6.1.2 Research questions

The IndoMath study followed a development research approach that focused on evaluation and improving the in-service program. As noted earlier in Section 4.4, the research question in the second fieldwork is:

> *What are the characteristics of a valid and practical in-service education program as a vehicle to introduce RME to Indonesian mathematics teachers?*

Within this research question the focus of the formative evaluation was to find out the validity and practicality of the in-service program. For this purpose, participants' satisfaction about the in-service program as well as the potential impact on their understanding about RME were examined.

These in turn led to the following sub questions, and success criteria concerning the effects of the in-service program:

- *Do participants perceive the program as relevant and meeting their expectation?*
  Teachers value the organization and components of in-service program positively, meaning that the program activities (workshops, classroom practices, and reflection meetings) are meeting their expectation, instructive, useful, enjoyable, relevance and informative.
- *Do participants perceive the program activities as helping them to understand RME?*
  This would be indicated by (a) perceive of gain knowledge of RME theories; and

(b) participants' perceive positively of the usefulness of the program activities and RME exemplary curriculum materials.

- *Do participants perceive the program activities as supporting them to implement RME lesson?* This would be indicated if there was a perceived change in participants' confidence of possible implementation of RME.
- *Can participants realize the characteristics of RME approach in mathematics instruction?* This would be indicated if there was an observed change in participants' knowledge and skill in RME approach in mathematics lesson.

In addition to the above purpose, the formative evaluation in the second fieldwork also intended to find out the validity and practicality of the adapted RME curriculum materials. The formative evaluation of the lesson materials followed cyclic approach of evaluation and revision: (1) extensive use of exemplary lesson materials; (2) high degree of iteration through a cyclic process; and (3) teachers' participation (Nieveen, 1997; Ottevanger, 2001). The adapted RME exemplary lesson materials were used by several JHS mathematics teachers from different schools from rural to urban areas in the Yogyakarta Province. The extensive use of the lesson materials were results in lesson learned about the valid and practical RME materials for Indonesian school context which is characterized by big class-size (40 to 45 students per class), and passive nature of students.

Furthermore, teachers played an important role in the try out of RME in their classroom setting. Teachers' obvious knowledge of their own local conditions, not necessarily always known to the designer in enough detail, contributed to an increase in the practicality of the materials (Ottevanger, 2001).

Next to the two previous goals of formative evaluation in the second fieldwork, namely examining the validity and practicality of in-service education program and the RME curriculum materials, two instruments to measure the impact on the intervention to the teachers were also applied for the purpose of validation. These two instruments, namely Realistic Contextual Problem test or RCP-test (developed by the researcher in consultation with RME expert in the Netherlands) and Innovation Profile (van den Akker & Voogt, 1994; van den Berg, 1996) were going to be employed in the third fieldwork (semi-summative evaluation) to study the effectiveness the IndoMath in-service program.

6.1.3 Methods and instruments for data collection

In the IndoMath study, especially during development and evaluation stages, the rigor information was desired that supposedly result in an appropriate interpretation, and subsequently the developer could take proper actions in the next cyclic of tryout and implementation. For those reasons, according to Denzin (1994) the developer could use triangulation strategies: interpretations that are built upon triangulation are certain to be stronger than those that are rest on the more constricted framework of a single method.

The study (the second fieldwork in Yogyakarta) used of four kinds of data collection methods and instruments to evaluate the in-service program:

- *Questionnaires* administered to participants at the end of each workshop, and at the end of whole program.
- *Classroom observation* during the program (RME lesson practice) to get insight in the ways in which the teachers implement the RME exemplary curriculum materials.
- Analyses of *reflective reports* of teachers during the reflection meetings about lessons they carried out in their classrooms using RME exemplary curriculum materials.
- Analyses of *focus group discussion* among the researchers and participants after the program about the whole aspects of the program.

The RCP-test was administrated to participant before and after the IndoMath in-service program. The results of the test (teachers' works) were then analyzed.

The Innovation Profile was used during classroom observation. By using this instrument in the real situation, its practicality can be measured (see Figure 6.2 for sample and Appendix E for detail).

Data collection procedures and their relation to evaluation questions are summarized in table 6.1. These data collection instruments are included in Appendices.

Table 6.1
Evaluation questions and data collecting procedures

	Data Collecting Procedures							
Evaluation Questions	*OQ*	*WQ*	*PQ*	*CO*	*RR*	*FGD*	*PT*	*PPT*
What are characteristic of participants	√							
What's teachers' expectation in participating in the program?	√							
Did participants perceive the program as relevant and meeting their expectation?		√	√		√	√		
Did participants perceive the program activities as supporting them to implement RME lesson?			√		√	√		
Can participants realize the characteristic of RME approach in mathematics instruction?				√	√	√		
Was workshop implemented as planned?		√	√		√	√	√	
Did workshop facilitate learning?					√	√		√
Was classroom practice implemented as planned?				√			√	
Did classroom practice facilitate learning?					√	√		√
Was reflection meeting implemented as planned?			√				√	
Did reflection meeting facilitate learning?			√		√	√		√
Was RME exemplary lesson materials practical?				√	√		√	

Note: OQ = Orientation Questionnaire; WQ = Workshop Questionnaire; PQ = Program Questionnaire; CO = Classroom observation; RR = Reflective Report; FGD = Focus Group Discussion; PT = Program Tryout; PPT = Pre and Post Test.

Questionnaires

There were three type questionnaires, namely orientation questionnaire, workshops questionnaire, and whole program questionnaire.

Orientation questionnaire was delivered to participants at the beginning of the program and consisted of questions about participants' background and expectation in following the program.

Workshops questionnaire was questionnaire delivered to participants at the end of each workshop which gather participants' immediate perception about aspects in the workshop. Workshop questionnaire (see Figure 6.1) consist of 14 items of 5-scale of Likert-type questions from 1 (strongly disagree) to 5 (strongly agree), and 2 open questions which ask about participants' perception of the best aspect (session) during the workshop, and comments to improve the program activities.

1. The activity was carefully planned	1*	2	3	4	5*
2. The content was accurately and adequately delivered	1	2	3	4	5
3. The time was used effectively	1	2	3	4	5
4. The trainer was well prepared	1	2	3	4	5
5. Participants were active learners	1	2	3	4	5
6. The topic targeted was adequately covered	1	2	3	4	5
7. The materials are immediately useful	1	2	3	4	5
8. My understanding on RME is enhanced	1	2	3	4	5
9. My confidence in implementing RME is enhanced	1	2	3	4	5
10. The advice for classroom practice is concrete and clearly delivered	1	2	3	4	5
11. The lesson materials for classroom practice are sufficiently provided	1	2	3	4	5
12. The lesson materials are relevance with the SLTP curriculum content	1	2	3	4	5
13. I am confidence my students will enjoy the lesson material and approach of RME	1	2	3	4	5
14. I am confidence the RME lesson material and approach will improve student learning	1	2	3	4	5

Note:* 1 = strongly disagree, 5 = strongly agree.

Figure 6.1
Five scale Likert-type questionnaire delivered after the workshops

Whole program questionnaire was the questionnaire delivered to participants after the whole program. The focus of the questionnaire was to reveal participants' perception about the whole aspects in the program, namely

- Overall impression of the workshops, classroom practices, and reflection meetings. The questions are in the form of 5-scale Likert-type from 1 (highly negative) to 5 (highly positive).
- Opinion about general aspects of the program (information before program, pedagogical quality of resources persons, methods used, materials used, learning

atmosphere, and technical organization). The opinion ranges from 'very poor' to 'excellent.'

- The usefulness of the program sessions in workshops, classroom practices, and reflection meetings, ranged from 'not useful at all' to 'very useful.'
- Open questions about 'the most' and 'the least' effective session of the program.
- Perception of gain understanding about RME which consist of 7 items of 5-scale Likert-type questions ranged from 1 (strongly disagree) to 5 (strongly agree).
- Perception of implementation aspect of RME which consist of 5 items of 5-scale Likert-type questions ranged from 1 (strongly disagree) to 5 (strongly agree), and a closed question about the intention to use RME exemplary curriculum materials in mathematics lesson, and an open question about the possible obstacle of RME implementation in mathematics instruction.

Reflective reports

During reflection meetings, ten pair of teachers (who was performed classroom practice in collaboration including preparing the lesson and observing each other) reported to other participants their activities in classroom practices. The focus was about joint preparation before practice, classroom lesson itself, and impression after the lesson. This could also various aspects that were embedded in the teaching and learning process such as the RME exemplary materials, classroom atmosphere, and students' impression about the lesson. The reflective reports were used to gain insight in the lessons that could not be observed.

All the reports were recorded, and their transcriptions were made. The information from transcript were coded and displayed in a matrix format for the purpose of analyses.

Classroom observation

To examine the effect of the IndoMath program to teachers' understanding of RME in classroom lesson, observations of 2 lesson practices were carried out in which the RME exemplary curriculum materials were used. These classroom observations were intended as addition information and verification to the data from participants' reflective reports.

The observations were also held to gain information about the validity and practicality of the adapted RME exemplary curriculum materials.

The observation of the lessons was done by means of an 'innovation profile' that focused on the following elements of RME approach: the use of context as starting point, bridging by vertical instruments (from concrete to abstract), students' contribution in the lesson, interactivity, and intertwining (see Figure 6.2). The observations held by the researcher himself accompanied by a teacher whose colleague was in stage.

Variable	**Category**
Start the lesson that enables students to engage immediately in meaningful mathematical activity.	Threshold criterion
Teacher gives students independent work time before the group or whole class discussion.	Ideal element
Teacher gives wrong information about the subject matter and/or does not answer simple questions correctly, which leads to confusion.	Unacceptable element
In addition to taking account of students' current mathematical ways of thinking, the learning arise from problem solving activities and subsequently can help to bridge the gap between the concrete level and the abstract level, or between the intuitive level and the level of subject-matter systematic.	Threshold criterion
The problems are discussed in various levels, from concrete to abstract, or from informal to formal mathematics procedures.	Ideal element
Teacher answers his/her own questions.	Unacceptable element
Instructional sequences involving activities in which pupils create and elaborate symbolic models of their informal mathematical activity. The constructive element is visible in the large contribution to lesson coming from pupils' own constructions and productions.	Threshold criterion
Students put their solution in their own worksheet and/or explain to other pupils in classroom discussion.	Ideal element
Teacher carries a pencil or picks up student's pencil to do work for students.	Unacceptable element
Interactive instruction: explaining and justifying solutions, understanding other pupil's solutions, agreeing and disagreeing, questioning alternatives, and reflecting afterward.	Threshold criterion
During interactivity more than 1/3 of the pupils looses attention.	Unacceptable element
Intertwining of learning strands that is exploited in problem solving and application.	Threshold criterion
Teacher summaries the lesson by posting problems that involves intertwining of learning strand or application.	Ideal element
Not all the solutions in the summary problems are discussed because not enough time is spent on this summary phase.	Unacceptable element

Figure 6.2
Sample of variables (checklist) in observation form

Focus group discussion

The focus group discussion was a half-day meeting a week after the program. The meeting was arranged to gain insight from the group (participants IndoMath program) about the aspects in the program. Each reaction from one teacher could be commented by others until the group come to the agreement. So, the results of the discussion were reflected group conclusion about the program and its aspects. The discussion was held in open atmosphere in term of each participant free to comment whatever they like. If the rest of group member did not object to a statement from a person, meaning that they agree to such statement. The discussion was co-ordinated by one of assistant researchers. All the statements, comments and reactions during focus group discussion were recorded and transcription was made for the purpose of analyses.

6.2 THE SECOND TRYOUT OF INDOMATH PROGRAM

In this section elaborates the description of participants of IndoMath program and the implementation of the in-service program that consists of workshops, classroom practices, and reflections.

6.2.1 Description of participants

The participants of the IndoMath program were invited voluntarily based on the references of five *guru intis* (key teachers of PKG program). After Department of National Education Office of the Yogyakarta Province gave approval for the teachers being invited, the invitation letter was sent which was enclosed with the program schedule. In the beginning 22 teachers wanted to join, but at the start of the program 4 teachers withdrew because of personal reasons. Among five key teachers, two were asked to become observers (assistant researchers). In addition, a teacher educator from State University of Yogyakarta was also asked to be an observer that made three assistant researchers altogether.

Table 6.2
Participants' characteristic

Teacher	Sex	Age	Edu-cation	Experience in year	School location
Sis	Male	51	D3	24 (24)*	SLTPN 5 Yk (Urban)
Rui	Female	40	S1	19 (6)	SLTPN 5 Yk (Urban)
Rin	Female	37	S1	15 (7)	SLTP Muh. 2 Yk (Urban)
Kar	Female	42	S1	19 (19)	SLTPN 2 Yk (Urban)
Wid	Male	30	S1	8 (1)	SLTPN 3 Yk (Urban)
Mur	Female	37	S1	14 (4)	SLTPN 3 Yk (Urban)
Suw	Female	36	D3	14 (14)	SLTP St. Aloysius (Sub-urban)
Yay	Female	35	S1	12 (4)	SLTPN 3 Sleman (Sub-urban)
Sid	Male	39	D3	16 (12)	SLTPN 2 Mlati (Sub-urban)
Wac	Female	30	S1	3 (1)	SLTPN 2 Mlati (Sub-urban)
Ded	Male	41	S1	20 (4)	SLTPN 1 Mlati (Rural)
Rus	Female	42	S1	20 (20)	SLTPN 1 Mlati (Rural)
Muk	Male	43	D3	20 (1)	SLTPN 2 Pakem (Rural)
Wih	Female	36	S1	16 (16)	SLTPN 2 Pakem (Rural)
Ani	Female	36	S1	15 (10)	SLTPN 2 Bantul (Sub-urban)
Dwi	Female	37	S1	16 (5)	SLTPN 2 Bantul (Sub-urban)
Tuk	Female	39	D3	17 (15)	SLTPN 1 Bantul (Sub-urban)
Sun	Female	39	D3	17 (15)	SLTPN 1 Bantul (Sub-urban)
		Mean = 38.3 s.d.= 4.8		Mean = 15.8 (9.9) s.d.= 4.8 (7.2)	

Note: * in bracket is teaching experience in current school
S1 = bachelor degree; D3 = three years diploma

The participants were qualified and experienced mathematics teachers. Eleven teachers have S1 (bachelor degree) in mathematics education; a teacher has S1 in physics education. Six other teachers have D3 (three-year diploma) in mathematics education. The average participants' age was 38.3 years old. The average of participants' teaching experience was 15.8 years. While the average of participants' teaching experience in current school was 9.9 years (see Table 6.2 for participants' characteristics).

6.2.2 Overview of the implementation process

The IndoMath program (the second tryout) was conducted in the time range between October 26 till December 7, 2000 (see Table 6.2 for program schedule).

The program consisted of 2 one-day workshops, 2 times classroom practice, 2 half-day reflection meetings, and an evaluation meeting. Eighteen mathematics teachers from eleven JHSs (junior high schools) from three districts/city (Bantul distrct, Sleman district, and Yogyakarta city) participated in the program.

Table 6.3
Schedule of the IndoMath program

Program	**Date**	**Place**
Workshop I	Thursday, Oct 26, 2000	PPPG Matematika*
Classroom practice I	A day between Oct 27 and Nov 8, 2000	Participants' schools
Reflection meeting I	Thursday, Nov 9, 2000	PPPG Matematika
Workshop II	Thursday, Nov 16, 2000	PPPG Matematika
Classroom practice II	A day between Nov 17 and Nov 29, 2000	Participants' schools
Reflection meeting II	Thursday, Nov 30, 2000	PPPG Matematika
Evaluation meeting (Focus Group Discussion)	Thursday, Dec 7, 2000	PPPG Matematika

Note: * PPPG Matematika = Pusat Pengembangan Penataran Guru Matematika (The National Development Training Center for Mathematics Teachers)

The program was conducted largely according to the planning, beside some small problem with timing and participants' attendance. The start of Workshop I was postponed 30 minutes because some participants came late due to a big rain in the whole morning. In Workshop II two teachers were absent. Two other teachers were absent in Reflection Meeting II, and a teacher was absent in Evaluation Meeting. The reason for this absence could be explained as following. Two teachers participated in the IndoMath program without official permission from principal due to the hectic school academic activities preparing Grade 9 students for *Ebtanas* (although the letter from the Provincial Education Office had been received). As consequence they had to come to the workshops alternately with colleagues in order not to disturbance mathematics lesson in their schools. A participant was busy with his preparation to perform hajj pilgrimage to Mecca.

Workshops

There were four sessions in Workshop I (Table 6.4), namely *Doing mathematics*, *RME theory*, *Video presentation*, and *Preparation of classroom practice*. In the Doing mathematics session participants solved some problems related to the concept of ratio which was adapted from MiC (Mathematics in Context). This doing mathematics activity was intended to give participants a real experiences in dealing with contextual problems. They were expected to reinvent mathematics ideas and concepts by themselves. This was one of the philosophies of RME that they should understand.

Table 6.4
Program activities in Workshop I

Session	Content and Procedure	Relevance to RME
Session 1: Doing Mathematics (1 ½ hours)	First, teachers work in a pair to solve contextual problems in RME exemplary curriculum material 'Pencemaran Udara' (from section 'Traffic Pollution').	In this activity teachers learn to find mathematics ideas by themselves, find procedure by themselves in interactive discussion among group member and share the findings to whole class.
Session 2: RME theories (1 hour)	Instruction on RME theories started from the general review of RME background and history. Trainer facilitates the discussion about *students' reinvention* and *interactivity* based on the results of doing mathematics.	In the previous session teachers learn how to find mathematics concept by themselves. From this experience they get the idea of *students' reinvention*. Since the activity is conducted in a group work they experience the idea of *interactivity*.
Session 3: Video presentation (1 ½ hours)	Teachers watch the video on the lesson using RME material performed by a junior high school teacher.	It gives them visual support how to conduct the lesson, such as start the lesson by giving students contextual problems that facilitate students to immediately engage in meaningful mathematical activity.
Session 4: Preparation for classroom practice (2 hours)	Teachers work individually and in a group to solve contextual problems on the topic of *Perbandingan* (Comparison) from section 'Telephones and Populations'. A teacher performed microteaching.	By solving the problems in the RME curriculum material that is being used in the classroom practice teachers understand the content of the lesson. Teachers also understand *the use of contexts* as one of RME tenets. In this session trainer act as a teacher in a way that relevance to RME approach, thereby participants can mirror from it as they intended to use it in their classroom lesson. In this regard trainer should be able to be a good role model of RME teacher.

After doing mathematics session participants got an instruction on RME theory that was related to what they had done. In this session the trainer introduced some RME tenets such as students' reinvention and interactivity. The next session was video presentation. In this session participants watched the video of RME lesson performed by an Indonesian JHS's mathematics teacher. The video was appraised as a fair model of RME lesson. It is different from the usual lesson in Indonesian JHS's mathematics instruction because it emphasis on discussion and interactivity. This video lesson, at least, reflects some aspects of RME tenets such as 'start the lesson by giving students contextual problems', 'interactive communication between teacher and students', and 'teacher role as a guide in the learning process.' It also reflects Indonesian teacher interpretation of RME lesson.

The last session in Workshop I was the preparation of classroom practice. In this session participants did mathematics activity as in 'doing mathematics' session and performed microteaching. The material in this activity was the one for classroom practice.

Next to the Workshop I, there were three sessions in Workshop II: *Doing Mathematics*, *RME theories*, and *Preparation for classroom practice*. There was no *video presentation* like in Workshop I (see Table 6.5).

Table 6.5
Program activities in Workshop II

Session	Content and procedures	Relevance to RME
Session 1: Doing Mathematics (1 ½ hours)	In this session teachers will work with some contextual problems related to building formulas. First, they do experiment of *stacking cups*, and guess the high of the stacking. Second, they will deal with similar problems about *stacking chairs*, and Third, they will use the two previous activities to find formula the sum of the first n-th terms of arithmetic sequence.	Teachers learn *the use of context* to facilitate mathematics learning and the *reconstruction of mathematical ideas* from the informal procedure to the formal mathematics formula.
Session 2: RME Theories (1 ½ hours)	Trainer facilitates discussion about *bridging by vertical instrument* and *the use of contexts* based on the results of doing mathematics.	In doing mathematics activity teachers learn how to find mathematics concept by themselves. From this experience they get the idea of *students' reinvention*. Since the activity is conducted in a group work they experience the idea of *interactivity*.
Session 3: Preparation for Classroom Practice (2 hours)	Teachers work individually and in a group to solve contextual problems on the topic of 'Persamaan Belanjaan' (Shopping Equations).	By solving the problems in the RME curriculum material that is being used in the classroom practice teachers understand the content of the lesson. Teachers also understand *the use of contexts* as one of RME tenets. In this session trainer act as a teacher in a way that relevance to RME approach, thereby participants can mirror from it as they intended to use it in their classroom lesson. In this regard trainer should be able to be a good role model of RME teacher.

Classroom practices (CPs)

There were two times classroom practices in the days following each workshop (Table 6.6). In this lesson practice, each participant conducted mathematics instruction in his/her own class using RME exemplary curriculum materials that they already learned in the workshop. In the classroom practices teachers performed in form of peer collaboration with their colleagues from the same school or the neighbor school in order to give opportunity to prepare the lesson, observing each other and discuss the lesson afterward.

Table 6.6
Program activities in classroom practices (CPs)

Session	Content and procedures	Relevance to RME
CP-1 *(3 hours)*	The following days after the workshop teachers plan with their peer to conduct classroom practice. The material for classroom practice is *Perbandingan* (Comparison) from section 'Telephones and Populations.' They perform classroom practice with peer collaboration by emphasizing on mutual observation (both teachers observe each other in the classroom practice).	Teachers will learn the aspects of RME, such as the *lack of authority*, *interactivity*, and *students' free production*.
CP-2 *(3 hours)*	The following days after the workshop teachers plan with their peer to conduct classroom practice. The material for classroom practice is *Persamaan Belanjaan* (Shopping Equations). They perform classroom practice with peer collaboration by emphasizing on mutual observation (both teachers observe each other in the classroom practice).	Teachers will learn the aspects of RME, such as the *lack of authority*, *interactivity*, and *students' free production*.

Reflection meetings

Reflection Meeting was held two times (Table 6.7). It followed the classroom practices that were performed by participants. There were two sessions in reflection meeting that is *reflective report* on the result of classroom practice and *feedback & discussion*. In the first session each pair (who performed classroom practice collaboratively in term of preparing the lesson and observing each other) reported or shared to others participants their activities in the classroom practice. The issues that they addressed in the report could be joint preparation before practice, the practice itself and their impression after the practice. The reporting could also consist of various aspects that embedded in the teaching and learning process such as the materials, classroom atmosphere, and students' impression on the instruction process using the RME materials. They were also reporting their collaboration activity for the whole aspects that mentioned above.

Table 6.7
Program activities in reflection meetings

Session	Content and procedures	Relevance to RME
Session 1: Structured sharing (2 hours)	Each pair addresses to other participants the results of their collaboration. They bring the works of their students in lesson. They should explain to other participants what is the meaning of their students' free production.	In this session teachers will learn that gain understanding can be achieved by collaborating with colleagues. That is the way that they also use in RME instruction that emphasize on the interactivity and intertwining in the mathematics concept building.
Session 2: Feedback and discussion (2 hours)	The trainer give comments on the reports by paying special attention on the issues related to the aspects of RME. The trainer asks participant to share their experiences.	Students' work as results of classroom practice are discussed in this session. The discussion is directed to map out the learning route of the students from which they learn how to assess the process of students' mathematics learning.

All the reports (in Reflection Meeting I and Reflection Meeting II) were recorded. The transcriptions of these reports were made. The information from the transcripts were coded and displayed in a matrix format for the purpose of analysis (see Appendix D for the participants' reflective reports on classroom practices).

From the reports we were interested in knowing some aspects in RME lesson like teachers' perception about RME lesson, their understanding about RME material and its approach, the RME curriculum materials, class management, peer collaboration activity, and the obstacles in instruction.

6.3 PARTICIPANTS' PERCEPTIONS*)

As the focus of the formative evaluation in the second fieldwork was to find out validity and practicality of IndoMath in-service program, participants' perception of the components of the in-service program were analyzed. Parallel to this, participants' perceptions about the usefulness of program as a whole are also analyzed. In addition to these aspects, their perceptions of the possibility of RME implementation in schools are discussed at the end of this section.

6.3.1 Workshops

Immediately after the workshop the participants were asked to fill in the questionnaire on the aspects in the workshop. The questionnaire used a 5-point Likert type questions ranged from 1 (highly negative) to 5 (highly positive).

*) Two guru intis who acted as observers during the IndoMath program also complete all questionnaires as others participants, so their answers were counted as respondents.

Table 6.8

Participants' perception on the aspects in the workshops (immediately after the workshops)

	Workshop I			Workshop II		
	*Mean**	*s.d.*	*n*	*Mean**	*s.d.*	*n*
The activity was carefully planned	4.6	.76	20	4.8	.43	18
The content was accurately and adequately delivered	4.1	.64	20	4.3	.46	18
The time was used effectively	4.3	.47	20	4.3	.59	18
The trainer was well prepared	4.9	.37	20	4.7	.46	18
Participants were active learners	4.2	.59	20	4.5	.51	18
The topic targeted was adequately covered	3.9	.93	20	4.2	.65	18
The materials are immediately useful	4.5	.61	20	4.6	.50	18
My understanding on RME is enhanced	4.3	.56	20	4.4	.62	18
My confidence in implementing RME is enhanced	3.9	.72	20	4.2	.62	18
The advice for classroom practice is concrete and clearly delivered	4.1	.45	20	4.2	.43	18
The lesson materials for classroom practice are sufficiently provided	4.0	.65	20	4.4	.50	18
The lesson materials are relevance with the SLTP curriculum content	4.3	.73	20	4.4	.61	18
I am confidence my students will enjoy the lesson material and approach of RME	3.9	.69	20	4.2	.55	18
I am confidence the RME lesson material and approach will improve student learning	4.2	.67	20	4.2	.62	18

Note: * 1 = strongly disagree; 5 = strongly agree.

Participants' perceptions about the workshop were positive to highly positive (see Table 6.8). They perceived that the activity was carefully planned (score: 4.6); the trainer was well prepared (4.9); and the material were immediately useful (4.5). Furthermore, they perceived that the content was accurately and adequately delivered (4.1); the time was used effectively (4.3); and participants were active learners (4.2). On the aspects of the likely RME implementation, participants' perceptions were slightly lower than the aspects that previously mentioned. Their confidence for the implementation of RME was moderately positive (3.9). Participants' confidence that their students will enjoy the lesson material and approach of RME were also moderately positive (3.9). Participants were positively confidence that the RME lesson material and approach will improve students learning (4.2).

There were three sessions in Workshop II, namely *Doing mathematics*, *RME theory*, and *Preparation of classroom practice*. There was no video presentation as in the Workshop I. Participants' perceptions on the aspects in the workshop were slightly higher for Workshop II (see Table 6.8). It is worth noting that their confidence on RME implementation after Workshop II were more positive than Workshop I. Participants' confidence in implementing RME were positively enhanced (score 4.2 higher than 3.9 for Workshop I). Participants' confidence that their students will enjoy the lesson materials and approach of RME were also positive (score 4.2 higher than 3.9 for Workshop I). A possible explanation why participants' perceptions were slightly more positive may be that Workshop II was improved based on experiences with Workshop I. Furthermore, the participants had had real experiences on the RME lesson in the classroom practice that positively increased their confidence on RME implementation (see Section 6.4.3 for teachers' reflective reports of their lesson practice).

The participants highly appreciated the sessions on the workshops (Table 6.9). The *Video presentation* was valued as the best session in Workshop I (9x). In Workshop II participants appreciated *RME theory* session as the best session (10x). The *Doing mathematics* session was also highly valued by participants. In Workshop I, 8 participants chose Doing mathematics as the best session, and in Workshop II, 6 participants chose it as the best session.

Table 6.9
The best session in the workshops

Session	**Workshop I (n = 20)****	**Workshop II (n = 18)****
Video presentation	9x	-*
RME theory	2x	10x
Doing mathematics	8x	6x
Preparation for classroom practice	4x	3x

Note: * No video session in Workshop II;
** Some participants chose two sessions.

Prior to the Workshop I participants were asked to fill in orientation questionnaire from which their expectations in participating in the program were revealed. After the program participants were asked again whether the program fulfilled those expectations. In general, the participants valued the workshops as according to their expectation (4.5). Furthermore, they also had impression that the program was instructive (3.9); useful (4.5); enjoyable (4.5); relevant (4.1); and informative (4.7).

6.3.2 Classroom practices

Classroom practices as part of the IndoMath program had been proved to be a very strong component in the program in term of giving the participants actual experiences of RME instruction in a real setting. Participants' reflective reports of their lesson practices indicated the improvement from CP-1 to CP-2 (See Section 6.4.3). Apparently the CP-1 had given them useful experiences and knowledge how to conduct RME lesson. Based upon the results of CP-1, in the CP-2 the participants able to construe and build RME instruction based on their previous interaction with their students. They also could manage the teaching and learning process with the trajectory of students' mathematical thinking and learning.

6.3.3 Reflection meetings

Reflection Meetings as part of the IndoMath program were considered useful in order to get idea about the whole description of the classroom practices that performed in their respective schools. In this meeting participating teachers also got feedback from the trainer on the various problems they encountered in the classroom practice. For the participants, this meeting was apparently important since as some of them noted their understanding of RME approach was remain fuzzy (particularly after Workshop I). The important issue in this meeting was how important the role of teacher in the process of learning. What should teacher do if students are stuck in dealing with the problems and did not know what to do. From the discussion in the meeting they came to common thought that in RME it is important that teachers taking an active role as facilitators in the learning process particularly in helping students in interpreting the problems and giving alternative examples. The guidance for the students can be done as long as teachers did not answer the contextual problem him/herself. Most of participants were using this strategy in the CP-2 and were quite successful in their practices.

Giving the above facts on the activities in the *Reflection Meetings* it was understood how the reflective was performed, that is self-reflection and take information from outside. This process was in line with what Kruse (1997) stated about three important aspects in reflection: (1) viewing one's self as a resources; (2) relationships with other teachers as resources; and (3) ability to identify multiple sources of knowledge.

6.3.4 Participants' perception of the usefulness of IndoMath program as a whole

Participants (n = 19) valued the sessions in the program were useful to very useful. The average score for the sessions in Workshop I was 4.7, while the average score for the sessions in Workshop II was 4.6. The average score for the sessions in the Classroom Practice was 4.6, and the average score for the sessions in the Reflection Meeting was 4.6 (see Table 6.10).

Table 6.10
The usefulness of the sessions in the program

Program sessions	**Mean***	**s.d.**	**n**
Workshop I			
Doing mathematics	4.6	.49	19
RME theory	4.7	.46	18
Video session	4.7	.45	19
Preparation of classroom practice	4.6	.49	19
Classroom Practice I			
Classroom practice with RME exemplary curriculum material	4.5	.61	19
Peer collaboration and observation in classroom practice	4.8	.42	19
Reflection Meeting I			
Reporting classroom practice and collaboration	4.4	.51	19
Feedback and discussion	4.7	.49	18
Workshop II			
Doing mathematics	4.5	.61	19
RME theory	4.7	.58	19
Preparation of classroom practice	4.7	.45	19
Classroom Practice II			
Classroom practice with RME exemplary material	4.4	.68	19
Peer collaboration and observation	4.7	.58	19
Reflection Meeting II			
Reporting classroom practice and observation	4.4	.51	19
Feedback and discussion	4.7	.56	19

Note: * 1 = Not useful at all; 5 = very useful.

Furthermore, the most effective session that chose by the participants were *Feedback and discussion* (6x); *RME theory* (5x); *Doing mathematics* (4x); and *Reporting the result of classroom practice* (4x) (see Table 6.11). Both *feedback and discussion* and *reporting the result of classroom practice* were sessions in the *Reflection Meeting*. In session of reporting the result of classroom practice, the participants shared with their colleagues their experiences in using RME materials and its approach. To some extend they had the same obstacles and problems that prevent them to feel alone for being unsuccessful in practice. This session was continued with feedback and discussion which was intently be created as a room for reflection and confirmation between the participants and the trainer. The trainer should be able to give participants appropriate suggestions for the difficulties they were encountered. The trainer suggestions in this session may be viewed as relevance because trainer himself observed the classroom practice that performed by some participants. The classroom observation was considered useful for the trainer to get insight about teachers' lesson and in formulating ample comments in the reflection meeting.

Table 6.11
The most effective session in the program

The most effective session	**N = 19***
Feedback and discussion	6x
RME theory	5x
Doing mathematics	4x
Reporting the result of classroom practice	4x
Preparation of classroom practice	2x
Classroom practice	2x
Not decided	2x
All sessions effective	1x

Note: * Some participants chose more than one

6.3.5 Participants' perception of RME implementation

The IndoMath Program was designed with two purposes, that is to make teachers understand RME and to support them for effective implementation of RME in school. To achieve these purposes the program was designed in accordance to RME tenets. In developing the IndoMath in-service program it was designed to construe the program activities relevant to RME philosophy like the use of context, students' reinvention, and interactive instruction. Participants' understanding of the RME tenets are described as follows.

Participants were agree to strongly agree that in RME the use of context is important; the lesson must be started with something real for students; the lesson is structured by means of a set of contextual problems; teacher should give students opportunity to reinvent mathematical idea and concept by themselves; teacher should develop interactive instruction; teacher should ask students to use their informal way to understand and solve the problems; and every student has ability to understand mathematics idea and concept on his own level (see Appendix B: Table 10).

To what extend the IndoMath program has affected participants' perception about RME implementation? The participants were agree that the program has given sufficient information and suggestion on how to implement RME; has provided a clear image of how to implement RME; and has enhanced confidence in implementing RME in the lesson. Furthermore, their opinion about RME had enhanced; and they will structure their lesson in accordance with RME (see Table 6.12).

Table 6.12
Program affect on teachers' perception about implementation of RME

Program effect	**Mean***	**s.d.**	**n**
▪ The program has given sufficient information and suggestions on how to implement RME in the lesson	4.4	.51	19
▪ The program has provided a clear image of how to implement RME in the lesson	4.3	.58	19
▪ The program has enhanced confidence in implementing RME in the lesson	4.3	.73	19
▪ Opinion about RME has enhanced as a result of the program	4.2	.60	19
▪ I will structure my lesson in accordance with RME because of the program	4.1	.66	19

Note: * 1 = strongly disagree; 5 = strongly agree.

In the IndoMath program the participants received the RME exemplary curriculum materials in various topics. Two of these were used in the Classroom Practices (as part of the training program). The rest of the materials were for additional resources for reading or to be used in the next lesson. Sixteen (16) participants *had intention to use those RME exemplary curriculum material as long as they are relevant to the current* *curriculum*; a participant intent to use them *often*; and 2 participant intent to use the materials *sometimes* (see Table 6.13).

Table 6.13
Teachers' intention to use the provided RME lessons materials

Intention	**N = 19**
Yes, often	1x
Yes, as long as relevant to the current curriculum	16x
Yes, sometimes	2x

Regarding RME exemplary curriculum materials, it is worth to note here the results of focus group discussion a week after the IndoMath program that for most of them, those materials had made the IndoMath program different from the previously professional development program they had ever followed. For most of them those materials are (see Hadi, 2001):

- unlike 'module systems' that they had ever known because RME exemplary curriculum materials were designed with contextual problems;
- have advantage in motivating students use their reasoning;
- made mathematics instructional process different from what they are usually use (using PKG model: introduction – examples – exercises); and
- potential to promote students' active learning.

Participants judged the RME exemplary curriculum materials used in the IndoMath program as being good at the one hand, but at the same time they pointed to weaknesses such as (see also Hadi, 2001):

- the contents were difficult to understand (content level were too high for students);
- some sentences or messages (questions) were not easy grasped by students;
- the use of materials in lesson were time consuming;
- the contents were not match to the current curriculum.

In commenting those facts, participants recommended to develop (put) in the workshop an additional session to redesign the material in order to reduce the difficulty of their content. That session can be enclosed with the activity of 'Preparing Instructional Planning Unit' based on the materials that are already redesigned. According to participants the benefits of that activity are the following.

- It can replaced the microteaching activity which was teachers do not like.
- Teachers are more in depth in understanding the content and its approach in teaching.
- Time that allocated in the teaching and learning process (classroom practice) will be more efficient.

Regarding the likely obstacles on RME implementation, the participants mentioned the following (see Table 6.14):

- the preparation and development of materials (14x);
- time constraint or time allocation for teaching (12x);
- the duplication budged of students' materials (12x).

Table 6.14

The likely obstacle of RME implementation

Obstacle	N = 19*
The material development	14x
Time constraint	12x
The copying budget of students' materials	12x
The difference of pupils' ability	1x
Pupils are not used to discuss	1x
The mismatch between the method and the test	1x

Note: * Respondents can write more than one aspect.

6.4 DESIGN AND EVALUATION THE ADAPTED RME LESSON MATERIALS

In this section discusses the design and evaluation of the adapted RME curriculum materials. There are three lesson materials that had been adapted, namely system of linear equations of two variables (consists of two topics: *shopping equations*, and *minivan & van*), number pattern (*stacking cups*), and comparison (*telephones & population*). In the following these materials are described (section 6.4.1). Subsequently, the results from classroom observations are discussed (section 6.4.2).

6.4.1 The adapted RME curriculum materials

Shopping Equations

In this lesson students are going to created and solved shopping equations in order to decide the price of goods based on the total price of combination of different things. By using algebra the students are going to decide the prices of a pair of jeans, t-shirt, cassette, book, radio and watch, as well as variables x and y (see Figure 6.3 for sample of lesson content).

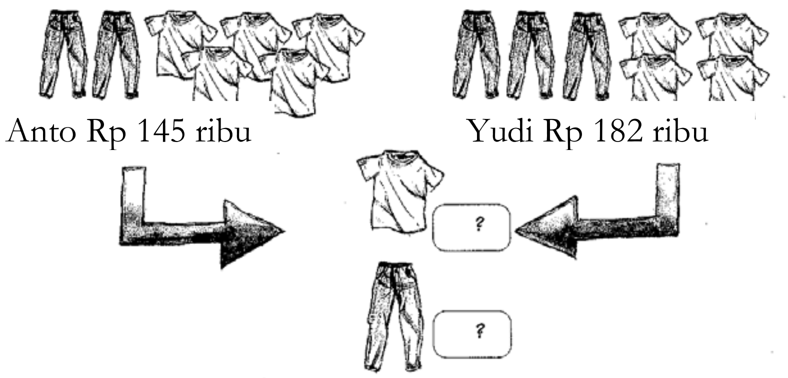


Figure 6.3
Shopping equations: jeans and t-shirts (reprinted from *MiC,* 1997)

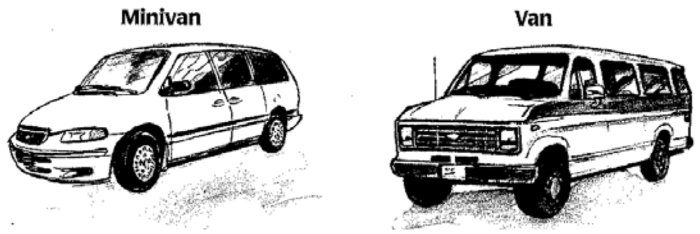
The goals of the lesson are the students are able to determine a common solution of a pair of linear equations by using algebra. The students are expected to be able to interpret and create the information from the story to mathematical notation using equations. Moreover, the students are expected also to understand and able to use the power of algebra to display and solve problems.

The lesson gives several methods to determine the common solution of two linear equations of two variables. The examples given are exchange method, combination diagram, equation multiplication, and notebook notation. On each example, the context given is useful to motivate students to understand the concept of algebra. All the strategies applied in this lesson are directed by the concept of to find a new equation of one variable, then using that equation to decide the price of the good asked.

The pacing time for the lesson is 3 time 45 minutes. During the lesson the students are supposed to learn and solve each equation by their own way. The different solutions came up in the class are expected can motivate students to try another strategy in addition to their previous solution.

Minivan and Van

By using the context of renting cars for the purpose of going to camping site, the students learn the principle of fair exchange, that is how to organize and determine the number of cars to be rented based on the number of people. The students also learn how to find a solution of system of linear equations using graph as well as algebra (see Figure 6.4 for sample of lesson content).



Seats: 6 people	Seats: 8 people
Cargo space: 5 boxes	Cargo space: 4 boxes

Figure 6.4
Minivan and Van (reprinted from *MiC*, 1997)

Based of the information given about the minivan and van (fig. 6.4) the starting point in the teaching is as follows. If there are 96 people are going to go to the camping site, and all the bags, luggage and other staffs are put in the 64 equal-sized boxes, the students are asked to suggest to the camping organizer the number of minivan and van should be rented.

The goals of the lesson are the students expected to understand and able to make graph of equation AZ + BY = C, and also able to find a common solution of a pair of linear equations using graph and algebra. The students are expected to understand relation between the equation and its graph.

An equation of AX + BY = C has a graph which is called a line. A set of all solutions of a single equation can be found using one solution only, then by using the fair exchange method the other solutions can be determined. The first solution can be found using guess-and-check method or by determining the common point of the line and one of the axes (by substituting zero to one of equations).

The pacing time for the lesson is 2 or 3 time 45 minutes. Teachers are allowed to briefly guide the students to the concept of fair exchange before they start working with the minivan and van problem.

Stacking Cups

In this lesson the students conduct a group work activity of stack cups and decide the height of the stack using arrow language formulas. Each group needs a centimeter ruler and at least four same cups (Figure 6.5).

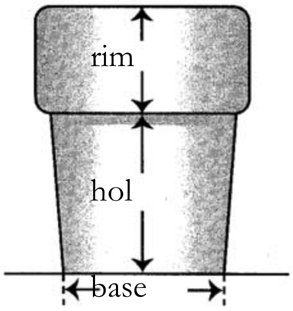


Figure 6.5
A cup for group work activity (reprinted from *MiC*, 1997)

The students compute the heights of stacks of different kinds of cups. They also determine whether or not a new formula could be used to determine the height of a stack of cups.

The goals of the lesson are the students create and interpret the simple formula derived from the informal arrow language formula (Figure 6.6). The students are also expected to be able to use sentence (words) variable to explain a formula or a certain procedure.

Complete the following arrow string for a formula using the number of cups as the input and the height of the stack as the output.

number of cups $\xrightarrow{?}$? $\xrightarrow{?}$ height of stack

Figure 6.6
Arrow string formula to decide the height of stack of cups

Telephones and Population

In this lesson the students compare the number of telephones in several countries. When they use the number of population of each country to compare the number of telephones, they use relative comparisons. The students start to think of ratio as a mean when comparing the number of population to the number of telephones as a single number. Subsequently they use the idea of relative comparison and absolute comparison in analyzing the data of different countries (see Table 6.15).

Table 6.15
The number of population and telephones in 14 countries

Country	**Population**	**Number of telephones**
Bolivia	7.9 million	208,000
China	1.2 billion	15.6 million
Denmark	5.2 million	3.06 million
Ecuador	10.9 million	545,000
Finland	5.1 million	3.92 million
France	58.1 million	30.6 million
India	936.5 million	7.15 million
Japan	125.5 million	57.0 million
Liechtenstein	30,600	19,000
Nauru	10,000	1,700
Solomon Islands	399,000	8,700
South Africa	45.1 million	5.9 million
Sudan	30.1 million	112,000
United States	263.8 million	202.9 million

Sources: *MiC* (1997).

The context used in the lesson is the number of telephones in several countries. For example, China has more telephones than Denmark (15.6 million as compared with 3.06 million): this is an absolute comparison. However, Denmark has more telephones per person (0.59 telephone per person as compared with 0.01 telephone per person): this is a relative comparison (a ratio). In conclusion, a person in Denmark has more access to use telephone for communication. It is important that the students can distinguish these two ways of comparison and decide which one is more appropriate. For a telephone company for instance they are more interested in the number of telephones in each country.

The goals of the lesson are the students can connect ratio to fraction, percent and decimal, use a procedure to divide or multiple the decimal number, and use the relation among ratio, rate and mean to solve problems. Finally, they analyze and solve problems related to absolute and relative comparison, and decide whether and how ratio can be applied to solve problems.

By using the adapted RME exemplary lesson materials, participating teachers performed lesson practices in their respective schools. In the following section the results of two classroom observations on teachers' lesson practices are summarized, namely lesson practices of teacher Muk and teacher Wac. Both teachers used the RME material of 'Shopping Equations.'

6.4.2 Classroom observation

By using the adapted RME exemplary curriculum materials as described above, the participating teachers of the IndoMath in-service program performed classroom (lesson) practices. In this section the results of two classroom observations are addressed, firstly from lesson practice performed by teacher Muk and secondly teacher Wac. Both teachers Muk and Wac used the RME exemplary curriculum material of 'shopping equations.'

In the lesson of teacher Muk, the class learned about *solving linear equation*. The material was designed using the contexts of shopping as Figure 6.2: Two boys bought jeans and t-shirt in a big sale in a store at their city. Anto bought 2 jeans and 5 t-shirts for *Rp 145 ribu* (145 thousand rupiahs) and Yudi bought 3 jeans and 4 t-shirts for *Rp 182 ribu* (182 thousand rupiahs).

Teacher Muk found that his students had difficulty in dealing with the shopping equations as described in Figure 6.2, i.e. to decide how much is the price of a pair of jeans and of a t-shirt. He realized that the prices were too big to allow students immediately engage in mathematics learning. So, instead of using that problem as a starting point he used his own problem:

Teacher: *Ani bought 3 books and 4 pencils for 10 thousand rupiahs. How much the price of 1 book and of 1 pencil?*

It was a good start because students immediately involve in mathematics thinking. By encouraging students to dare sharing ideas he received some answers from them orally, such as:

1 book = Rp 2000
1 pencil = Rp 1000

and

1 book = Rp 3000
1 pencil = Rp 250

ect.

In the next sequence teacher Muk asked students to read and solve some problems in *student book* that is prepared for the purpose of the practice (RME exemplary material). After 15 minutes he brought students to class discussion. And so on. The shift from teacher's own problem to the problems in the *student book* was not smooth. It seemed it was better for the teacher to continue learning path using his own problem and bring students to the concepts that they directed to achieve. It could save his time.

The time constraint was the main obstacle in the classroom practice. Students in teacher Wac's lesson needed 35 minutes for solving the jeans and t-shirt problem (Figure 6.3). Unlike teacher Muk, teacher Wac directly asked her students to make a group of four. She distributed the material (*student book*) and left them to solve problems. The classroom was silent because all students were busy reading the book. There was no discussion among group member. Each student tried to answer the problem based upon his/her own interpretation. In the next sequence teacher asked students to answer the problem. There was no response. Then teacher pointed a student to go to the blackboard to write his work. A student wrote

$$2\ jean\ is\ \frac{2}{7}\ x\ 154000 = 44000$$
$$price\ 1\ jean = Rp44000 : 2 = Rp22000$$
$$5\ jean\ is \frac{5}{7}\ x\ 154000 = 110000$$
$$price\ 1\ t-shirt = Rp110000 : 5 = Rp22000$$

Teacher: *All answers are the same?*
Students: *Yes ….*
Teacher: *Is there any other answer?*
Students: *No.*

At this point there was no alternative answer from students. Time went out without any response from students. Teacher tried hard to push students to think. In this regard it was realized that Indonesian students have a perception that one question only has one single correct answer. In this critical situation, because time was running, teacher said

Teacher: *How about if the price of 1 t-shirt is 10 thousand rupiahs, how much the price of 1 jeans?*

After a certain moment a students replied

A student: *Fifty two thousand rupiahs.*
Teacher: *Others?*
Students: *The same.*

Again, teacher asked students to find other answer. Students worked in each group. After a few minutes teacher asked students to complete a price list (a table) she wrote on the blackboard. The teacher started with the two previous answers, namely Rp22000 for 1 jeans and 1 t-shirt respectively, and Rp52000 for 1 jeans and Rp10000 for 1 t-shirt.

Price 1 jeans	*Price 1 t-shirt*
Rp22000	*Rp22000*
Rp52000	*Rp10000*
Rp27000	*Rp20000*
Rp64000	*Rp5000*
Rp39500	*Rp15000*
Rp38500	*Rp15400*

The time needed to come to this point was 35 minutes. It was considered very slow because there were eleven other problems that should be solved in 2 or 3 hours lesson (the proposed time allocation).

From the above description we learn that two teachers had two different interpretation about the process of learning using the same exemplary curriculum material. The RME exemplary curriculum material used in the practice can be viewed as the product of development research on mathematics learning. The result of that development research is learning trajectory for specific subject matter. Using learning trajectory we can plan teaching and learning process in advance and in similar manner, but the actual teaching and learning process has to be constituted in interaction with the conditions and developments one encounters (Gravemeijer, 1997).

6.4.3 Teachers' reflective reports

All the participants of the IndoMath in-service program reported the results of their classroom practices.

From the participants' reports on the result of CP-1 we can derive the following facts.

- Teaching and learning processes (TLPs) were not performed well. Students had passive nature, class discussion were not going well, some teachers had interpretation that students should left freely in dealing with problems.
- Teachers had problem in mastering the materials. This fact raises question about the effectiveness of the session of preparation of classroom practice in Workshop I. In that session participants did mathematics activities solving the problems in the materials to be practiced. The cause may be time allocation for that session (90 minutes) was not enough for solving all the problems.
- Materials contents were difficult for students due to the numbers in the problems were too big. This big numbers difficulty even faced by students who come from schools with high level *NEM* (pure score in primary school national leaving examination) intakes. The use of calculator was not help much because students were not to use it. The reason was in *Ebtanas* (National Leaving Examination) students are not allowed to use calculator. Students had difficulty to understand the problems due to unclear messages (inappropriate translation). Also open-ended questions brought difficulty to students. According to participants their students were not use to deal with this type of problem. They usually give students closed question that has only one correct answer.
- Time allocation (2 or 3 hours lesson) was not enough.

- Collaboration was not performed as expected especially for pair who come from two different schools, time constraints (teachers just observing each other without any discussion before and after practice), teacher failed to observe his/her peer, and teacher failed to conduct practice because of school holiday.

It is noteworthy to mention here that the various obstacles faced by participants in CP-1 allowed them for valuable lesson for the purpose of CP-2. This is, in fact, give evidence of the teachers' increasing understanding of RME lesson practice in participants' schools from their first practice to the second one. In general, TLPs in CP-2 were performed a much better than in CP-1. The obstacles appeared in CP-1 were substantially decrease in CP-2 because teachers had known how to manage the lesson.

6.4.4 In retrospect

Observing teachers' classroom practice as a part of the IndoMath program was essentially important for the improvement of the program in the next implementation. Moreover, this observation had contributed to the researcher understanding of Indonesian teachers' interpretation of RME lesson. As part of training program the classroom practice was intentionally designed as a room for participants to gain experiences about RME. The objective was to give them opportunity to mirror themselves in real experiences of RME instruction. This idea is in line with the principle of effective professional development from which the IndoMath program found its basis. Analyses the results of teachers' classroom lessons gave description how they build their knowledge after interaction with their students in the lesson practices. The analyses uses the same way as Simon (1995) about teacher's role in the process of decision making about content and task as it emerged in a small classroom teaching experiment (cf. Gravemeijer, 1997).

Simon used the term of 'hypothetical learning trajectory' (HLT) to explain that the actual learning trajectory is still in the domain of teacher's knowledge. Teacher bring their knowledge of learning path in the actual practice from which he or she gain insight about instructional activity and decided to what extent the actual learning trajectory related to its hypothesis. This experience will be the basis for the subsequent learning process. Simon (1995) described this concept as a 'mathematics teaching cycle' (Figure 6.7).

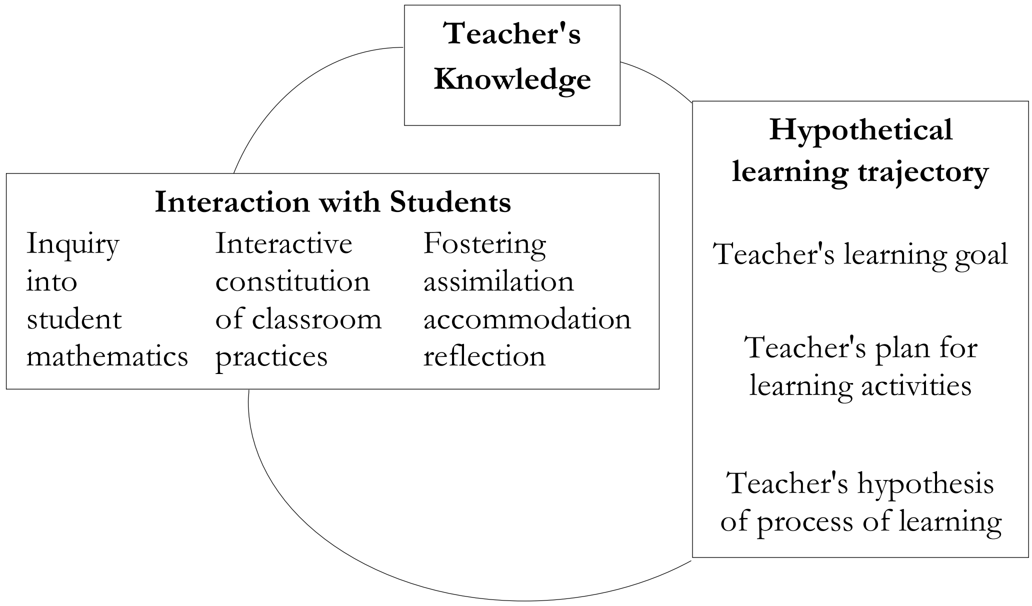


Figure 6.7
Mathematics teaching cycle (Simon, 1995)

According to 'mathematics teaching cycle' teacher should manage the teaching and learning process with the trajectory of students' mathematical thinking and learning. This is apparently what the researcher saw when observing Indonesian teachers in their practice using RME exemplary curriculum materials.

In addition, the classroom observations also give useful information for the revision of the adapted RME curriculum materials. In the following section the results of classroom observation and teachers' reflective reports are applied to revise the materials.

6.4.5 Revision of the adapted RME lesson materials

Based on the results of classroom observation and teachers' reflective reports of their classroom (lesson) practices, some revisions were made to the adapted RME materials as follows.

The context of jeans and t-shirts in the topic of shopping equations were change to pencils and books which seem more realistic to Indonesian students (Figure 6.8, see Appendix I for the complete RME lesson material). In the previous version the prices of 2 pairs of jeans and 5 t-shirts are Rp145000 (or Rp145 ribu, 145 ribu means 145 thousand) to adjust with the original version of $145. The price of

Rp145000 closes to the real price of those things, but students experienced a difficulty in dealing with this quite big number (thousands) and they could not immediately involve in meaningful mathematics activities because they had to think of these numbers.

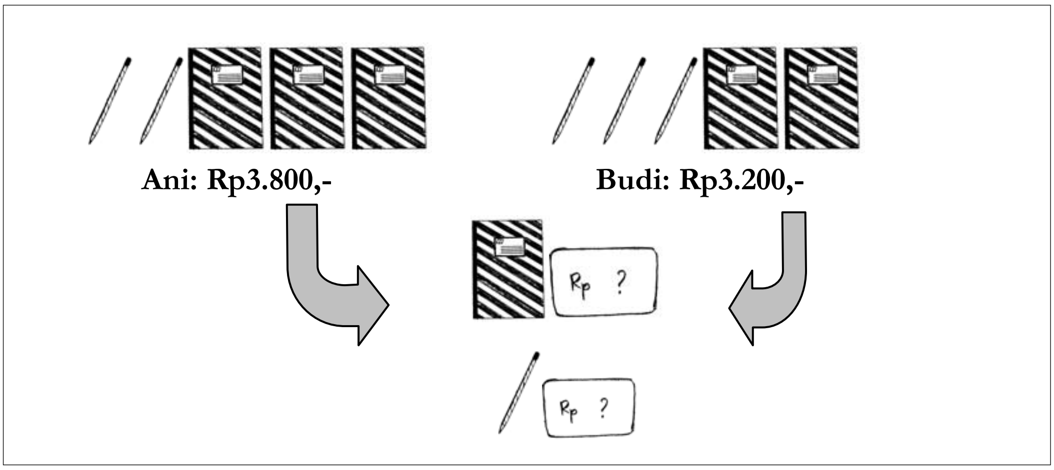


Figure 6.8
Shopping equations: pencils and books

In the revised version of shopping equations, the context are highly related to students' life and activities in school that is to buy school supplies. Furthermore, the numbers used in the context (3,800 and 3,200) are moderate, means not too big for JHS students to deal with.

The problems with numbers also faced by students in the context of telephones and population. Teachers who used this material in their classroom practices experienced the slowness in the learning process which apparently are caused by these decimal numbers. In order to reduce this difficulty, the rounding number for each number of telephone and population in each country is applied to replace the original version. The data for Liechtenstein is removed from the table, and replaced by the data for Indonesia. This change is because some students wonder about the Indonesian figure (number) for telephone and population (Table 6.16, see Appendix L for the complete RME lesson material).

Table 6.16
Number of population and telephones in 14 countries

Country	Population	Number of Telephones
Bolivia	8 million	200,000
China	1,200 million	16 million
Denmark	5 million	3 million
Ecuador	11 million	550,000
Finland	5 million	4 million
France	58 million	31 million
India	940 million	7 million
Indonesia	210 million	5 million
Japan	125 million	57 million
Nauru	10,000	1,700
Solomon Islands	399,000	8,700
South Africa	45 million	6 million
Sudan	30 million	112,000
United States	264 million	203 million

The context of 'minivan and van' had been revised to become 'kijang and colt' (Figure 6.9, see Appendix J for the complete RME lesson material). The car model of minivan and van is not known in Indonesia. In the contrary, the later model of cars (kijang and colt) is very common in Indonesia. This context (the problem of renting car to go to camping ground) was very insightful for students, and becoming more realistic when the cars are changed to the models that students familiar with.

Kijang

Seats: 6 people
Cargo space: 5 boxes

Colt L-300

Seats: 8 people
Cargo space: 4 boxes

Figure 6.9
Renting cars to go to the camping ground

6.5 DESIGN AND EVALUATION OF RCP-TEST

The development of RCP-test is motivated by the needs to measure the impact of the IndoMath program on teachers' understanding of RME. It is also based on the premise that it is too far to go to students' achievement in learning to evaluate the impact of the training to mathematics teaching practice. Because teacher is the individual who will use the innovation in her teaching, it is reasonable to assess her knowledge about the new strategy before we go to students' achievement. Moreover, in the short time the new strategy is not yet ironed in the new context.

The test consists of six contexts in which some questions embedded, namely:

- Context 1: Jeans and t-shirt (3 questions);
- Context 2: Telephones and populations (5 questions);
- Context 3: Stacking chairs (4 questions);
- Context 4: Law enforcement dead during 24 hours (4 questions);
- Context 5: Electricity (5 questions); and
- Context 6: Water (5 questions).

Participants were asked to answer the questions in each context. The questions were divided into three categories, namely finding the solution of the problem related to the context, explaining mathematics concept addressed in the context, and explaining the relevance of the context to the current JHS mathematics curriculum.

Using the test administered to the participants before and after the IndoMath program, teachers' gain in understanding of RME are expected can be figured out that consist of three aspects:

- Teachers' understanding about contextual problems (that is solving the problems using informal as well as formal mathematics procedures);
- Teachers' understanding about mathematics concept addressed in the contexts; and
- Teachers' understanding about the relevance of the contexts to the current JHS mathematics curriculum.

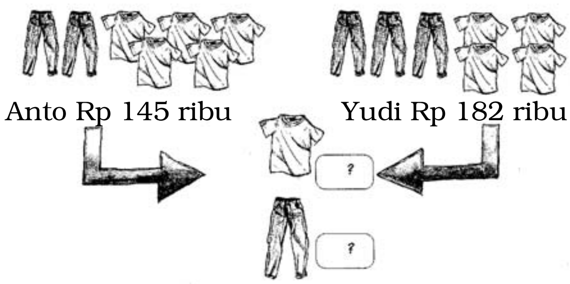
The test had been administered to participants of the IndoMath program in Yogyakarta during second fieldwork (September 2000 – February 2001). There were 18 JHS (junior high school) mathematics teachers participated in the IndoMath program. Among them, there were 17 teachers finished the test. So, there were 17 teachers' works used for analyses.

6.5.1 Analysis of teacher' works

The results of tryout of Realistic Contextual Problem Test (RCP-Test) are discussed in this section. First, the problems in the test are given, then followed by the analysis of teachers' works.

Context 1: Jeans and T-shirt

Context 1: Jeans and T-shirt



1. By using the above information decide the price of a t-shirt and a pair of jeans.
2. What mathematics concept can be explained using the above context? Explain your answer.
3. On which topic in JHS mathematics curriculum the above context is match? Explain your answer.

Figure 6.10
Context 1: Jeans and T-shirt

1. *By using the above information decide the price of a t-shirt and a pair of jeans.*
   Fifteen out of 17 teachers answered using the method of elimination and substitution, and the other 2 teachers just wrote directly the answer. However, none of them use informal mathematics procedure in solving the question. The cause could be that the informal way could take time, and they did not want to use too much time on it whereas there are many other questions left (there are 26 questions in the test) to be solved.

2. *What mathematics concept can be explained using the above context? Explain your answer.*
   All of the teachers answered in a very short sentence (without explanation) that the context could be used to explain the concept of *linear equations system of two variables.*

3. *On which topic in JHS mathematics curriculum the above context is match? Explain your answer.*

   Teachers confused of this question that they thought redundant to the previous one (question 2). Sixteen out of 17 teachers answered that the context match to the topic of *Solving Linear Equations Systems of Two Variables*. One other teacher answered that *to make students getting use to find the possible solution* (no further explanation what kind of solution).

Context 2: Telephones and Populations

Context 2: Telephones and Populations

The table below shows the population and the total number of telephones for 14 different countries.

Country	Population	Number of Telephones
Bolivia	7.9 million	208,000
China	1.2 billion	15.6 million
Denmark	5.2 million	3.06 million
Ecuador	10.9 million	545,000
Finland	5.1 million	3.92 million
France	58.1 million	30.6 million
India	936.5 million	7.15 million
Japan	125.5 million	57.0 million
Liechtenstein	30,600	19,000
Nauru	10,000	1,700
Solomon Islands	399,000	8,700
South Africa	45.1 million	5.9 million
Sudan	30.1 million	112,000
United States	263.8 million	202.9 million

4. How can you use the above table?
5. Make problems (could be more than one) based upon the above table
6. Solve your own problems
7. What mathematics concept addressed in the problem you made?
8. On the current JHS mathematics curriculum in what topic the

Figure 6.11
Context 2: Telephones and Population

4. *How can you use the above table?*

   Eight out of 17 teachers answered that the table can be used to explain the concept of absolute and relative comparison. Nine teachers confused with the words 'how … use' in the question. This is an example of the ambiguity of meaning of the message addressed in the question. Three teachers answered: 'using calculator.' A teacher answered: 'make contextual problems.' Another teacher answered: '[it can be] related to the relevance topic.' One other teacher answered: 'It must be understood the meaning of the table [before can be used].' Another teacher answered; 'To decide which country with the most population.' One other teacher answered: 'Using comparison table.'

5. *Make problems (could be more than one) based upon the above table.*

   All the teachers were able to make problems (more than one) based upon the table. Most of those problems were related to the concept of relative and absolute comparison. The following are the sample of problem that teacher made:

   a. *Decide the average number of telephone in Bolivia, Japan, and United Stated.*
   b. *Among Bolivia, Japan and United States, in which country the population most rely on the telephone?*

6. *Solve your own problems.*

   All the teachers gave answers for their respective questions. The following are the answer for the problem that teacher made in the above question (#5):

   a. *Bolivia = 208,000 / 7,900,000 = 208 / 7,900*
      Japan = 57,000,000 / 125,500,000 = 570 / 1255
      United States = 202,900,000 / 263,800,000 = 2029 / 2638
   b. *United States, because the ratio is bigger.*

7. *What mathematics concept addressed in the problem you made?*

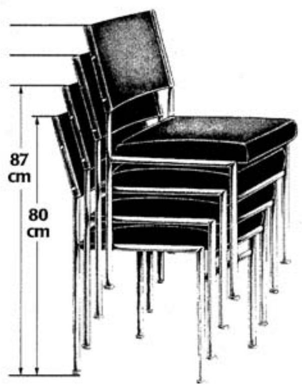
   Teachers' answers:

   - *Comparison (8x)*
   - *Absolute comparison (4x)*
   - *Absolute and relative comparison (3x)*
   - *Relative comparison (1x)*
   - *Comparison the number of population over the number of telephones, and the number of telephones over the number of population (1x)*

8. *On the current JHS mathematics curriculum in what topic the problem you made is match?*
   Teachers' answers:
   - *Comparison (13x)*
   - *Comparison, but JHS mathematics curriculum emphasizes on equivalence and in-equivalence comparisons (1x)*
   - *Comparison, because we can compare the number of population in one country to another, the number of telephones in one country to another, the number of telephones to the number of population, and the number of population to the number of telephones (1x)*
   - *Comparison, related to the number of population and telephones in one country, there is an idea of 'rely and not rely on telephone' (1x)*
   - *Equivalence comparison (1x)*

Context 3: Stacking chairs

Context 3: Stacking Chairs



9. How tall is a stack of 8 chairs?
10. What mathematics concept can be explained using the context?
11. On the current JHS mathematics curriculum in what topic the context is match?
12. Explain the possible solution (if any) in algebra for the above

Figure 6.12
Context 3: Stacking Chairs

9. *How tall is a stack of 8 chairs?*

   Teachers' answers:
   - Ten teachers (10x) answered as following:
   - *Height of 8 chairs = 80 cm + (7 x 7) cm = 80 cm + 49 cm = 129 cm*;
   - Two teachers (2x) used arrow string formula;
   - Two teachers gave (2x) direct answer, that is 129 cm (correct answer);
   - A teacher (1x) gave direct answer, that is 136 cm (wrong answer);
   - A teacher (1x) answered as following:

     Height of 1 chair = 80

     Height of 2 chairs = 87 = 80 + 7 = 80 + (2 – 1) 7

     .

     .

     .

     Height of 8 chairs = 80 + (8 – 1) 7 = 80 + 7 . 7 = 80 + 49 = 129 cm

10. *What mathematics concept can be explained using the context?*

    Teachers' answers:
    - *Pattern of numbers (7x)*
    - *Sequence of numbers (3x)*
    - *Deciding general formula of stacking something (2x)*
    - *Arithmetic series (1x)*
    - *Pattern and sequence of numbers (1x)*
    - *Pattern of numbers, sequences and series (1x)*
    - *Deciding general formula of stacking chairs (1x)*
    - *Height of something (1x)*

11. *On the current JHS mathematics curriculum in what topic the context is match?*

    Teachers' answers:
    - *Pattern and sequence of numbers (5x)*
    - *Pattern of numbers, that is the topic for grade 3/trimester 3 (5x)*
    - *Pattern of numbers, sequences and series (3x)*
    - *Pattern and sequence of numbers. In this matter, students are guided to observe the pattern and sequence of numbers and hopefully they can decide n-th term of the numbers sequence (1x)*

- *Pattern of numbers, sequence and series. By trying to stack 1 chair, 2 chairs, 3 chairs and so on, and measuring the height of the stacking, students can find a pattern. If students can find the pattern, then they can decide the height of stacking whatever the number of chairs (1x)*
- *Number series (1x)*
- *Numbers pattern (1x)*

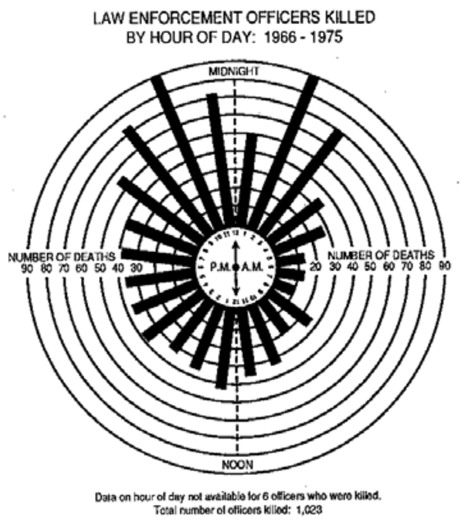
12. *Explain the possible solution (if any) in algebra for the above problem.*

    Teachers' answers:

    - *Using the formula: Height of stacking chairs = 80 + (n – 1) 7; n = the number of chairs (11x)*
    - *Using arrow string formula (3x)*
    - *Using inductive mathematics to find the formula (2x)*
    - *Using table (1x)*

Context 4: Law enforcement officers killed

Context 4: Law enforcement officers killed



13. What is the graph talk about? Explain.
14. Why do people make a graph as the design above?
15. How can you use the graph as a media or a context of mathematics instruction? Explain your answer.
16. On JHS mathematics curriculum in what topic the context is match?

Figure 6.13
Context 4: Law enforcement officers killed

13. *What is the graph talk about? Explain.*
    Teachers' answers:
    - *The number (data) of law enforcement killed by our of day from 1966 until 1975 (11x)*
    - *The number of law enforcement killed in 24 hours (3x)*
    - *The number of law enforcement killed on a certain hour in a day (1x)*
    - *The number of law enforcement killed in 24 hours in 9 years (1x)*
    - *Population figure of dead as well as born (1x)*

14. *Why do people make a graph as the design above?*
    Most of the teachers (12 out of 17) gave answer that the graph is designed to make it easier to be read, that is the readers will understand on which time the law enforcement killed most in 24 hours.

15. *How can you use the graph as a media or a context of mathematics instruction? Explain your answer.*
    Most of the teachers (13 out of 17) gave answer that the graph can be used for data display (describing statistic data using graph).

16. *On JHS mathematics curriculum in what topic the context is match?*
    All teachers (17) answered that the context can be used in the topic of statistic.

Context 5: Electricity

Context 5: Electricity

Electricity is measured in watts. However, since most electrical appliances require a lot of electrical power, a larger unit, called the kilowatt, is used. One kilowatt is equal to 1,000 watts. If something uses one kilowatt of electricity for one hour, one kilowatt-hour (KWh) of electricity is used. The table below shows the most common electrical appliances used at home.

Appliance	**Kilowatts**
Water-heater	4.5
Stove	12.2
Air Conditioner	1.5
Freezer	0.34
Color TV	0.33
Tape-recorder	0.1
Iron	1.2
100-Watt Bulb	0.1
60-Watt Bulb	0.06
Washing Machine	0.5
Coffee Pot	0.9
Toaster	1.2

17. How can you use the above table?
18. Make two or three problems related each other from the above context.
19. Solve your own problems that you make for question 18.
20. What is mathematics concept explained from your own problems?
21. On current JHS mathematics curriculum in what topic the context is match? Explain your answer.

Figure 6.14
Context 5: Electricity

17. How can you use the above table?

The same problem of ambiguity of the sentence 'how … use' again appears here. Three teachers (3x) answered: '*using calculator*', and a teacher (1x) answered '*by reading the table.*' Many answers were not related to mathematics, such as '*the table can be used to explain about electric appliances that commonly used at home*' (4x); '*the table can be used to know the amount of energy used for each appliance*' (4x); and '*the table can be used to know the amount of energy used at home*' (1x). Some other answers were very general like '*the table can be used to explain every day life problems*' (1x); and '*the table can be used to make problem related to the information in the table like make a graph*' (1x). A teacher (1x) answered that '*the table can be used to explain about the concept of absolute comparison.*' And one other teacher (1x) answered that '*the table can be used to explain comparison.*'

18. *Make two or three problems related each other from the above context.*

A sample of teacher's answer (teacher Mur):

1. *If you use AC for 6 ¼ hours every day, how much energy (kWh) needed for a month?*
2. *If you use in a day: AC for 6 ¼ hours, Freezer for 24 hours, TV for 6 hours, tape-recorder for 10 hours, iron for 2 hours, and washing machine for 1 hour:*
   a. *How much energy (kWh) needed for one family in a day?*
   b. *Determine energy (kWh) needed for one month.*

Another sample of teacher's answer (teacher Rin):

1. *Determine electric appliance that uses energy most.*
2. *Determine electric appliance that uses energy least.*

Sample of teacher's answer (teacher Yay):

1. *What appliance are using the most, and using the least amount of energy?*
2. *Determine the comparison of energy used by AC and washing machine.*

19. *Solve your own problems that you make for question 18.*

A sample of teacher's answer (teacher Mur):

1. *6 ¼ x 1.5 = 9.375 kWh*
2. a. *{(6 ¼ x 1.5) + (24 x 0.34) + (6 x 0.33) + (10 x 0.1) + (2 x 1.2) + (1 x 0.5)} kwh*
   b. *Answer (a) times 30.*

Another sample of teacher's answer (teacher Rin):

1. *Stove (12.2 kWh)*
2. *60 watt bulb lamp (0.06 kWh)*

Sample of teacher's answer (teacher Yay):

1. *Stove, and 60 watts bulb lamp.*
2. *AC uses three time energy of washing machine'*

20. *What is mathematics concept explained from your own problems?*

A sample of teacher's answer (teacher Mur):

Addition and multiplication of fraction

Another sample of teacher's answer (teacher Rin):

Statistic and environment

Sample of teacher' answer (teacher Yay):

Comparison

21. On current JHS mathematics curriculum in what topic the context is match? Explain your answer.

A sample of teacher's answer (teacher Mur):

Fraction, grade 1/trimester 1

Another sample of teacher's answer (teacher Rin):

Statistic

Sample of teacher's answer (teacher Yay):

Comparison

Context 6: Water

Context 6: Water

The following table describes water usage that a person might use daily

Daily activity	Water usage
Shower	30 – 75 liters
A toilet	20 – 30 liters
Brushing teeth	3 – 6 liters
Washing clothes	50 – 100 liters
Washing dishes	10 – 20 liters

22. How can you use the information in the table?
23. Compose a problem based upon the above table.
24. Solve your own problem.
25. What mathematics concept can be explained using the problem you made?
26. On what topic in the current JHS mathematics curriculum the problem you made is fit?

Figure 6.15
Context 6: Water

22. How can you use the information in the table?

Seven teachers (7x) answered that *'the table can used to know water usage in daily life'*, the answer which is not related to mathematics idea as intended in the context. Some others teachers (9x) had answers that *'the table can be used to facilitate learning about the concept of statistic (average water usage in daily life), table reading, approximation, making a graph.'* One other teacher (1x) had answer that explaining the way of reading (or interpreting) the table: *'look the first column that is daily activities, and go to the second column that is the amount of water used for each activity.'*

23. Compose a problem based upon the above table.

A sample of teacher's answer (teacher Wac):

How much the average of water usage in a day?

Another sample of teacher's answer (teacher Suw):

Based upon the above table, what activity is using the highest amount of water?

24. Solve your own problem.

A sample of teacher's answer (teacher Wac):

The average amount of water usage in a day is 172.0 liters.

Another sample of teacher's answer (teacher Suw):

Washing clothes (50 – 100 liters)

25. What mathematics concept can be explained using the problem you made?

A sample of teacher's answer (teacher Wac):

Average (mean)

Another sample of teacher's answer (teacher Suw):

Investigating the average amount of water usage in daily activities (24 hours)

26. On what topic in the current JHS mathematics curriculum the problem you made is fit?

A sample of teacher's answer (teacher Wac):

Statistic

Another sample of teacher's answer (teacher Suw):

Statistic, students are given task to record water usage in their daily activities in the form of table (recording data).

6.5.2 Revision of the RCP-test

The number of questions in each context is not equal. This implies to the difficulty to score using the same criteria. In order to make the scoring simpler that subsequently helpful for analyzing, the number of questions in each context will be made equal, that is 3 questions in each context.

- First, the question that ask teacher to solve the problem using formal and informal mathematics procedure (maximum point is 3);
- Second, the question about the mathematics concept addressed in the context (maximum point is 2);
- Third, the question about the relevance of the context to the current SLTP mathematics curriculum (1 point for correct and 0 for incorrect answer).

As the result of the try-out of the instrument, apparently the number of contexts in the test (6 contexts) was too many for teachers to work on. Teachers spent too much time to finish all of the questions that they tend to give short answer for each question. In the new instrument, the contexts are limited only four contexts. As there are three questions in each context, and then there are 12 questions in total. For all of these questions teacher are assumed can finish the questions in 60 minutes.

Reliability of the test

In the following Table 6.17 you will find teachers' scores in the test. The test is reliable (coefficient alpha = .7544) and internally consistent, except for contexts 3 and 5 (all but contexts 3 and 5, Pearson Correlation are significant at the 0.01 level). Context 5 is significant at the 0.05 level. However, context 3 still can be used after some revision. All of the contexts to be used in the test (for the next field-test) will be revised, because the message in the questions to some extend are confusing for teachers.

Table 6.17
Teachers' score in the test (maximum score is 48)

Teacher	C1	C2	C3	C4	C5	C6	Total score
Ded	3	5	5	5	5	5	28 (12)***
Rus	3	7	5	6	5	5	31 (13)
Wid	3	6	4	6	5	6	30 (12)
Mur	3	6	4	6	5	6	30 (-)
Rin	3	5	5	3	5	6	27 (21)
Kar	3	5	3	4	4	5	24 (14)
Wac	3	7	5	5	3	6	29 (16)
Sid	3	6	2	5	5	5	26 (11)
Suw	3	5	4	4	4	6	26 (15)
Yay	3	5	4	5	3	5	25 (12)
Tuk	3	5	4	5	3	6	26 (12)
Sun	3	4	4	5	3	6	25 (12)
Muk	2	2	4	3	3	3	17 (9)
Wih	3	5	4	5	4	6	27 (-)
Rui	3	5	4	5	4	5	26 (-)
Dwi	3	5	4	4	5	6	27 (14)
Ani	3	6	4	5	6	6	30 (17)
PearsonCorr.	.773*	.895*	.318	.702*	.601**	.709*	

Notes: * Correlation is significant at the 0.01 level;
** Correlation is significant at the 0.05 level;
*** In bracket is teacher's score in pre-test.

Three contexts, namely contexts 1, 2 and 3 have been chosen to be included in the test after some revision. Context 1 is changed to be 'Pencils and Books' to make it relevant to the content of the curriculum material for classroom practice. Context 2 is revised by making the numbers of telephones and populations for each country rounded to the closest unit in order to avoid decimal number which is take to much time for teachers to deal with (to multiply and to divide). This change is also related to the revision of the content of RME curriculum material to be used in the IndoMath Program. The big decimal number (such as 263.8 million, and 125.5 million) is not easy for SLTP pupils to calculate (to multiply or to divide), that imply that this number need to be rounded to the closest unit. In this matter, for example, 263.8 million is rounded to be 264 million and 125.5 million is rounded to be 126 million.

Context 3 is used in the instrument because its relevance to the material in the workshop (doing mathematics session). This context is useful in facilitating teachers' learning of the route from informal mathematics to formal mathematics procedure. In order to avoid ambiguity the questions for each context is explained clearly using direct message, such as: explain your answer (be more specific), and use formal as well as informal mathematics procedure.

For the purpose of classroom practices, a topic has been chosen that is the topic of Graphing of a Linear Function. In order to find the relevance of the content of the workshop to the questions in the instrument, the context of 'Transporting People and Box' that taken from RME curriculum material has been chosen.

The revised version of RCP-test and scoring criteria are given in Appendix G.

6.6 SUMMARY AND DISCUSSION

As the goals of the development and evaluation stage in the IndoMath Study in the second fieldwork were to examine validity and practicality of IndoMath in-service program, the discussion in this section is focused on those two quality aspects. Validity and practicality discussed here address both the in-service program and the adapted RME exemplary lesson material. Both of them are discussed separately.

In this section validity and practicality of IndoMath Program are discussed as their drawn from the results of its development process. Validity and practicality aspects were assured by a number of activities in the development process during the first and second fieldwork in Indonesia. The results of the first fieldwork are discussed in Chapter 5, and will be summarized here to give the whole ideas of the development process of IndoMath Program.

6.6.1 Validity of in-service program

The activities carried out during the development process to secure the validity of the IndoMath in-service program proceed:

- Literature study on RME and professional development for teachers has resulted in the design specification of in-service program. The in-service program has been design based on the principles of effective professional development for teachers. In order to guarantee its congruence to RME ideas, in-service program component were designed relevant to five tenets of RME. By doing this, the IndoMath Program has reflected the state-of-the-art knowledge.

- Discussion has been held with two Dutch experts on the field of RME and professional development respectively. The discussion gave useful ideas to the developer to choose the content of the workshop and the RME exemplary lesson material being used in the classroom practice as part of the in-service program.
- Discussion with Indonesian experts (a teacher educator and two experienced JHS mathematics teachers) provided clear directions to the developer to manage and execute the in-service program relevant to local situation.
- Review and continuous feedback from an independent observer who follow the program from beginning till the end avoided subjective view of the developer.
- Discussion with the participants of the in-service program was assured the relevance of the program to the current needs of Indonesian JHS mathematics teachers to improve their competencies in mathematics instruction.

6.6.2 Practicality of in-service program

In most cases of RME instruction learners have to find out mathematics procedures and algorithm by themselves. 'Doing mathematics' have been proved able to facilitate participating teachers to create and elaborate symbolic models of their mathematical activities. Moreover, since the RME curriculum materials usually designed in the form of problem solving, 'doing mathematics' session also facilitated participants to learn about strategies toward solving problems. This session was highly value by participants. In Workshop I, eight out of 20 participants chose as the best session, while in Workshop II six out of 18 participants chose as the best. Another fact found in the program implementation in Yogyakarta was 'doing mathematics' cost a lot of time, one and half hours was not enough for participants to solve all problems. In the next implementation, it should be considered to add more time for this activity.

During 'RME theories' session participants received an instruction about RME principles in general. The contents of this instruction were brief review of RME history, the needs to develop RME in Indonesia, conception of students in RME, teachers' role, conception of teaching, and expectation from RME for the improvement of mathematics education in Indonesia. After the instruction RME theories in general, participants discussed some RME tenets related to the results of previous activities in 'doing mathematics' session. The 'RME theories' session was highly appreciated by participants. After Workshop II ten participants pointed out this session as the best one.

All the participants of the IndoMath program had not seen RME teaching and learning process. Therefore, video presentation was important to give them visual support about how to conduct RME lesson. Apparently, there were several benefits from video presentation as revealed by Sherin (2000), when watching videotape of a classroom teachers were not constrained by the demand of instruction. Moreover, teaching is often an isolating activity that affords few chances to observe other teachers. In watching a video teachers focus on understanding what was happening in the classroom and used this information to decide how to proceed pedagogically. Video presentation was valued by participants of IndoMath program as one of the best sessions as nine out of 20 appreciated it.

Preparation of classroom practice was important to give participants an adequate content knowledge and pedagogical content knowledge before performing classroom practice. It has been indicated that the nature of RME curriculum materials in form of open-ended questions bring difficulty to Indonesian JHS students. It could be anticipated beforehand in this session.

Classroom practice has been proved to be a very strong component in IndoMath Program in term of giving the participants actual experiences of RME instruction in a real setting. Participants' reflective reports of their lesson practice indicated the improvement form CP-1 to CP-2. Apparently the CP-1 had given them useful experiences and knowledge how to conduct RME lesson. By learning from the results of CP-1, in CP-2 the participants able to construe and build RME instruction based upon their previous interaction with their students in the lesson practice. They also could manage the teaching and learning process with the trajectory of students' mathematical thinking and learning.

The results of IndoMath Program indicated that 'structured sharing' session was useful in term of helping participants to get the whole description of the classroom practices performed in participant respective school. From these sharing experiences, participants gained practical knowledge about RME instruction. For instance, they understand the important of teacher's role as a guide in the learning process like what should teacher do if students are stuck in dealing with the problems.

In the 'feedback and discussion' session participants got feedback from the trainer on various aspects they encountered in the classroom practice. For participants of IndoMath program this session was apparently important since as some of them recognized that their understanding of RME approach was remain vague, particularly after Workshop I. This session was intently created as a room for problem solving activities. It seemed that the trainer should be able to give participants appropriate suggestions for the problems they encountered. In the IndoMath Program it seemed that the trainer's suggestions viewed as relevance. The trainer's observations to some participants' classroom lesson helped in achieving this result. The trainer's observations were not intended previously to be part of the in-service program, but later on it was considered useful. Moreover, the participants (6x) valued 'feedback and discussion' as one of the most effective sessions during the program.

Teachers understanding of RME materials and their approaches contributed to the students' process of learning. The workshops gave participants chance to learn the content and pedagogical content knowledge of RME curriculum materials to be used in the classroom practice. Then classroom practice improved their understanding of the materials that used in real setting. The combination of theoretical and practical knowledge enhanced their confidence in the implementation of RME instruction.

From lesson practices teachers gained practical skills that enhance their understanding about RME realization in Indonesian JHS mathematics education. For instance, in order to help students understand better the sentences or the problems in RME exemplary materials teachers started with apperception or gave alternative example which is in the boundary of students' contextual understanding. Teachers took an active role in guiding students to deal with the problems (questions). Helping students in interpreting unclear questions. Furthermore, peer collaboration that was performed properly (such as teachers spend a certain time for discussion before and especially after the lesson) positively contributed to the improvement in CP-2. However, it is understandable if teachers remain disjointed in using the approach in mathematics instruction. Normally, individuals do not use an innovation for the first or even the second time as effectively and efficiently as they do after four or five cycles of use (Hall, et al., 1975; Hall & Hord, 2001).

6.6.3 Validity of the adapted RME exemplary lesson materials

The activities to assure the validity of adapted RME exemplary lesson materials proceed:

1. RME exemplary lesson materials were adapted from MiC. It is assured the validity of the content because the materials were developed by Freudenthal Institute people in collaboration with University of Wisconsin, USA. The adapted RME exemplary curriculum materials reflected the state-of-the-art knowledge in their content by the assumption that they are developed based on RME theories.
2. The selection of topic to be adapted from MiC was based on the Mathematics Curriculum of 1994 used in Indonesian (later on Revised Version of Curriculum of 1994). By consulting the current curriculum the developer assured the relevance of the topic with the mathematics teaching practice in Indonesian JHS.
3. After points 1 and 2 above, the first draft of the adapted RME exemplary lesson materials were validated in local situation. Junior High School mathematics teachers who used the materials in their mathematics class provided clear directions for the adapter of the RME exemplary materials. Analysis of students' works provided further insight of the nature of adaptation process.
4. The adaptation of other topics from MiC was based on 1, 2 and 3 above.
5. Review and feedback from RME experts in the Netherlands was important to secure the validity of the adapted RME exemplary lesson materials.

6.6.4 Practicality of the adapted RME exemplary lesson materials

The results of small-scale tryout of the first adapted RME exemplary lesson material of the topic of *What is the chance?* (probability) indicated that the material was practical. During the tryout showed that the content (texts and figures) were understandable. For the students there was no confusing on the texts, figures and sentences. Moreover, after the lesson students expressed their feelings that they enjoy the lesson and were not boring because there are some figures and stories that made it attractive. The lesson was easy to follow because the problems were arranged step by step begin with easy problem and increased the difficulty bit by bit. They also expressed that the lesson was different from their current mathematics lesson which is difficult, burdening and boring. However, on almost all the problems the researcher (who acted as the teacher in the tryout) noted that students worked alone. The interaction appeared when teacher asked for their reasoning for each solution they made. Direct interaction among them hardly occurred if teacher did not confront their different answers.

Mathematics teachers who used the adapted RME exemplary curriculum material of *What is the chance?* in their classroom lesson indicated that the material was practical. They did not have problems in realizing in their lessons the tenets of RME as reflected in the exemplary material. For instance, the first three problems in the RME exemplary material deal with the basic concept of chance. Students were expected able to estimate chances of events. These starting problems motivated students to engage in meaningful mathematical activities. Another example is the story of 'Frog Newton' in the form of comic as a reflection of a model situation. By reading this story students engaged in the situation that help them to interpret the problems. Moreover, the story also triggered a discussion among students that facilitated interactivity.

In short, Indonesian mathematics teachers have positive opinion about the adapted RME exemplary lesson materials of *What is the chance?* A teacher expressed: "*The material really help me to conduct the lesson, and students can learn from it. Students and I enjoy the lesson very much.*"

Based on the lesson learned from the successful of adaptation of the RME material of *What is the chance?* some other materials have been adapted that are 'system of linear equations of two variables' (consist of two topics: 'shopping equations' and 'minivan and van'), 'number pattern' (stacking cups), and 'comparison' (telephones and populations). However, after teachers used the materials in their classroom lesson practice several revisions were needed. The context of *jeans and t-shirt* in the topic of 'shopping equations' were changed to *pencils and books* which seemed more realistic to Indonesian students. In the previous version the prices of 2 pairs of jeans and 5 t-shirts are Rp145000. Students experienced difficulty in dealing with this rather big number (thousands), and so they could not immediately involve in meaningful mathematical activities. In the revised version of shopping equations the context of pencils and books are highly related to students' life and activities in school that is buy school supplies. Furthermore, the numbers used in the context (3800 and 3200) are moderate, means not too big for JHS students to deal with.

The problems with numbers also faced by the students in the topic of telephones and populations. Teachers who used this material in their classroom practices reported the slowness of the learning process which is apparently are caused by decimal numbers in the table of numbers of telephones and populations in 14 different countries. In order to avoid this obstacle the rounding number for each number of telephone and population in each country is applied.

The topic of minivan and van have been revised to become kijang and colt. The car model of minivan and van is not known in Indonesia. In the contrary kijang and colt is very common. So, the context of renting car to go to camping site was more insightful for students because they are familiar with.

7

THE IMPACT OF INDOMATH PROGRAM ON TEACHERS' RME UNDERSTANDING: RESULTS OF SEMI-SUMMATIVE EVALUATION

As the development research approaches its final stage, the focus of the research was on the impacts of the intervention on teachers' understanding of new strategies. In this chapter those aspects are discussed based on the results of semi-summative evaluation on the effectiveness of the IndoMath program. Section 7.1 summaries research design in which research questions and methods and instruments for data collection are discussed. Section 7.2 elaborates the implementation of IndoMath in-service program. The characteristic of participants of the program is given in this section. Section 7.3 discusses participants' perception about the IndoMath in-service program. Section 7.4 addresses the result derived from Realistic Contextual Problem Test as an indicator of participants' understanding of RME theories. Section 7.5 discusses participants' use of RME knowledge and lesson materials in their mathematics lesson. In this section three aspects are discussed: participants' stage of concerns (Section 7.5.1), level of use (Section 7.5.2), and the differences in practice (Section 7.5.3). Section 7.6 concludes the results of the third fieldwork.

7.1 RESEARCH DESIGN

This section discusses the research questions and the methods and instruments for data collections used in the semi-summative evaluation stage of IndoMath Study. The evaluation activities in this fieldwork applied the level of effectiveness of professional development as proposed by Guskey (1999, 2000): (1) participants' reactions, (2) participants' learning as the impacts of intervention, and (3) participants' use of the innovation in their classroom lesson (see Section 4.5).

7.1.1 Research questions

The third fieldwork focused on the impact of IndoMath program on participants' understanding of RME theories and their practical implications on classroom lesson. The research question was formulated as:

> *To what extend does the in-service program effectively contribute to teachers' understanding on RME?*

The research about the characteristics of the IndoMath Program was intended to find out its practicality and effectiveness. The activities were directed as semi-summative evaluation, because the implementation of IndoMath program in the third fieldwork was not the final journey of the IndoMath Study. The next efforts are still waiting in the long process of the innovation efforts in Indonesia, and the study hopefully can be the corner stone for the process of the improvement mathematics teaching in the country.

Within that general research question above, three levels of professional development effects were used for formulating the evaluation questions (Guskey, 2000).

- *Perception*: Participants' perceptions of the effectiveness and usefulness of program's aspects;
- *Learning effects*: Participants' understanding of RME theory and practice;
- *The use of RME exemplary curriculum materials*: The use of RME exemplary curriculum materials and approach in the participants' mathematics classes.

These in turn has led to the following sub-questions, and success criteria, concerning the effects of the inservice program:

- *Do participants perceive the program as relevant and meeting their expectation?*
  The teachers value the organization and components of in-service program positively, meaning that the program activities (workshops, classroom practices, and reflection meetings) meet their expectation, and are considered as instructive, useful, enjoyable, relevant and informative.
- *Do participants perceive the program activities as helping them to understand RME?*
  This would be indicated by the fact that participants: (a) gain knowledge of the RME theory; and (b) the participants perceive the RME approach, the in-service program activities, and the RME exemplary curriculum materials as positive and useful.

- *Do participants perceive the program activities as supporting them in implementing RME in their classes?*
  This would follow from a perceived change in the participants' confidence on the possible implementation of RME.
- *Do participants understand the RME theory?*
  This would be indicated by the participants' work and their scores on Realistic Contextual Problems Test (RCP-Test) before and after the program.
- *Can participants realize the characteristics of the RME approach in mathematics instruction?*
  This would be indicated by an observed change in participants' knowledge and skills in applying the RME approach in their teaching.
- *Do participants use after the IndoMath program the RME exemplary curriculum materials in their lesson?*
  This would be indicated if the participants use the RME exemplary curriculum materials in their actual lessons or as supplementary material to the governmental compulsory textbook.
- *Do what participants' learn inspire them to use RME method in their teaching for other mathematics topics?*
  An indicator for this would be participants' other mathematics lessons show characteristics of the RME approach (such as using contextual problems and students active learning).

7.1.2 Methods and instruments for data collection

During the third fieldwork triangulation strategies were used. The use of multiple methods in the study was supposedly could overcame the weaknesses or biases of a single method. According to Denzin (1994) the realities to which sociological methods are fitted are not fixed: The social world is socially constructed and its meaning, to the observers and those observed, is constantly changing. As a consequence no single research method will ever capture all of the changing features of the social world under study (p. 6462).

This research has been carried out in Yogyakarta with 16 teachers and used six kinds of data collection methods and instruments to evaluate the in-service program:

- *Questionnaires* were distributed to the participants at the end of each workshop session, and at the end of the whole program.
- *Realistic Contextual Problem (RCP) Test* was administered to the participants before and after the program. This test assessed participants' understanding about

RME contextual problems and the relevance of the contexts to the current Indonesian Junior High School mathematics curriculum.

- *Classroom observation* was conducted during the program (in RME classes at the junior high schools) to get insight in the ways in which the teachers were implementing the RME exemplary curriculum materials.
- *Reflective reports,* during the reflection meetings, were provided by the teachers about the instructions they carried out in their classrooms using the RME exemplary curriculum materials.
- *Focus group discussion* took place of the researcher and participants after the program, about the program as a whole.
- Three months after the program, the researcher visited the participants' schools for several weeks to conduct *classroom observations* focusing on the effects of the program on the actual daily mathematics classes. During the observation each teacher's lesson was video recorded.

The evaluation questions and data collecting instruments during the third fieldwork are summarized in table 7.1, and discussed a long with.

Table 7.1

The evaluation of the effectiveness of the IndoMath program (adapted from Guskey, 1999)

Evaluation level	Questions	Data Collecting Procedures								
		OQ	*WQ*	*PQ*	*FGD*	*SCQ*	*PT*	*CO*	*I*	*PPT*
Participants' background information	What are characteristic of participants?	√								
	What are teachers' expectations in participating in the program?	√								
Level 1: Participants perception	Did participants perceive the program as relevant and meeting their expectation?		√	√	√					
	Did participants perceive the program activities as supporting them to implement RME lesson?			√	√					
Level 2: Participants understanding of RME	Did participants gain knowledge on RME theories?							√		√
	Can participants realize the characteristic of RME approach in mathematics instruction?				√			√		
Level 3: Participants use of RME material and approach in their teaching	Was there any impact of the program on teachers' stage of concern?					√				
	Was the program has an impact to teacher's level of use of RME ideas in mathematics instruction?							√	√	
	Were there differences in teachers' professional work after the program?							√	√	

Note: OQ = Orientation Questionnaire; WQ = Workshop Questionnaire; PQ = Program Questionnaire; FGD = Focus Group Discussion; SCQ = Stages of Concern Questionnaire; PT = Program Tryout; CO = Classroom Observation; I = Interview; PPT = Pre and Post Test.

Level 1: Participants' perception

Teachers' perception of the in-service course are identified as a prerequisite, though by no means sufficient, conditions for a potential impact of the course on classroom practice. In most study on teacher professional development program the evaluators are interested in some aspects to be evaluated such as participants expectation, usefulness of program session, and learning outcomes or perceive benefit from the program (see e.g. van den Berg, 1996; Thijs, 1999). In the IndoMath program these aspects were evaluated in accord with the first objective of the program, that is to make teachers understand RME means that they know a day to day requirement for RME implementation. It subsequently supported them for proper RME implementation in mathematics instruction. In this regard, the questions to be answered are if the participants perceive the program activities help them to understand RME, and if participants perceive the program activities support them to implement RME lesson.

In order to answers these questions information were gathered using questionnaires administrated at the end of each workshop, and at the end of the whole program. The questionnaire about the participants' perception about the program consists of some 5-point Likert type items. Using this type of questionnaire the participants indicate the usefulness, the degree to which they enjoy the program, and other aspects such as perceive benefits and intentions for use RME in practice. By doing so, the initial satisfaction of teachers experiences during their participation in the program can be measured.

To investigate the relevance of the IndoMath program participants were asked to write down (before the start of the program) their expectations. They also were asked to fill in a background information questionnaire, aimed at gathering information about basic characteristics. At the end of the last meeting the participants were asked to write down whether their expectation are fulfilled.

Level 2: Participants' understanding about RME

One of main focuses in the evaluation of the IndoMath Program is on the participants' understanding about RME. This is particularly important because it relates to the first objective of the IndoMath program to give participants basic knowledge about RME as preparation of implementation of this approach in mathematics instruction. Certainly then we are interested in if the participants gain knowledge about RME theories, and if they can realize the characteristic of this innovation in mathematics instruction. In order to answer this questions several data collecting procedures were employed, namely pre on posttest, teacher portfolios, classroom observation, and participant reflection.

The instrument to test participants' understanding about RME had been developed. The instrument (RCP-Test) consists of four contextual problems which each of them contains three similar questions. First, teachers are asked to solve problem embedded in the context using formal and informal mathematics procedure. Second, they should explain mathematics concept addressed in the context. Third, they should explain the relevance of the context to the current JHS mathematics curriculum. So, the test distinguishes teachers who understand contextual problems and some of their pedagogical aspects to those who do not.

During the workshop teachers were asked to work on RME curriculum materials individually and in a group ('doing mathematics' session). These materials are the same to the one for the classroom practice. Teachers' understanding about RME was also assessed by observing their classroom practices. In fact, classroom practices are part of the IndoMath program. There were two time classroom practices which each of them are performed after the workshop. So, these classroom practices can be seen as the reconstruction of teachers' understanding about RME theories in the real classroom setting. Each classroom practice was observed by the researcher and an assistant researcher who equipped with innovation profile. This profile consists of some statements about activities or processes that should appear in the lesson, and what those that we do not want to see in the classroom. The certain point was used to score the lesson process.

Both teachers' understanding about RME theories and their construe of RME lesson were reflected in reflection meeting right after all participants perform their classroom practice. In this meeting (also as part of the IndoMath program) each teacher reported to other participants their experiences in implementing RME curriculum material and its approach. All the reports and comments were recorded. The excerpt from each participant's report about her/his experiences were added as information to complete three previous data about participant's understanding of RME.

Level 3: Participants' use of RME materials and approach in their teaching

The third level of effectiveness focuses on the issue whether participants are using their new knowledge and skills of RME on the work place. To facilitate teachers implement realistic approach in their lesson the IndoMath program was equipped with RME exemplary curriculum materials. These materials are intently developed to support teachers get insight of the approach as well as to narrow the gap between the ideal and its enactment.

This level was evaluated using classroom observations (as part of schools visit three months after the program), structures interview to participants, and teachers' portfolio.

Another important issue in any innovation change effort is teachers concerns about the innovation. Concerns are feelings and perceptions about innovation and change process (Hall & Hord, 2001). Since the RME is a new concept in mathematics education in Indonesia, most of the participants of the IndoMath program are novice in this field. It is important to reveal what is participants thought and consideration to the issue of RME implementation in school. Participants concerns about RME were measured using Stages of Concern Questionnaire or SoCQ (Hall & Hord, 2001). The questionnaire was administered before and after the program as well as three moths after the program (the third tryout). By doing so, the change of participants' concerns about RME before and after program can be revealed. The intention of using the concern profile is not to put a label to each participant about her/his feeling and preoccupation given to RME issue, but more as an effort to find the particular pattern of participants concern about RME and its conformity to the other contexts such as school environment and students background.

Classroom observations were held to all participants (in the third tryout there are 16 teachers from 8 schools). For the purpose of classroom observation, an assistant researcher helped the researcher. The instrument for classroom observation was the innovation profile (van den Akker & Voogt, 1994; van den Berg, 1996). The innovation profile consists of a limited number of five components that characterized the five tenets of RME. These components are operationalized in various elements to more specific classroom activities that each of them consists of the followings.

- A threshold criterion, that reflects an acceptable way of implementation. The threshold criterion covers 33% of the total profile. The highest achievable score on the innovation profile is 100. So, 33% of this total could be obtained by the thresholds and 67% by the ideal elements. The score of 33% for threshold and 67% of ideal elements are adapted from Van den Berg (1996) with some adjustment based upon RME tenets. In the RME all components are relatively equally important.
- Ideal elements, that strengthen the implementation. The ideal elements in the profile are mostly adapted from Reinhart (2000) who summarized his reflection on problem-based student-centered teaching.

- Unacceptable elements, that weaken the implementation. These are the learning processes (or teacher activities) that we really do not want to see. If these are happen in the lesson, negative point will be given.

Scores were assigned to each component of the innovation profile reflecting the relative importance of the components and the elements within the components.

Teachers were also asked to keep a teacher log during six weeks after the course to record their experiences with the use of RME teaching approach and peer collaboration for preparing, conducting and evaluating the RME lesson.

Structured interview was held to teachers to find out the level of use of RME innovation. However, it must be understood that the use of an innovation is not an automatic, nor is it a matter of some persons using it and others not. Change is a process through which people and organizations move as they gradually come to understand, and become skilled and competent in the use of new ways (Hall & Hord, 2001). Again, by using the level of use the intention is not emphasized to individual teacher and put a label that, 'Yes, he is using it,' and 'No, she is not,' but we are interested in to find out the pattern of group of teachers in implementing the innovation. The pattern of, let us say, the 'top 5' of users and 'bottom 5' of nonusers could be confirmed to others contexts such as school's advocacy, support, accommodation, and recognition.

7.2 IMPLEMENTATION OF INDOMATH PROGRAM

This section discusses the implementation of the IndoMath in-service program. There are two aspects described here, namely the overview of implementation process and the characteristic of participants.

7.2.1 Overview of the implementation process

The IndoMath in-service program was conducted in period September 20 till October 10, 2001 at the *PPPG Matematika* (The National Training Development Center` for Mathematics Teachers) and at the participant respective school. The program consisted of 2 one-day workshops, 2 times classroom (lesson) practice, and 2 half-day reflection meetings (see Table 7.2 for program schedule). The time spent for workshops, classroom practices, and reflection meeting was 32 hours. So, the IndoMath in-service program can be categorized as an introductory course as preliminary effort to support teachers in the implementation of the RME theories to mathematics instruction.

Table 7.2
Schedule of the IndoMath program

Program	Date	Place
Opening*)	Thursday, Sept. 20, 2001	PPPG Matematika
Workshop I	Saturday, Sept. 22, 2001	PPPG Matematika
Classroom practice I	A day between Sept. 23 and Sept. 28, 2001	Participants' schools
Reflection meeting I	Saturday, Sept. 29, 2001	PPPG Matematika
Workshop II	Monday, Oct. 1, 2001	PPPG Matematika
Classroom practice II	A day between Oct. 1 and Oct. 8, 2001	Participants' schools
Reflection meeting II	Tuesday, Oct. 9, 2001	PPPG Matematika
Evaluation meeting *) and closing (certificate)	Wednesday, Oct. 10, 2001	PPPG Matematika

The components of the IndoMath in-service program are similar to those on the second tryout (as part of the second fieldwork). Only a little difference is on the content and procedure in the 'doing mathematics' session. In this session participants worked on the 'last card problem' and learned how to approach a problem using '4-steps toward problem solving.' At the end of the session they discussed their findings. Another difference was on the topic for session 'preparation for classroom practice.' In this session participants worked on the topic 'shopping equations' (see Table 7.3).

*) In the opening (two days before the workshop I) participants filled in the orientation questionnaires and did the pretest. In the evaluation meeting the participants filled in the evaluation questionnaires and did the posttest before conducted a focus group discussion. Both orientation and evaluation meeting were not part of the in-service program, but more focused for the benefit of the research.

Table 7.3
IndoMath program activities in Workshop I

Program Component	Content and Procedure	Relevance to RME
Session 1: Doing Mathematics (2 hours)	First, teachers work in a group to solve 'the last card problem.' Second, they learn how to approach a problem using '4-steps toward problem solving.' Third, discussion of their findings.	In this activity teachers learn to find mathematics ideas by themselves, find procedure by themselves in interactive discussion among group member and share the findings with whole class.
Session 2: RME theories (1 hour)	Instruction on RME theories started from a general review of RME background and history. Trainer facilitates the discussion about students' reinvention and interactivity based on the results of doing mathematics.	In the previous session teachers learn how to find mathematics concepts by themselves. From this experience they get the idea of students' reinvention. Since the activity is conducted in a group they experience the idea of interactivity.
Session 3: Video presentation (1 ½ hours)	Teachers watch the video on a lesson using RME material performed by a junior high school teacher.	It gives them visual support how to conduct the lesson, such as starting the lesson by giving students contextual problems that facilitate them to immediately engage in meaningful mathematical activity.

To be continued

Table 7.3 (*Continued*)

Program Component	**Content and Procedure**	**Relevance to RME**
Session 4: Preparation for classroom practice (2 hours)	Teachers work individually and in a group to solve contextual problems on the topic of Persamaan Belanjaan (Shopping Equations).	By solving problems in the RME curriculum material that is being used in the classroom practice teachers will understand the content of the lesson. Teachers also understand the use of contexts as one of RME tenets. In this session the trainer acts as a teacher in a way that is typical for the RME approach, thereby participants can mirror from it as they intended to use it in their classroom lessons. In this regard the trainer should be able to be a good role model of RME teacher.

The day, after the workshop, each teacher wrote a lesson plan for teaching practice in collaboration with his or her partner. The material for the classroom practice was *Persamaan Belanjaan* (Shopping Equations). They performed teaching practice, by emphasizing the mutual observation (the teachers in each pair observed each other in their teaching practice). Teachers experienced important aspects of RME, such as the *lack of authority*, *interactivity*, and *student's free production*.

After classroom practice teachers came again to the training center to participate in the Reflection Meeting (Table 7.4). There were two sessions in this meeting, namely *structured sharing* and *feedback and discussion*. This meeting facilitated participants to share their own experience in RME lesson and got information from other teachers as well as received comments and feedback from the trainer.

Table 7.4
IndoMath program activities in Reflection Meeting I

Program Component	Content and Procedure	Relevance to RME
Session 1: Structured sharing (2 hours)	Each pair presents to other participants the results of their collaboration. They show the works of their students. They explain to the other participants the meaning of their students' free production.	In this session teachers learn that gaining understanding can be achieved by collaborating with their colleagues. This is the way that is also used in RME instruction emphasizing the *interactivity* and *intertwining* in mathematics concept building.
Session 2: Feedback and discussion (2 hours)	The trainer comments on the reports by paying special attention to the issues related to the aspects of RME. The trainer asks participants to share their experiences.	Students' work as the results of classroom practice will be discussed in this session. The discussion is directed to map the learning route of the students from which the teachers learn how to assess the process of students' mathematics learning.

The IndoMath in-service program had been revised based on the results of the first and the second tryout. The description of the change of the program from the first to the second and finally to the third model is given in Table 7.5.

Table 7.5
The change of IndoMath program from the first to the third tryout

	First tryout		Second tryout		Third tryout	
Program component	*Content*	*Time 11 hours*	*Content*	*Time 31 hours*	*Content*	*Time 32 hours*
Workshop I						
Doing math	The last card problem	45 min.	Traffic Pollution	90 min.	The last card problem; 4-steps toward problem solving	120 min.
RME theories	Instruction on the theory of RME	30 min.	RME background and history; reinvention and interactivity	60 min.	RME background and history; reinvention and interactivity	60 min.
Audio session	Audio recording of RME lesson	30 min.				
Video presentation			Video recording of RME lesson	90 min.	Video recording of RME lesson	90 min.
Micro teaching	Fail (replaced by looking of photograph)	30 min.				

To be continued

Table 7.5 *(Continued)*

Program component	First tryout Content	Time 11 hours	Second tryout Content	Time 31 hours	Third tryout Content	Time 32 hours
Observing skill	Interpret RME lesson and class activities	30 min.				
Preparation classroom practice	Discussion of RME material	30 min.	Telephones and Population	120 min.	Shopping equations	120 min.
Classroom practice I						
RME material	What's the chance?	2 x 90 min.	Telephones and Population	180 min.	Shopping equations	180 min.
Collabo-ration	Observing each other lesson	2 x 90 min.	Preparing and ob-serving each other	180 min.	Preparing and ob-serving each other	180 min.
Reflection meeting I						
Structured sharing	Reporting results classroom practice	50 min.	Teachers share experiences on classroom practice	120 min.	Teachers share experiences on classroom practice	120 min.
Feedback and discussion	Trainer gives comment on teachers' reports	60 min.	Trainer gives com-ment on teachers' experience	120 min.	Trainer gives com-ment on teachers' experience	120 min.
Workshop II						
Doing math			Stacking cups	90 min.	Stacking cups	90 min.
RME theories			Bridging by verti-cal instruments; the use of context	90 min.	Bridging by verti-cal instruments; the use of context	90 min.
Preparation classroom practice			Shopping equations	120 min.	Kijang and Colt	120 min.
Classroom practice II						
RME material			Shopping equations	180 min.	Kijang and Colt	180 min.
Collabo-ration			Preparing and ob-serving each other	180 min.	Preparing and ob-serving each other	180 min.
Reflection meeting II						
Structured sharing			Teachers share experiences on classroom practice	120 min.	Teachers share experiences on classroom practice	120 min.
Feedback and discussion			Trainer gives com-ment on teachers' experience	120 min.	Trainer gives com-ment on teachers' experience	120 min.

7.2.2 Participants' characteristic

Sixteen mathematics teachers from 8 JHSs in Yogyakarta participated in the program. Each school was represented by two teachers. In this way enables them easier to perform classroom practice in collaboration (support each others in preparation, observation and discussion (see Table 7.6).

Table 7.6
The participants of IndoMath program

No.	Teacher's name	Sex	Age	Education	Experience	School
1	Suw	Female	59	S-1	34 (34)	SLTPN 1 Yk
2	Sri	Female	32	S-1	5 (1)	SLTPN 1 Yk
3	Sug	Male	45	D-3	17 (1)	SLTPN 6 Yk
4	Wij	Male	38	D-3	15 (2)	SLTPN 6 Yk
5	Kin	Male	52	D-3	26 (23)	SLTPN 10 Yk
6	Wat	Male	45	S-1	23 (20)	SLTPN 10 Yk
7	Sen	Male	53	S-1	23 (23)	SLTPN 12 Yk
8	Wah	Male	40	S-1	11 (2)	SLTPN 12 Yk
9	Sab	Male	47	S-1	24 (20)	SLTPN 14 Yk
10	Har	Male	33	S-1	8 (3)	SLTPN 14 Yk
11	Nug	Male	45	S-1	24 (24)	SLTPN 1 Depok
12	Sud	Male	44	D-3	20 (2)	SLTPN 1 Depok
13	Moc	Male	56	PGSLP	33 (33)	SLTP Piri 1 Yk
14	Tut	Female	36	S-1	5 (1)	SLTP Piri 1 Yk
15	Ton	Male	47	S-1	21 (9)	SLTP Muh 3 Depok
16	Agu	Male	32	S-1	5 (5)	SLTP Muh 3 Depok

Most of them have no prior knowledge of RME, that make them felt pleasure to participate in the in-service program. They were also expecting to get new knowledge and experiences about innovation in mathematics teaching and to improve their teaching skill (Table 7.7).

Table 7.7
Participants' feeling and expectation to IndoMath program

No	Teacher's name	Feeling	Knowledge of RME	Expectation
1	Suw	Please	No prior knowledge	Gain new knowledge* and experience; Improve teaching competence, i.e. students like to learn math and easy to understand.
2	Sri	Please	No prior knowledge	Gain new knowledge; Improve teaching competence, i.e. math becoming favorite subject for students; To improve math education in Indonesia.
3	Sug	Doubt	No prior knowledge	Gain new knowledge.
4	Wij	Please	No prior knowledge	Gain new knowledge; Develop professionalism as math teacher; Eager to participate in the follow up of this program.
5	Kin	Please	No prior knowledge	Gain new knowledge and experience; Improve teaching competence, i.e. more successful in teaching math.
6	Wat	Please	No prior knowledge	Gain new knowledge; Get books, articles, and brochure about math and math teaching.
7	Sen	Please	No prior knowledge	Gain new knowledge; Improve student achievement in math.
8	Wah	Please	No prior knowledge	Gain new knowledge; There will be follow up for this program.
9	Sab	Usual	No prior knowledge	Gain new knowledge, except to improve content mastery.
10	Har	Please	No prior knowledge	Gain new knowledge; Improve teaching competence, i.e. to ease subject matter delivery, student do understand and able to apply their knowledge.
11	Nug	Please and eager to know	No prior knowledge	Gain new knowledge, except to improve content mastery.
12	Sud	Please	No prior knowledge	Gain new knowledge.
13	Moc	Usual	No prior knowledge	Gain new knowledge; Improve teaching skill, i.e. math teaching more practical and easy to understand by student.
14	Tut	Please	No prior knowledge	Gain new knowledge, except to improve content mastery.
15	Ton	Eager to know more	Have ever heard	Gain new knowledge; Improve teaching competence, i.e. no boring in teaching.
16	Agu	Please	No prior knowledge	Know of realistic approach for math teaching; Able to use of realistic approach for math teaching.

Note: * Gain new knowledge should be interpreted as get new knowledge in general, improve content mastery, know about new method in mathematics teaching, and know and able to apply RME theories in instruction.

7.3 PARTICIPANTS' PERCEPTIONS

Participants' initial satisfaction of the program are identified as a prerequisite, though by no means sufficient, conditions for a potential impact of the in-service program on teachers' understanding of the new strategies. Guskey (2000) puts this as the first level of professional development evaluation. The participants' initial satisfaction to the experience is important to assess whether or not the program design and delivery already reaches the intended quality.

7.3.1 Workshops

The participants of the IndoMath in-service program indicated that the workshops in accord to their expectations. Meaning that the activities in the workshops that consisted of the 'doing mathematics,' 'RME theory,' 'video presentation,' and 'preparation for classroom practice' sessions met their hope to gain new knowledge and experiences of mathematics teaching, specifically the theories of RME. The participants positively appreciated the organization, the activities, and the materials delivered during the workshops (Table 7.8).

Table 7.8
Participants' perception on the aspects in the workshops immediately afterward (N = 16)

	Workshop I		**Workshop II**	
	*Mean**	*s.d.*	*Mean**	*s.d.*
The activity was carefully planned	4.4	.62	4.5	.52
The content was accurately and adequately delivered	4.0	.52	4.4	.50
The time was used effectively	4.3	.60	4.1	.50
The trainer was well prepared	4.4	.89	4.6	.50
Participants were active learners	4.3	.48	4.4	.62
The topic targeted was adequately covered	3.9	.93	4.2	.58
The materials are immediately useful	4.4	.62	4.4	.63
My understanding on RME is enhanced	4.3	.48	4.4	.62
My confidence in implementing RME is enhanced	4.0	.63	4.1	.50
The advice for classroom practice is concrete and clearly delivered	4.1	.50	4.5	.52
The lesson materials for classroom practice are sufficiently provided	4.0	.75	4.2	.66
The lesson materials are relevance with the SLTP curriculum content	4.1	.50	4.2	.58
I am confidence my students will enjoy the lesson material and approach of RME	3.4	.68	3.9	.44
I am confidence the RME lesson material and approach will improve student learning	4.0	.82	4.2	.58

Note: * 1 = strongly disagree, 5 = strongly agree.

It is worthy to mention here that participants' perception about the RME lesson were slightly higher in workshop II. They were more confidence that the students will enjoy the lesson (from 3.4 in workshop I to 3.9 in workshop II) and it will improve their learning (from 4.0 in workshop I to 4.2 in workshop II). Apparently the participants' real experience using the RME exemplary lesson material in the classroom practice after workshop I positively increase their confidence of RME implementation. Moreover, the participants perceived the IndoMath program has given them sufficient information and suggestion on how to implement RME in the instruction. It also has provided a clear image of how to implement the lesson which is subsequently enhanced their confidence in implementation.

The participants valued the workshops as instructive, useful, enjoyable, relevant, and informative. The 'doing mathematics' session was appreciate as the one of the best sessions in workshop I (8 x) and workshop II (6 x) (see Table 7.9).

Table 7.9
The best session in the workshops (N = 16)

	Workshop I *	**Workshop II**
Session	*f*	*f*
Doing mathematics	8	6
Preparation for classroom practice	3	7
RME theory	2	3
Video session	1	-**

Note: * A participant chose two sessions, 3 participants did not decide;
** No video session in workshop II.

7.3.2 Classroom practices

The classroom practice as one of components in the IndoMath in-service program is intentionally provided as a vehicle for the participants gain real experience of RME lesson. The participants positively perceived this component for their own benefit. They perceived that the classroom practices were instructive, useful, enjoyable, relevant, and informative. These activities also perceived as useful sessions during the IndoMath program (Table 7.10).

Table 7.10
The usefulness of the classroom practices (CPs) (N = 16)

	CP I		CP II	
Session	*Mean**	*s.d.*	*Mean*	*s.d.*
CP with RME exemplary curriculum materials	4.2	.66	4.4	.62
Peer collaboration and observation in CP	4.3	.48	4.3	.70

Note: * 1 = Not useful at all; 5 = very useful.

The classroom practices were also contributed to the participants perceive understanding about RME theories in term of how those theories are implemented in mathematics instruction. They were apparently aware that the use of context was important and the lesson must be started with contextual problems such that students can use their informal way to understand and solve the problems (Table 7.11).

Table 7.11
Participants' perceive understanding of RME theories (N = 16)

RME instruction principles	**Mean***	**s.d.**
The use of context is important	4.7	.48
The lesson must be started with something real for the students	4.7	.48
The lesson is structured by means of a set of contextual problem	4.4	.50
Teacher should give students opportunity to reinvent mathematical idea and concept by themselves	4.7	.60
Teacher should develop interactive instruction	4.6	.51
Teacher should ask students to use their informal way to understand and solve the problems	4.5	.52
Every student has ability to understand mathematical idea and concept on his own level	4.3	.60

Note: * 1 = strongly disagree; 5 = strongly agree.

7.3.3 Reflection meetings

The participants perceived the reflection meeting in accordance to their expectation in term of achieving its intention as a room for them to discuss their experiences in classroom practices. The sessions in this meeting: *structured sharing* and *feedback and discussion*, contributed to enhance their understanding about RME practices. The participants perceived the reflection meetings as instructive, useful, enjoyable, relevant, and informative. The participants valued both *structured sharing* and *feedback and discussion* sessions as one of the most effective sessions during the IndoMath program (Table 7.12).

Table 7.12
The most effective session in the program (N = 16)

The most effective session	f
Structured sharing of the results classroom practices	5
Feedback and discussion	5
Doing mathematics	3
RME theories	1
Preparation of classroom practice	1
Classroom practices	1

The impact of the IndoMath in-service program to teachers' understanding of RME is discussed in the following section.

7.4 PARTICIPANTS' UNDERSTANDING OF RME*)

In order to know the participants understanding of RME, the RCP-Test**) was administrated to them before and after the IndoMath in-service course. The RCP-Test consists of four contexts in which some questions were embedded, namely a context of *pencils and books*, a context of *stacking chairs*, a context of *cars, viz. Kijang and Colt L-300* (see figure 7.1), and a context of *telephones and populations*.

The results of the test were used to find out the change of the teachers understanding of the RME on three aspects:

- teachers understanding of contextual problems (that is, solving the problem using informal as well as formal mathematics procedure);
- teachers understanding of the mathematical concept addressed in the contexts; and
- teachers' understanding of the relevance of the contexts to the current Junior High School mathematics curriculum.

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*) This section is based on Hadi, Plomp and Suryanto (2002).

**) The Realistic Contextual Problem Test (RCP-Test) has been tried out with the participants of the IndoMath program in Yogyakarta during the second fieldwork. 18 SLTP mathematics teachers participated in the tryout, and 17 teachers finished the test. Their results were used for the analysis of the content validity and reliability of the items (contexts) in the test. The test appears to be reliable (coefficient alpha .7544) and internally consistent (Pearson correlation is significant at the 0.01 level).

Context 3: Kijang and Colt L-300

Second grade students from *SLTP Realita* are going to make a camping trip. There will be 96 people going, including the students and teachers. All the luggage, gear, and supplies are already packed into 64 equal-size boxes. The organizers want to rent the right number of vehicles to take everyone to the campsite. They can choose between two different types of vehicles from a car rental agency:

Kijang

Seats: 6 people

Cargo space: 5 boxes

Colt L-300

Seats: 8 people

Cargo space: 4 boxes

1. What combination of vehicles would you recommend to the camping organizers? (Use formal as well as informal mathematics procedure).
2. What mathematics concept, can be explained using the above context? Explain your answer (be more specific).
3. With which topic of the current SLTP mathematics curriculum does that context match? Explain your answer.

Figure 7.1
Sample of question in Realistic Contextual Problem (RCP) test

All the problems in the test were judged as being on the level of JHS students' knowledge, and appeared to be quite simple for teachers (as concluded from tryout in the second fieldwork). Moreover, all the mathematical concepts in which the problems have their basis are relevant to the current JHS mathematics curriculum. So, for mathematics teachers those problems are solvable. However, the test does not merely assess teachers' ability to solve the problems by a formal procedure, but also their ability to solve the problems using informal procedures. Equally important, the test also explores teachers' knowledge about the concepts behind the contexts, and the relevance of the contexts to the current JHS mathematics curriculum. The results of the test for the participants in the third fieldwork period are presented in Table 7.13.

Fifteen participants stated that they had never heard about RME until they participated in the in-service course. The result of the pretest also indicates that they had little or no prior knowledge about RME. Particularly, they were not familiar with informal procedure for solving problems. For example, in the context of *Kijang and Colt L-300* most of the participants solved the problem using formal procedure: translating the problem into two linear equations of two variables, then solved the linear equation systems by elimination and substitution methods. Five participants gave no solution to the problem, had no idea about the mathematical concept addressed in the context, and had no idea of the relevance of the context to the current JHS mathematics curriculum.

Table 7.13
Participants' scores on RCP-test

No.	Teacher	Pretest*	Posttest*
1	Suw	44	92
2	Sri	35	79
3	Sug	15	33
4	Wij	29	67
5	Kin	35	63
6	Wat	56	38
7	Sen	63	75
8	Wah	67	75
9	Sab	63	67
10	Har	63	79
11	Nug	35	67
12	Sud	27	50
13	Moc	25	54
14	Tut	46	83
15	Ton	25	67
16	Agu	33	75

Note: * The scores are in percentage. Participants' work was also assessed independently by second evaluator. The Spearman correlation between the scores of the two evaluators are 0.789 (pre test) and 0.760 (post test). Correlation is significant at the 0.01 level.

Participants' scores on the posttest indicated that they gained knowledge about the importance of solution variation in solving contextual problems. In the context of *pencils and books*, 10 participants made use of two or more procedures using formal as well as informal procedures. Also, in the context of *stacking chairs* and the context of *Kijang and Colt*, 8 participants made use of two or more procedures. The increase of participants' scores in the post-test are contributed mostly by their ability to solve the problems using different ways.

Teachers' understanding of the variety of possible answers to one contextual problem is important for RME mathematics teaching. Teachers should be aware of the different responses coming from their students in classroom lesson, and should be ready to facilitate discussions (see Section 7.5.3 for the differences in mathematics teaching practice as a result of teachers' participation in IndoMath in-service program).

7.5 PARTICIPANTS' USE OF RME KNOWLEDGE AND LESSON MATERIAL

Participants' use of the knowledge they gained on their participation on professional development program is essential part in evaluation. Guskey (2000) mentions three aspects of this issue: participants' stage of concern, participants' level of use, and indication of change in teaching practice. In this section these aspects are discussed.

7.5.1 Participants' stage of concerns

The teachers had gotten the invitation to participate in the IndoMath program and decided to joint. They had attended the workshops, did classroom lesson practices, and shared their experienced in the reflection meetings. After all these processes were passed, what are their feelings and perceptions about RME? It is apparently relevant to understand participants' ideas about the new strategies using a well - established theory. According to Hall and Hord (2001) feelings and perception about the innovation and the change process can be sorted and classified as concerns. They state that there is a developmental pattern to how feelings and perceptions evolve as change process unfolds, which they have named the Stages of Concerns (Hall & Hord, 2001). They argue that understanding the Stages of Concerns can result in significantly more effective professional development for teachers such as one-on-one coaching sessions, more relevant workshops, and strategic plans that take into account the personal side of the change process (Hall & Hord, 2001).

According to Guskey (2000) for many years, researchers have noted that when faced with demands for improvement and change, individuals experience a common set of characteristic concerns. These concerns evolve as participants become more familiar with the change and more comfortable with related practices and consequences. Horsley and Loucks-Horsley (1998) state that such concerns represent an important affective dimension in the change process (cf. Guskey, 2000).

There are four different categories of concerns that encompass seven distinct stages (Hall & Hord, 2001; Guskey, 2000). The first category, Awareness (Stage 0), describes people who either are not aware of the change or do not want to learn about it. The second category of Self includes individuals who are just learning about the change (Stage 1, Informational) and those concerned about how it might affect them (Stage 2, Personal). The third category, Task (Stage 3, Management), describes individual who want to know what alterations or adaptations in present structures will be necessary to make the change work. The fourth category of Impact includes individuals concerned about how the change affects students (Stage 4, Consequence); how results might be improved by actively working with colleagues (Stage 5, Collaboration); and how even better results might be attained through additional refinement and adaptation (Stage 6, Refocusing). These categories and stages are described in Figure 7.2.

In assessing teachers' stage of concern about RME as an impact of their participation in the IndoMath program, Stage of Concern Questionnaire (SoCQ) was applied (Hall & Hord, 2001). The SoCQ consists of 35 Likert-type questions of 7 scale and 2 open questions (see Appendix G for Indonesian version of SoCQ). The questionnaire was distributed and filled in by the participants of IndoMath program three times, at the beginning, at the end, and three months after the in-service program.

Category	Stage/Label	Description
Impact	6, Refocusing	The focus is on the exploration of more universal benefits from the innovation, including the possibility of major changes or replacement with a more powerful alternative. Individual has definite ideas about alternatives to the proposed or existing form of the innovation.
	5, Collaboration	The focus is on coordination and cooperation with others regarding use of the innovation.
	4, Consequence	Attention focuses on impact of the innovation on students in his or her immediate sphere of influence. The focus is on relevance of the innovation for students, evaluation of outcome including performance and competencies, and changes needed to increase student outcomes.
Task	3, Management	Attention is focused on the processes and tasks of using the innovation and the best use of information and resources. Issues related to efficiency, organizing, managing, scheduling, and time demands are utmost.
Self	2, Personal	Individual is uncertain about the demands of the innovation, his/her inadequacy to meet those demands, and his/her role with the innovation. This includes analysis of his/her role in relation to the reward structure of the organization, decision-making, and consideration of potential conflicts with existing structures or personal commitment. Financial or status implications of the program for self and colleagues may also be reflected.
	1, Informational	A general awareness of the innovation and interest in learning more detail about it is indicated. The person seems to be unworried about himself/herself in relation to the innovation. She/he is interested in substantive aspects of the innovation in a selfless manner, such as general characteristics, effects, and requirements for use.
Aware-ness	0, Awareness	Little concern about or involvement with the innovation is indicated.

Figure 7.2
Stages of concern about the innovation (Hall & Hord, 2001)

At the beginning of the in-service program most of teachers were on Stage 0 (awareness) and less intense to Stage 1 (informational) and Stage 2 (Personal) (Table 7.14). It means that they had no or little concern about RME. It was apparently related to the fact that most of them have no prior knowledge about RME (see Table 7.7).

Table 7.14
Teachers' stage of concern at the beginning of the program

No.	Teacher's name	Stage of Concern	Written concern
1	Suw	Awareness, Informational	I'm looking for other method for students with low ability.
2	Sri	Awareness, Informational	How to deal with students with low ability?
3	Sug	Informational, Personal	–
4	Wij	Informational, Personal	I wish this innovation could optimize the result of mathematics teaching.
5	Kin	Awareness, Informational	I wish that math teachers could build constructive communication with the students in order to avoid antipathy to math.
6	Wat	Awareness, Informational	I'm very concern if there is training for math teachers, but for a long time I'm never asked to be involved.
7	Sen	Awareness, Informational	How to motivate students to love mathematics?
8	Wah	Informational, Personal	I want to change students' view that math is a difficult subject.
9	Sab	Awareness, Information	–
10	Har	Awareness, Information	–
11	Nug	Awareness, Informational	I want to change my teaching style such that students like it.
12	Sud	Awareness, Informational	I hope that all JHS math teachers could participate in this training, so that they know what RME is.
13	Moc	Awareness	–
14	Tut	Awareness, Information	I want to increase students' motivation to learn math.
15	Ton	Awareness, Informational	I want to teach well, but my problem at home and school is not supportive.
16	Agu	Informational, Personal	With this innovation I hope there is a right method so that students easier understand.

From teachers' written answers to the open question in SoCQ it was clear that their concerns were intense to the problems they faced in mathematics teaching in general. Teachers Suw and Sri had concerned about dealing with students with low ability. Teachers Kin, Sen, Wah, and Nug concerned about changing the students' view of mathematics as difficult subject to be the one that students like. While teachers Wij and Agu concerned about how to increase students' achievement in mathematics.

Table 7.15
Teachers' stage of concern at the end of the program

No.	Teacher's name	Stage of Concern	Written concern
1	Suw	Informational, Personal	If there is a follow up, it will be good.
2	Sri	Informational, Personal	I want that there is a follow up to this introduction program.
3	Sug	Awareness, Informational	My work was not good because of my knowledge shortage.
4	Wij	Informational, Personal	Because this innovation is very good, we need support from the government to follow up and spend budget for researching, training, developing, and implementing.
5	Kin	Informational,	I want that each student love mathematics.
6	Wat	Awareness, Refocusing	–
7	Sen	Awareness, Personal	In principle I support and proactive to the innovation in mathematics teaching which aims to develop students to be logical, critical, and systemic thinkers.
8	Wah	Informational, Personal, Collaboration	I want to teach mathematics in a way that my students understand quickly and right using appropriate method and in accord with students' level of thinking.
9	Sab	Awareness, Informational, Personal	–
10	Har	Informational, Personal	I'm concern that the method used right now is less supportive for developing students' activity and creativity, so we need some changes. One of these is using RME. At least some parts of the teaching can use contextual problems.

To be continued

Table 7.15 *(Continued)*

No.	Teacher's name	Stage of Concern	Written concern
11	Nug	Informational, Personal	I want to see the implementation of the innovation fully, so that each teacher understands this innovation in comprehensive way.
12	Sud	Awareness, Informational	I'm very concern about this innovation and I expect that in not a long time RME can be used in mathematics teaching.
13	Moc	Awareness	–
14	Tut	Awareness, Personal	I support this innovation to be implemented in order to develop students interesting toward mathematics.
15	Ton	Awareness, Informational	I want a positive change of situation in my school, because it influences my work.
16	Agu	Informational, Personal	I want to know if all topics in the curriculum can be delivered using this innovation. I want that contextual problems are published in the form of book and can be acquired easily.

At the end of the IndoMath in-service program, teachers' concerns were a little bit change toward stage 1 (Informational) and stage 2 (Personal). Their participation in the in-service program provided them a feeling that there is something out there that promising to improve their current practice. However, they were concerns that their knowledge about this new method was limited. Because of this reason, the intense of their concerns were high in acquiring information about the innovation. In spite of informational concern, they also showed intense, although it was less intense compared to informational concern, on personal concern (Table 7.15).

Teachers' written comments were clearly indicated their concerns of informational and personal. Teachers Suw, Sri, Wij and Nug concerned about the need of the follow up to this program in order to give teachers opportunity to learn more of this theory. Several other teachers indicated their expectation that the innovation can be implemented officially shortly after the program (Teachers Sud, Har, and Tut). There was also an indication of their support to the new way of teaching which is in their view promising to increase students' performance and achievement in mathematics. Teacher Sen wrote that in principle he supported and proactive to the innovation in mathematics teaching which aims to make students to become logical, critical, and systematic thinkers. While Teacher Wah commented that he wants to teach mathematics in a way that his students understand the concept better and quickly, and in accord to students' level of thinking.

Three months after the IndoMath program teachers' concerns were not so much different from their concerns at the end of the program. Their concerns remained on informational, personal. Some teachers had intense to management. On the other hand several other teachers back to their initial concerns of stage 0 (awareness) like at the beginning of the program (Table 7.15). It was apparently caused by little support to use the new method in teaching. Teachers' written comments indicated this matter. Teacher Nug commented: "*It is rather difficult to imagine the continuation of this innovation due to the preparation of curriculum materials – student book and teacher guide – is rather difficult.*" The need for support in term of availability of curriculum materials was also indicated by Teacher Sud: "*I agree with this innovation although the implementation needs relatively a long time. While it is on the way I need some more exemplary curriculum material to be used in my teaching.*" Teacher Sen who showed concern on management questioning if all topics in the current curriculum can be taught using RME: "*I am thinking if every topic in the curriculum can be taught using RME and to what extend this approach influence the curriculum changing in primary, junior high, and senior high schools.*"

Table 7.16
Teachers' stage of concern three months after the program

No	Teacher's name	Stage of Concern	Written concern
1	Suw	Informational, Personal	RME is good. By using this method students are really actively involve in learning. They can understand and analyze the problems. But, it needs a lot of time while the content coverage is also a lot. For material preparation needs more time; I like this method, more and more if all the materials are available.
2	Sri	Informational, Personal	To develop and determine contextual problems to be taught is not yet comprehended; I face difficulty in using this innovation.
3	Sug	Awareness, Informational	–
4	Wij	Informational, Personal	I want that the results of this innovation can help to change the image that mathematics is a difficult subject.
5	Kin	Informational, Personal	In every learning activity I try to link with every day life.
6	Wat	Awareness, Information	The school needs more facilities like math lab, book s and mathematics references including their pedagogic.
7	Sen	Awareness, Informational, Management	I'm thinking if every topic in the current curriculum can be taught using RME and to what extend this approach influence the curriculum changing in primary, junior high, and senior high schools.
8	Wah	Informational, Personal, Collaboration	–
9	Sab	Awareness, Informational, Management	–
10	Har	Informational, Personal	–
11	Nug	Awareness, Informational	It's rather difficult to imagine the continuation of this innovation due to the preparation of curriculum materials – student book and teacher guide – is rather difficult.

To be continued

Table 7.16 *(Continued)*

No	Teacher's name	Stage of Concern	Written concern
12	Sud	Awareness, Informational	I agree with this innovation although the implementation needs relatively a long time. While it is on the way I need some more exemplary curriculum material to be used in my teaching.
13	Moc	Awareness, Personal	–
14	Tut	Information, Personal	I want that students love mathematics. Because up to the present students don't like mathematics. I do hope RME can be implemented immediately; I'm optimistic that using RME students will love mathematics.
15	Ton	Awareness, Informational	I will do my best to use this innovation, but not in my current workplace, because the situation and condition is really not conducive for me.
16	Agu	Informational, Personal	I want to use this innovation if there is a positive change. I want to combine the old method with this innovation relevant to topic taught.

7.5.2 Participants' level of use of RME

Hall and Hord (2001) provide eight classifications or level of how people act or behave with a change. These levels have been identified and verified through research which each of them has operational definition (Figure 7.3).

Category	Level/Label	Description
Users	6, Renewal	State in which the teacher re-evaluates the quality of use of the innovation, seeks major modification of or alternatives to present innovation to achieve increased impact on students, examines new developments in the field, and explores new goals for self and the system.
	5, Integration	State in which the teacher is combining own efforts to use the innovation with related activities of colleagues to achieve a collective impact on students within their common sphere of influence.
	4b, Refinement	State in which the teacher varies the use of the innovation to increase the impact on students within immediate sphere of influence. Variations are based on knowledge of both short- and long-term consequences for students.
	4a, Routine	Use of the innovation is stabilized. Few if any changes are being made in ongoing use. Little preparation or thought is being given to improving innovation use or its consequences.
	3, Mechanical	State in which the teacher focuses most effort on the short-term, day to day use of the innovation with little time for reflection. Changes in use made more to meet teacher needs that student needs. The teacher is primarily engages in a stepwise attempt to master the tasks required to use the innovation, often resulting in disjointed and superficial use.
Nonusers	2, Preparation	State in which the teacher is preparing for first use of the innovation.
	1, Orientation	State in which the teacher has recently acquired or is acquiring information about the innovation and/or has recently explored or is exploring its value orientation and its demands upon the teacher and school system.
	0, Nonuse	State in which the teacher has little or no knowledge of the innovation, no involvement with the innovation, and is doing nothing toward becoming involved.

Figure 7.3
Levels of use of the innovation (Hall & Hord, 2001)

There are two general categories in LoU scheme, Nonusers and Users. The nonusers are divided into three levels. The lowest level of 'nonuse' describes individuals who are taking no action whatsoever with respect to the new knowledge or skill. People at the 'orientation' level are just beginning to seek information, whereas those at the 'preparation' level have acquired the new knowledge and skills and are getting ready for use. Participants who have just completed a professional development experience and are preparing to put into practice what they learned would be considered at the 'preparation' level (Guskey, 2000).

The first category of use is the 'mechanical' level which represents individuals implement the new ideas, but they are doing so in very mechanistic, uncoordinated, and superficial ways. Those at the 'routine' level have established a regular pattern of use but are making few, if any, changes, whereas 'refined' users are assessing impact and making changes to improve effectiveness. People at 'integration' level are individuals who are making deliberate efforts to coordinate with others who are also engage in use. According to Horsley and Loucks-Horsley (1998) those at the 'renewal' level are actively seeking more effective alternatives to established patterns of use (cf. Guskey, 2000).

The levels of use are directly related, although it is not necessarily causal, to participants' comprehension of knowledge and skill (Guskey, 2000). Meaning that individuals at higher and more complex levels of use typically have a more comprehensive and sophisticated understanding of the innovation or change.

In order to assess the IndoMath program participants' levels of use toward RME, LoU branching interview was applied (Hall & Hord, 2001). The branching interview is constructed so that the researcher, through a series of questions, gain information about the teacher's related behavior (see Figure 7.4.)

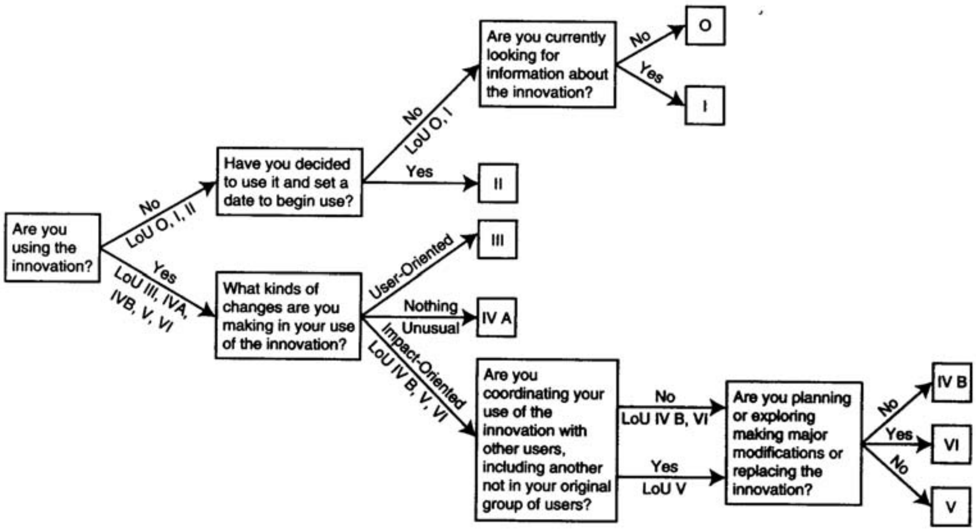

Figure 7.4
Format for the LoU branching interview (Hall & Hord, 2001)

The LoU of the participants of IndoMath in-service program toward RME as a new strategy in mathematics teaching mostly varied among the first three levels of nonusers. Five teachers remain on Level 0 (nonusers), three in the Level 1 of orientation, five indicated that they were preparing to use the innovation in the next academic term (Level 2). Three other teachers indicated that they had already used some ideas of RME in their mathematics teaching (Level 3 of mechanical) (see Table 7.16).

Table 7.17
Participants' level of use of RME

No.	Teacher's name	Level of use	Oral statement
1	Suw	2: Preparation	Next term I'll use the available RME curriculum materials: 'Kijang & Colt' and 'Pensil & Buku.'
2	Sri	2: Preparation	Next academic term I'll use the available RME curriculum materials.
3	Sug	0: Nonuse	For the moment I've no further effort to find information on RME.
4	Wij	3: Mechanical	In case no RME curriculum materials available I emphasize students to find solution using their own efforts and give them opportunity for their own learning.
5	Kin	3: Mechanical	I use RME curriculum materials and try to link the content to every day life problems.
6	Wat	0: Nonuse	RME is not easy, materials preparation cost long time and efforts.
7	Sen	0: Nonuse	It's still difficult to retreat from telling method in math teaching.
8	Wah	2: Preparation	Next term, at the time the topic is match to the available RME curriculum materials, I'll use it.
9	Sab	0: Nonuse	No relevance materials to be used and no time to look for further information on RME.
10	Har	2: Preparation	I'll use the RME curriculum materials of 'Stacking Cups' in my class of Grade 3.
11	Nug	1: Orientation	Not use until the government officially declares to use the innovation. I learn further by looking for information on RME.
12	Sud	1: Orientation	Not use until I really competence to use the innovation. I always learn on RME.
13	Moc	2: Preparation	I'll try to use the innovation next term when the current curriculum content is match to the available RME materials.
14	Tut	0: Nonuse	I'm not sure I can use the innovation.
15	Ton	1: Orientation	I try to use the innovation for my math lesson, but then I got criticism from students that I never explain the subject matter.
16	Agu	3: Mechanical	I use some aspects of RME such as student contribution and self effort to find solution in seatwork (individual exercise).

Teachers who on Level 0 of non-use indicated that RME is not easy to be used due to the problems in materials preparation in term of developing contextual problems, while they perceived that the available RME curriculum materials were not relevant to their classes. During the IndoMath in-service program only a limited number of RME exemplary curriculum materials were delivered to participants. Those materials were 'Pensil dan Buku' and 'Kijang and Colt' which are relevant for topic 'solving linear equation of two variables' for Grade 2 JHS. Another exemplary was 'Menyusun Cangkir' which is relevant for topic 'number patterns' for Grade 3 JHS. One other material was 'Telepon and Penduduk' which can be used for topic 'comparison' in Grade 2 JHS. However, most of teachers taught that the last exemplary (Telepon dan Penduduk) was less relevant to be used for topic 'comparison' because it emphasizes on absolute and relative comparison which are not part of the content of the current JHS mathematics curriculum.

In fact, all the participants had used the exemplary materials when being observed. The teachers who on the Level 2 (Preparation) indicated their willingness to use again the RME exemplary curriculum materials for their mathematics lesson. Teachers on this level had set a certain date to use the available RME materials for their class in the next academic trimester.

The teachers on the Level 1 of orientation had tendency to wait until either they are really competence to use it or the government officially declares to use the innovation. In their waiting time, they indicated that they remain involve in to look for information and learn further the new ideas.

The teachers on Level 3 of mechanical indicated that they had used the RME even if there is no relevant RME exemplary curriculum materials. They perceived that the important thing is to use RME ideas in their teaching such as emphasize on students learning and to link the content to every day life problems. The teachers at this level were implementing RME in mechanistic, uncoordinated and superficial ways (Guskey, 2000).

7.5.3 Differences in practice

According to Guskey (2000) the third aspect of questions related to participants' use of new knowledge and skill concerns determination of actual difference in professional practice. Joyce (1993) asks if the practices observed truly different from what participants used in the past or from what other teachers or administrators are using at the present time (cf. Guskey, 2000).

To gather the information about the difference in teachers mathematics teaching before and after the IndoMath in-service program the participants were asked to indicated explicitly the change of their professional practices (e.g., How is this different from what you did in the past?). The information were also gathered through classroom observation before and after the IndoMath program (Guskey, 2000).

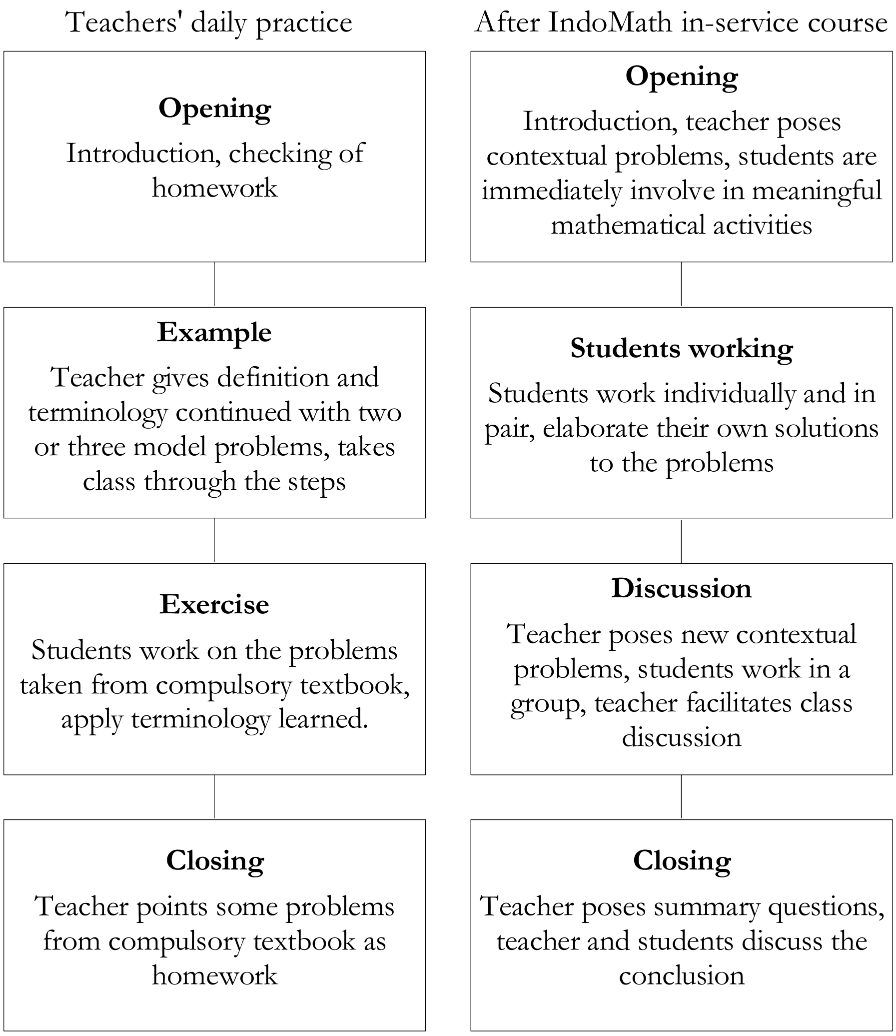

Figure 7.5
Teachers' mathematics lesson structure (Hadi, Plomp and Suryanto, 2002)

There were observed changes in teachers' mathematics lesson structure during and after the IndoMath in-service course. The results of the classroom observations indicated participants' ability to translate RME philosophy into classroom lesson. By the support of RME exemplary curriculum materials (student's book and teacher's guide) the teachers could perform instruction that was different from what they usually did (Fig. 7.5). In their daily practice, teachers perform their instruction following the sequence: Opening – Example – Exercise – Closing. Their lesson structure was dominated by traditional 'chalk and talk' that put intellectual authority in the hands of the teachers, and students' activities of note taking. Teachers have the tendency to 'spoon-feed' their students. This unfortunate nature of the 'traditional' learning process makes the students to become passive learners and with little responsibility for mathematical thinking and reasoning.

In the classroom practice during and after the IndoMath in-service course, teachers tried to structure their lessons by emphasizing the student's learning. Although it was rather troublesome because the students were used to being 'spoon-fed', the teachers always ask their students to explain their thought, or to comment on the other student's response, and facilitate discussion.

The RME exemplary curriculum materials provided significant support for the teachers in their mathematics teaching. The classroom observations to participants' lesson indicated that most of them could fulfill the threshold criterion: (1) the use of contextual problem as starting point; (2) conceptual mathematization: from concrete to abstract; (3) pupil contribution; (4) interactivity; and (5) intertwining. These threshold criteria contribute 33% of teachers' practice profile. Teachers' practice profile gave evidence that all of them had scores more than 33 (Table 7.18).

Table 7.18
Participants' practice profile

No.	Teacher's name	Innovation Profile Score
1	Suw	37
2	Sri	73
3	Sug	43
4	Wij	78
5	Kin	68
6	Wat	52
7	Sen	37
8	Wah	40
9	Sab	38
10	Har	75
11	Nug	72
12	Sud	57
13	Moc	39
14	Tut	41
15	Ton	34
16	Agu	52

However, from teachers' practice profile we understand that it was rather difficult for them to fulfill the ideal elements of RME teaching. Some of them were difficult to retreat from telling method by dominating class activity with lecturing and explaining in most of the time (Teachers Suw, Moc, and Tut). On the other extreme, some teachers gave their students all the freedom to work on contextual problems without or less intervention (Teachers Sug, Wah and Sen). In fact, these two extremes of teachers' practice profile were not reflected the ideal model of RME teaching.

The third group of teachers had position between those two extremes (Teachers Sri, Wij, Kin, Har, and Nug). They succeeded to show some ideals elements of RME teaching to be appeared in their lesson. Some of these ideal elements are among others: teacher gives pupils independent work time before the group or whole class discussion; teacher gives pupils more time to process their thought that results in more and better responses; teacher always requires pupils to ask a question when they need help.

7.6 CONCLUSIONS

The study described in this chapter explored the effectiveness of the IndoMath in-service program in term of its contribution in supporting teachers to understand RME. The teachers' understanding is defined as their ability to comprehend the RME ideas and to translate those ideas in mathematics lesson.

The effectiveness of the IndoMath in-service program was measured using three level of effectiveness as proposed by Guskey (2000): participants' perception, participants' understanding of RME, and participants' use of RME.

Participants perceived the organization and components of in-service program positively. It means that the program activities that consisted of Workshops, Classroom Practice, and Reflection Meeting meet their expectation, and considered as instructive, useful, enjoyable, relevant and informative. All of the teachers, before the in-service program, had expectation that their participation in the in-service course could benefit them in gaining new knowledge in term of mathematics pedagogy in general, improving content mastery, knowing of new method in mathematics teaching, and knowing and able to apply RME theories in mathematics instruction (Table 7.7). Almost all of their expectation could be fulfilled during the IndoMath in-service program. The participants mostly appreciated *doing mathematics* as one of the best sessions during the Workshops (Table 7.9), and perceived Classroom Practices as useful (Table 7.10). They also valued the Reflection Meetings that consisted of *structured sharing* and *feedback and discussion* as one of the most effective session during the program (Table 7.12).

The impacts of the IndoMath in-service program to teachers' understanding of RME were measured using the RCP-test. The results of the test indicated that there was an increasing of their understanding before and after the program (Table 7.13). Fifteen out of 16 participants stated that they had never heard about RME before they participated in the in-service course. The result of the pre test indicated the matter. After the program, they were more familiar with contextual problems as the main ingredient of RME. They were aware about variety of possible answers to one contextual problem. It brings consequences to RME teaching. Participants were also strongly agree to the theories of RME teaching that (Table 7.11):

- the use of context is important;
- the lesson must be started with something real for the students;
- the lesson is structured by means of a set contextual problem;
- teacher should give students opportunity to reinvent mathematics idea and concept by themselves;
- teacher should develop interactive instruction;
- teacher should ask students to use their informal way to understand and solve problems; and
- each student has ability to understand mathematical idea and concept on his/her own level.

Another important aspect of the impact of the IndoMath program is participants' use of the new knowledge of RME in their mathematics class. Guskey (2000) mentions three aspects of this issue: participants' stage of concern, participants' level of use, and indication of change in teaching practice.

At the beginning of the IndoMath in-service program most of the teachers' concerns were around two initial stages of Stage 0 (Awareness) and Stage 1 (Informational) (Table 7.14). Meaning that they had little concern about RME, and there is an indication that they want to learn more the innovation. At the end of the program teachers' concerns were a little bit change toward Stage 1 (Informational) and Stage 2 (Personal) (Table 7.15). Meaning that they know about general characteristic of RME, its effects, and requirement for use. However, teachers were uncertain about the demands of RME, their inadequacy to meet those demands, and their role with the innovation. Being aware of that teachers' concerns are evolved in the process of change as they become more familiar with RME and more comfortable with related practices and consequences (Guskey, 2000), three months after the program teachers' concerns were measured again. The data indicated that teachers' concerns were not so much different from their concerns at the end of the program. Their concerns remained on informational and personal. Few teachers had intense to management (focused on the process and tasks involved in applying the change and the best use of information and resources; attention centered on efficiency, organization, management, and time demands). One other teacher had concern on collaboration (focused on coordinating and cooperating with others regarding the change). On the other hand, several other teachers back to their initial concerns of awareness like at the beginning of the program. The message that derived from teachers' concerns was they need continued support in term of RME curriculum materials – it is not their task to develop such kind of materials – in order to be able to implement the innovation in their mathematics instruction.

Regarding the use of RME in mathematics teaching, the data indicated that the level of use of the teachers mostly varied among the first three levels of nonusers. Five teachers remained on Level 0 (nonusers), three on the Level 1 of orientation, five indicated that they were preparing to use the innovation in the next academic trimester (Level 2). Three other teachers indicated that they had already used several ideas of RME in their mathematics teaching (Level 3 of mechanical) (Table 7.17).

Although the implementation of RME in mathematics teaching was rather troublesome, teachers' practice profile indicated a shift from traditional Opening – Example – Exercise – Closing model of teaching to more realistic approach (Figure 7.6 and Table 7.18). The RME exemplary curriculum materials provided significant contribution for this change in practice. The use of RME exemplary curriculum materials reduced the difficulty of the introduction of the innovation to the teachers.

8

SUMMARY, DISCUSSION, AND RECOMMENDATIONS

This chapter outlines the results of the IndoMath study. After the summary (Section 8.1), the main findings of the study are discussed (Section 8.2). Having looked at the impacts of the program to its participants (Section 8.2.1), the discussion is devoted to the characteristics of such a program (Section 8.2.2). In Section 8.2.3 lessons learned from development research activities are given particularly related to the current development in Indonesia. Section 8.2.4 discusses three possible obstacles of RME implementation in Indonesia: provision of RME curriculum materials and its consequences to mathematics instruction, the obstacles from teachers' point of view, and the obstacles from students' point of view. Finally, Section 8.3 gives several recommendations for policy makers also for practitioners and further research.

8.1 SUMMARY

From the beginning of the implementation of mathematics teaching in schools (since 1973) many efforts have been done by the Indonesia government to improve the quality of mathematics instruction such as the development of curriculum materials, pre and in-service education for teachers, and provision of media of instruction. However, those endeavors have not yet resulted in satisfactory impacts at student level. Students' achievement in national leaving examinations remains low (*Informasi Ebtanas*, 2002), and in the international comparative study like TIMSS Indonesian students have poor performance (Mullis et al., 2000). Also when comparing with their South East Asian neighbors (such as Singapore, Malaysia, and Thailand) Indonesian students perform relatively low in mathematics and in mastering science and technology (*Pengajaran Matematika Seharusnya Mengarah ke Logika*, 1999). It appears that the implementation of mathematics teaching in Indonesia is far from being successful in achieving its aims.

Many parties in Indonesia expressed their concern and their need for improvement. The issues of improving students' mathematical understanding and reasoning dominate people's (such as policy makers, teachers, mathematics teacher educators) concerns. The main reason of the revision of the National Curriculum of 1994 by the Indonesian government is there were continuous criticisms from the educational professionals and within the society at large about the irrelevance and meaninglessness of some subject matter contents. A lot of people said that most of the content is too difficult because there were neither relevant to the level of students' thinking nor related to everyday life.

The revision of the curriculum mentioned above does not promise satisfactory improvement. Realistic Mathematics Education (RME) seems to be a promising approach for improving the teaching and learning of mathematics in Indonesia. In the concept of RME students should be given opportunity to develop their reasoning and logic through exposure of real life or contextual problems. This idea is in line with the current view in Indonesia. If we carefully listen to the messages coming from mathematics teachers in Indonesia, one of their concerns is how to make mathematics teaching relevant for students in dealing with the daily life problems. However, since RME is so new for many people in Indonesia (teachers, teacher educators, curriculum developers, and students) a research has to be conducted to investigate whether and how an approach like RME can be adapted and realized for the Indonesian context. This research is needed to reveal necessary components for a successful innovation on both curriculum and teachers' level. Given the willingness of those who are involved in mathematics education, we have reasons to expect a fruitful innovative curriculum for mathematics if we know how to adapt RME to Indonesian context and know what a proper implementation strategy is on the school level. In this matter, teachers are viewed as the key actors in education innovation. They need to be well trained in order to understand the philosophy of RME as reflected by the new curriculum materials and need to have appropriate competencies to put this into practice.

Within this analysis of problems related to Indonesian mathematics education and the introduction of RME-based mathematics education, the main research question is formulated as follows:

What are the characteristics of in-service education that make Indonesian teachers understand RME and prepare them for effective implementation of RME in their classroom lessons?

To address the above question a development research approach has been chosen (Section 4.2). In simple words, development research can be defined as a research related to development of a solution to an education problem. This approach appears to be a promising one because to find out characteristics of effective teacher professional development can be done by developing it. Traditional research approaches (e.g. experiments, surveys, correlation analyses), with their focus on descriptive knowledge, hardly provide prescriptions with useful solutions for a variety of design and development problems in education (van den Akker, 1999).

The **IndoMath** (**In**-service education for **Indo**nesian **Math**ematics teachers) study, the name of this development research project, was conducted through stages of *orientation*, *development and evaluation*, and *semi-summative evaluation* (Section 4.3). In the orientation stage, it analyzed the literature on RME and the available RME lesson material relevant to the current Indonesian JHS mathematics curriculum and promising to be adapted to the Indonesian context. This analysis resulted in tentative RME exemplary lesson material adapted from Mathematics in Context (MiC) in Bahasa Indonesia (a student material and teacher guide), and the preliminary design guidelines for the development of in-service education program. Subsequently, in the development and evaluation stage, the adapted RME lesson material and the preliminary model of in-service program were formatively evaluated in the first fieldwork in Indonesia. After the first fieldwork in Indonesia, the activities focused on the reflective analysis of the process and outcomes of formative evaluation to the adapted curriculum material and the in-service model. This reflective analysis resulted in new adapted RME exemplary lesson materials for several other topics, and the revised model of in-service education program, which subsequently were formatively evaluated in the second fieldwork. Finally, the semi-summative evaluation stage (the third fieldwork in Indonesia), evaluated the effectiveness of the IndoMath program in addressing its goals, namely to make teachers understand and effectively capable using RME lesson materials in their mathematics classes.

Orientation stage

As it is mentioned in Section 4.4 the research questions in the first fieldwork was: *How can RME curriculum material be adapted to Indonesian context?*

The development of the first design of IndoMath in-service program and the first draft of the adapted RME lesson material were done simultaneously as they cannot be viewed as separated entities. The in-service program had to provide a profound introduction to RME theories, while the RME lesson material was integral part of the in-service program. In short, without RME lesson material the in-service program could not take its form.

The development of exemplary RME curriculum materials for the Indonesian context was performed through the following four kinds of activities.

1. Adapting the RME materials from MiC of the topic *Probability* (*What's the chance*) for the Indonesian context and culture. The adaptation was done by translating and redesigning them in order to be suitable for the Indonesian contexts.
2. Trying out the materials at some junior high schools to find out their adaptability to Indonesian contexts. This activity was carried out on the assumption that the exemplary material would reflect the RME tenets in itself (namely: the use of context, bridging by vertical instrument, students' contributions, interactivity, and intertwining).
3. Trying out the materials in a small scale to find out how the Indonesian junior high school students dealt with the contextual problems in the lesson materials..
4. Classroom practices using the materials by ten participating teachers in their respective classes. The researcher observed the classroom practices. In addition, the researcher also analyzes the students' works in the practices.

The results of the last two kinds of activities indicated that the material did not need a substantial revision (Section 5.3.1). This material was then used in the IndoMath in-service program, and used by the participants in their classroom practices.

Indonesian teachers who participated in the tryout of IndoMath program and who used the exemplary material in their classroom practice seemed to be aware of the nature of RME approach as was discussed in the IndoMath workshop. In their instructions, the teachers (i.e. ten mathematics teachers who participated in the first tryout) tried to realize the expected situation (for instance engaging their students in meaningful mathematical activities). There appears to be promising shift in the learning process from teacher centered to student centered. Also, students became aware of their role, that they were not only 'objects' that should be filled with information or knowledge, but they had the right to deliver their thoughts (Section 5.3.2).

The results of teacher classroom practice (in one lesson of a participant of the IndoMath program) indicated that almost half (42.5%) of the students had a positive perception (such as easier, enjoyable, and interesting) of the material as well as the teaching-learning process. Only 5% of the students had negative responses (not interesting and boring) to the lesson. Twelve and half percents (12.5%) of the students had neutral position that is they thought that the material was interesting. However, the RME approach, where the teachers emphasized the students' own learning rather than explaining mathematics, was difficult for those who were used for a long time to being taught in a teacher-centered approach. There was a substantial proportion of students, namely 40%, who had no comment on the lesson they had just followed. It was unclear whether this group had positive and negative response. But, from the report of the teacher who conduct the lesson it seemed that students enjoyed the lesson as she said, "Students and I enjoyed the lesson. I didn't need to prepare materials. The RME material really helped me to conduct the lesson, and my students could learn from it." (Section 5.3.3).

In the orientation stage of the IndoMath program, the researcher developed the RME exemplary lesson materials, conducted a literature study on the theory of professional development in the Netherlands, and then carried out the first fieldwork in Indonesia. The result of the literature study was the insight of the principles of effective strategies for professional development for teachers (Section 3.4). The focus of the first fieldwork in Indonesia was a study of the current practice of the in-service education for mathematics teachers (Section 3.3). Based on the results of the study during the orientation stage, the researcher formulated the following the design guidelines of the IndoMath in-service education program (Section 5.4.1).

1. The primary attention in the IndoMath program must be to support teachers in improving their subject matter knowledge and pedagogical content knowledge with an emphasize on RME theory.

2. There must be high quality RME exemplary curriculum materials to support mathematics teachers, in the effort to introduce RME to Indonesian teachers.
3. The development of RME exemplary curriculum material should involve teachers from the very beginning.
4. The in-service course itself should reflect the approach that teachers could use with their students in classroom setting.
5. Exemplary curriculum materials for teachers are integrated in the in-service education to provide clear description of RME method in practice.
6. The flow of instruction in the in-service course should reflect the flow of learning and teaching activities in classroom.
7. Each participating school should be represented by two mathematics teachers in order to give opportunity for collaboration in classroom practices.

Development and evaluation stage

In the development and evaluation stage of IndoMathe program, the researcher found that there was lack of RME curriculum materials relevant to Indonesian contexts. At the same time the researcher was confronted by the need for developing an in-service education as a vehicle to introduce RME to the Indonesian mathematics teachers. Therefore, the research question in the development and evaluation stage was the following.

> *What are the characteristics of a valid and practical in-service education that can be used as a vehicle to introduce RME to Indonesian mathematics teachers?*

The design guidelines were operationalized into the first design of the in-service education program that consisted of a one-day workshop, two times classroom practices, and a half-day reflection meeting, as summarized below:

- The workshop consisted of 6 sessions, namely doing mathematics (45 minutes), instruction on RME theory (30 minutes), audio session on RME lesson (30 minutes), micro-teaching (30 minutes), observation skills (30 minutes), and preparation of classroom practice (30 minutes);
- The classroom practice (2 days 2 x 45 minutes each), in which each participating teacher conducted two RME lessons in his/her own class. Teachers worked in pairs, alternately taking the role of teacher in her/his own class and observer to the other teacher's class.

- The reflection meeting consisted of two sessions, namely reports of the classroom practice (50 minutes), and discussion (60 minutes).

The operationalization of the design guidelines into an in-service education program design is discussed in Section 5.4.3. A formative evaluation played important role during development process. In this phase, the first design model of in-service program was appraised by a Dutch RME expert, an Indonesian teacher educator and two Indonesian experienced mathematics teachers. The course was tried out with 10 participating teachers. Another teacher educator was also asked to become an observer or an independent evaluator to assess all aspects of in-service education program activities.

After the first tryout of IndoMath in-service program several revisions were made to the program design (Section 6.2).

1. The duration of the in-service program was expanded to become two one-day workshops, two time classroom practices and two half-day reflection meetings in a time range of two weeks. An adjustment was also made in the time allocation for each session. More time apparently was needed for doing mathematics session (with the same material as the classroom practice) to give the participants enough time to solve all the problems during the session. Time allocation for doing mathematics was added 45 minutes to become 90 minutes.
2. A video of RME lesson was made to be used in the next training program. So, the 'audio session' was skipped in the new design. Also, 'observation skills' session was removed from the program to be part of 'video presentation' session. It seemed useful to merge video presentation and observation skill in one session, because while teachers are watching the video they learn the aspects of RME lesson mentioned in the observation form.
3. Several other RME exemplary lesson materials were developed to give teachers more insight in the innovation. These exemplary materials were to be used in the next in-service course. The topics chosen to be adapted were accurately considered to meet the need of teachers in their mathematics instruction and relevant to the current JHS mathematics curriculum. Therefore, more topics than expected were covered in the training. The duration of the in-service program became longer than that mentioned in point 1, because more topics were covered in the training program.

The formative evaluation*) of the IndoMath program in the second fieldwork aimed at examining the validity and practicality of all aspects of program components, i.e. workshop, classroom practice, and reflection, including RME exemplary curriculum materials which have been adapted from MiC. The evaluation used several kinds of data collection methods and instrument (see Section 6.1.3 for detail description):

- IndoMath Program tryout, comprising all components of the in-service program;
- Questionnaires (three types): orientation questionnaire, workshop questionnaire, and whole program questionnaire;
- Classroom observation, to examine the effect of the IndoMath program to teachers' understanding of RME in classroom lesson, observations of two lesson practices were carried out in which the RME exemplary curriculum materials used;
- In the reflection meetings analyses of reflective reports provided by the teachers about the lessons they carried out in their classroom lessons using RME exemplary curriculum materials;
- Analyses of focus group discussion among the researchers and participants after the program about the whole aspects of IndoMath in-service course.

The formative evaluation during the first and second fieldwork in Indonesia has resulted in insights about the validity and practicality (Chapter 6) of the IndoMath program. The activities carried out during the development process to secure the validity of IndoMath in-service program were the following:

1. The in-service program has been design based on the principles of effective professional development for teachers. The program components were designed based on the five tenets of RME. By being based on the tenets, the IndoMath Program reflected the state-of-the-art knowledge.
2. The discussions with two Dutch experts on RME and on professional development respectively, helped the researcher choose the appropriate content of the workshop and the RME exemplary lesson material to be used in the classroom practice as part of the in-service program.
3. The discussion with Indonesian experts (a teacher educator and two experienced JHS mathematics teachers) provided clear directions to the developer to manage and execute the in-service program relevant to local situation.

*) There were two workshops (both workshops were attended by the same eighteen mathematics teachers), and two classes were observed.

4. The review and continuous feedback from an independent observer (an Indonesian mathematics teacher educator) who followed the program from beginning till the end avoided subjective view of the developer.
5. The discussion with the participants of the in-service program assured the relevance of the program to the current needs of Indonesian JHS mathematics teachers to improve their competencies in mathematics instruction.

The practicality of IndoMath in-service program was measured mainly during the program tryout (see Section 6.2 for the description of participants and the tryout of the program). After the conclusion of the in-service education, using questionnaires the researcher collected the participants' reactions to all components of the program. The practicality of IndoMath in-service program can be summarized as follows (Section 6.6).

- The *Doing Mathematics* has proved to be facilitating the teachers creating and elaborating symbolic models of their mathematical activities. Moreover, since the RME curriculum materials usually were designed in the form of problem solving, the *Doing Mathematics* session also facilitated participants in learn the strategies of solving problems. Participants valued this session high. In Workshop I, eight out of 20 participants chose *Doing Mathematics* as the best session, while in Workshop II six out of 20 participants (the same teachers as in Workshop I) chose it as the best session.
- The *RME Theory* (A discussion about the theory of instruction based on the tenets of RME) session was highly appreciated by participants. At the end of Workshop II ten out of 20 participants regarded this session as the best one.
- The participants stated that there were several benefits from *video presentation*. . Some participants stated that it was beneficial because it gave a visual support of how to conduct an RME instruction. Nine out of 20 participants regarded the *video presentation* as one of the best sessions.
- *The Preparation of classroom practice* was important to give participants an adequate content knowledge and pedagogical content knowledge before performing classroom practice.
- *The Classroom practice* has proved to be an essential component in the IndoMath program, because it gave the participants actual experiences of RME instruction in a real setting.

- The results of tryout indicated that *structured sharing* (of experiences) was useful in helping participants to get the whole description of the classroom practices performed in teacher respective school.
- In the *feedback and discussion* session, participants got feedback from the teacher trainer on various aspects they encountered in the classroom practice. For this session, the researcher chose carefully the appropriate suggestions for the problems confronted by the participants. The classroom practice observation records help the researcher determine the suggestions.

Semi-summative evaluation stage
The last stage of IndoMath study was the semi-summative evaluation of the effectiveness of the in-service program in achieving its aims to make Indonesian JHS mathematics understanding of RME and enable them implement RME ideas in their mathematics instruction . So, the research questions in this stage was:

> *To what extend does the in-service education effectively contribute to the teachers' understanding of RME?*

The data (see Chapter 7) indicated that the IndoMath in-service program had a promising development in the right direction in achieving its goals. The results of RCP-test indicated that the participants gained knowledge about the role of contextual problems in mathematics instruction. There was also a positive change in teachers' professional works after the teachers completed the in-service education (see Section 7.4).

The results of the IndoMath study are discussed further in the following section.

8.2 DISCUSSION

The effectiveness of the IndoMath in-service program was measured mainly in term of the teachers' comprehension of RME ideas and the change of their teaching method toward a meaningful mathematics instruction and students centered learning, using contextual problems as the main ingredient of RME. In this section the main findings of the IndoMath Study are discussed.

Firstly the impacts of the IndoMath program to mathematics teachers' understanding of RME will be discussed (8.2.1). The data indicated that the program had a promising development in the right direction in achieving its goals to make teachers understand RME and develop their competencies in mathematics teaching in favor to RME method. Having revealed the impacts of the in-service program, the researcher was interested in the characteristics of such a program. So, the next Section will be a discussion on the principles of the IndoMath in-service education program and the participants' perception of the program. (Section 8.2.2).

The next findings in the IndoMath Study are lesson learned from the development research activities during the entire processes of the study, particularly due to the fact that RME is a new theory in Indonesia. Only a few people are familiar with the innovation. Also that there is no curriculum material in Indonesian is based on the RME theory. The IndoMath Study faced dual challenges, i.e., preparing RME exemplary curriculum materials and designing and developing the in-service education program. How the researcher dealt with the challenge is discussed in 8.2.3.

Finally, the section addresses in 8.2.4 the likely implementation of RME in Indonesia in the near future. There are some potential difficulties in the implementation of RME in Indonesia. Some of these are discussed in this section: the provision of RME curriculum materials, the problem from teachers' point of view, and the problem from students' point of view.

8.2.1 Impact on teachers' RME understanding

Since the implementation of mathematics teaching in Indonesia in 1973, several innovations have been introduced, such as *CBSA* (student active learning), module system, and student mastery learning. The efforts to improve teachers' competencies had been conducted under the *PKG* Project (Somerset, 1997).). The publication of over one hundred million copies of textbooks for teachers and students, and the distribution of teaching aids to schools had provided support for the implementation of mathematics teaching (Moegiadi, 1994). Those efforts, however, left only little impact on teachers and students. Teachers' professional competencies remain unsatisfactory and students' achievements remain low (Suryanto, 1996).

Nowadays, we are witnessing a new trend in mathematics education in Indonesia. Many people in the country share common ideas that mathematics teaching should be meaningful for students and it should improve students' mathematical reasoning. These are the messages that come from students, teachers, educators and parents. In response to the concerns, the government tries to improve the curriculum for all schools, including the mathematics curriculum. But the new curriculum will be in effect only as from the academic year 1993/1994. The new mathematics curriculum seems to be in line with constructivism, so that it gives a favorable room for the implementation of Realistic Mathematics Education (Sembiring, 2002; *Matematika Kontekstual, Janjikan Kualitas Pembelajaran*, 2002).

The above description indicates that the IndoMath Study is in line with the current measures taken by the Indonesian Government. Furthermore, the results of study showed an evidence that the IndoMath in-service education program could be used as a good model for professional development for mathematics teachers, particularly in introducing a new approach to teaching. The data indicated that there was a positive change in teachers' professional works. The participating teachers gained knowledge and understanding of RME that enriched their mathematics pedagogy know-how. More specifically, the teachers understood the ideas of RME instruction , such as the emphasis on the importance of using of contextual problems in the instruction (Section 7.4). The results of RCP-Test (Realistic Contextual Problem Test) indicated that the teachers gained knowledge about the role of contextual problems in mathematics instruction (see Table 7.12). Particularly, they were aware that open-ended nature of such problems can trigger interaction among students because one problem could have different correct and possible answers, especially when they use informal mathematics procedures. The increase of participants' scores from pre to posttest showed that most of them were familiar with this important tenet of RME theories. The teachers also became aware of the necessity to give students opportunities to explore their previous experiences and to use informal strategies for building their own mathematical ideas and concepts.

Teachers' use of their knowledge of RME and the corresponding curriculum materials in their mathematics instruction are important aspects of the impacts of the IndoMath in-service education program. Hence the measures of the teachers' stage of concern, teachers' level of use, and the difference in practice indicate the level of the impact of the IndoMath on the teachers' understanding of RME. Therefore, the researcher measured those three variables to evaluate the impact of the IndoMath program.Most of the participants of IndoMath Program indicated that there was a shift in their concern after taking part in the program. In the beginning of the program, they had neither the knowledge of RME nor the interest in RME as a teaching method. Until three months after completing the in-service education, there were indications that they wanted to learn more about the innovation (Section 7.5.1).

As the participants understood the ideas of RME and became familiar with it, they implemented the innovation in their mathematics instruction (Section 7.5.2). Most of them had shifted from the nonusers to those who used the innovation, at least in the orientation level. The teachers who were already in the mechanical level of use indicated that they were in favor of using RME approach because the approach was in accordance with their belief of the ideal model of mathematics instruction and that the approach was potential to increase students' achievement. Those who were at the preparation level of use, indicated that they liked very much the RME exemplary curriculum materials and that they wished to get more materials. Teachers on this level delivered a strong message of the needs for RME lesson materials that covered all the mathematics topics in the curriculum.

There seemed to be a shift in the teachers' mathematics teaching practices toward a meaningful learning (Section 7.5.3). In the observations conducted three months after the end of the in-service education on the teachers' classroom instruction, the researcher found that there was a change from the traditional telling method teacher centered instruction to a more student-centered learning. The teachers tried to organize their lesson in such a way that students had enough time to explore the possible ways for solving the problems, either alone or in-group. They were also more open to different responses from their students.

In summary, the IndoMath in-service program had a promising development in the right direction in achieving it's goals in developing teachers' understanding of RME and preparing them for effective use of RME ideas in their mathematics instruction. The results of the IndoMath Study confirms the same findings reported by van den Berg (2001) that an introductory in-service course with good exemplary lesson materials can support teachers in their professional work by providing them a clear description of the change and accurate 'how-to' advice.

In the following section, the characteristics of the IndoMath in-service education program are discussed.

8.2.2 Principles of effective professional development

There are several principles of effective strategies for developing teachers' professional competencies. Those principles are as follows.

(1) Teachers are the subject and not the object of the professional development.
(2) Teachers must be given the opportunity to learn and reflect new instructional strategies and ideas in the context of their own classroom setting.
(3) Teachers must undergo an instruction using the approaches that closely reflect those to be used in their own classroom.
(4) The professional development should help teachers develop in-depth knowledge of their subject matters as well as pedagogical content knowledge.
(5) Teachers must be provided with sustained time and support for reflection, collaboration, and learning. (See e.g. Loucks-Horsley, et al., 1998; Ball & Cohen, 1996; Borko & Putnam, 1996; Joyce & Shower, 1988, 1995; van den Akker, 1988, 1998).

In addition to the above principles there must be conformity between the purpose of professional development and strategies chosen. Each in-service education program has a specific purpose in line with the teachers' needs and educational demand. Professional development should include a combination of some strategies, such as immersion in inquiry and curriculum implementation, in order to enrich the professional learning of teachers, (Loucks-Horsley, et al., 1998; Higin & Leat, 1997).

In order to be effective, the IndoMath Program has been design on the bases of the above principles. Specifically, the characteristics of the IndoMath are as follows. The program was a 32-hour introductory in-service education that consisted of three main components, namely: two one-day workshops, two classroom practices, and two half-day reflection meetings. In the workshops the participants were given the opportunity to learn RME in several sessions: '*Doing Mathematics*', instruction of RME theories, video presentation of RME lessons, and preparation for classroom practices. The classroom practices provided the teachers with the opportunities to work in pair collaboratively, to teach in turns and to observe each other's instruction. Each pair was two teachers from the same school. The collaboration also covered the preparation of the instruction. The classroom practices were conducted using an RME approach to teaching and RME exemplary lesson materials. It was expected that by doing the classroom practices the participants had experiences of using an RME approach to teaching and materials in a real class setting. The researcher observed the classroom practices, to make a record and to evaluate the practices. The reflection meetings provide the participants with the opportunity to share their experience, discuss the results, and receive suggestions and feedback from the researcher.

The participants of the IndoMath Program indicated that the workshops were in accordance to their expectations. This means that the activities that consisted of 'doing mathematics,' 'instruction on RME theories,' 'video presentation,' and 'preparation for classroom practice' sessions met their hope to gain new knowledge and experiences of mathematics teaching. The participants positively appreciated the organization, the activities, and the materials delivered during the workshops (Section 7.3.1).

The participants also positively perceived the classroom practice for their own benefit. They perceived that the classroom practices with collaboration with colleagues, and using RME exemplary lesson materials were useful sessions during the IndoMath Program (Section 7.3.2).

Furthermore, the participants perceived the reflection meetings in accordance with their expectation in terms of achieving its aims as a room for them to discuss their experiences in classroom practices. The activities in these meetings, such as structured sharing, and feedback and discussion, contributed to the development of their understanding of RME instruction . The participants perceived the reflection meeting as instructive, useful, enjoyable, relevant, and informative. They regarded the structured sharing and the feedback and discussion as one of the most effective sessions during the IndoMath in-service education (Section 7.3.3).

The important finding of the IndoMath Study is that professional development program should provide facilities that enhance the participants' content and pedagogical knowledge in a conducive environment that supports collaboration and reflection. The data of the IndoMath study (see Sections 7.4 and 7.5) confirmed the findings reported by Fennema and Franke (1992) and McLaughin's (1990), that there is an impact of teachers' content knowledge to their instructional practice (cf. Swafford, et al., 1999). However, the findings reported by Swafford, et al. (1999) indicates that teachers' content knowledge was not the sole factor that contributes to the difference in practice. Another factor seems to be the availability of exemplary lesson materials with procedural specification that give clear image to execute the lesson in practice. In the IndoMath program, the workshops provide the participants with opportunities to be involved in an intensive learning of mathematics, whereas the others activities gave the participants opportunities for collaboration and reflection. All activities in the IndoMath program served as catalysts for transforming new knowledge into mathematics instructional practice.

8.2.3 Development research in the IndoMath study

One of the issues in the 'traditional' research approach is that they give little contribution to overcome educational problems. The solutions proposed by most of the researches are too narrow to be meaningful, too superficial to be instrumental, and too artificial to be relevant, and they usually come too late to be of any use (van den Akker, 1999). It is also the case in Indonesia. Many research findings in Indonesia did not touch the reality of educational problems. The consequence of this circumstance is that many research reports stay untouched on the education institutions library's bookshelves for most of the time (Hadi, 2000).

The IndoMath Study gives a good experience of how one of the problems in education can be dealt with by applying development research approach. Mathematics teaching practice in Indonesia is dominated by narrative methods that is teaching as telling, and so giving little effect to students' mathematics reasoning. This problem, in fact, can be solved using an approach of several stages, involving context analysis, development and evaluation of the intervention, and evaluation of effectiveness. The result of the context analysis was the suggestions for developing the mathematics teachers' competencies using a sort of professional development program. The program was to introduce a new method of teaching and to develop curriculum materials to support teachers in their comprehension of the new ideas. The development and evaluation stages resulted in a model of forum that appeared to be effective to address the issue of improving teachers' competencies. The results of the evaluation of effectiveness indicated that there were some impacts of the intervention to the target learners. Hence the IndoMath program has given real contribution to the change in mathematics teaching practice from teacher-centered to more student-centered learning.

The IndoMath Study can be seen as an illustration of Plomp's 'theory of development' in development research (see Figure 8.1).

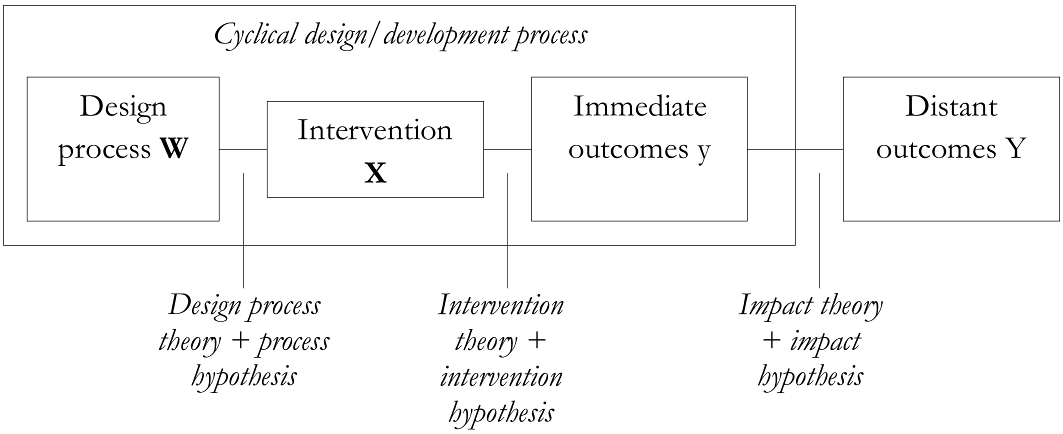

Figure 8.1:
'Theory of development' in development research (Plomp, 2002)

According to Plomp (2002) such a development model implies several theoretical assumptions:

- (intervention) *design process theory*: if we organize the designing of the intervention according the process W, then we expects that the resulting intervention will have characteristics X (*process hypothesis*: W => X);
- *intervention theory*: intervention X leads to the expected and desired immediate outcomes (*intervention hypothesis*: X => y);
- *impact theory*: the immediate outcomes y are expected to leads to the desired distant outcomes (*impact hypothesis*: y => Y).

In this development model, rejection of one of the hypotheses should be seen as 'failure' of the underlying theory and demands redesign of the intervention (Plomp, 2002).

Along the processes of the IndoMath Study the researcher understood how the data illustrated that theory of development. The planned *intervention* was an in-service education to introduce RME instructional approach and to develop instruction of junior high school mathematics, using the exemplary lesson materials, provided by the researcher. The designing process followed the principles of effective professional development. Therefore, the researcher had to put those principles into practice and evaluate its quality in term of validity, practicality and effectiveness. The intervention comprised several activities in workshops (consisted of several sessions, namely doing mathematics, instruction on RME theory, video presentation, and preparation of classroom practice), collaborative classroom practices, and reflections meetings. The reflection meetings were conducted to provide opportunities for the structured sharing and the feedback and discussion activities. Those activities were designed to support teachers in learning the RME, both its theory and practice (immediate outcomes). The evaluation during development process was carried out to find out whether the intervention program needed any revision. (During the IndoMath study several tryouts and revisions to in-service program and RME lesson materials were made). It is hypothesized that, in the long run, the immediate outcomes (i.e. teachers who understand RME and have practiced it in their classrooms) will result in a successful implementation of RME in Indonesian. However, investigating the validity of the impact hypothesis is beyond the scope of this study. Nevertheless, the results of the Indo Math study indicates that the theory of development proposed by Plomp's (2002) is applicable to the educational development in Indonesia. Many problems in education in Indonesia can be approached using this theory.

There is a possible conflict of interest among the various roles of the researcher. A triangulation can be used to overcome this kind of problems. Triangulation is the application and combination of several research methodologies in the study of the same phenomenon. By combining multiple observers, theories, methods, and empirical materials, the researchers can hope to overcome the weakness or intrinsic biases and the problems that come from single method, single-observer, single-theory studies (Denzin, 1994). In development research project, triangulation seems to be an important aspect (see e.g. Nieveen, 1997). During development and evaluation processes of the IndoMath study, different groups of JHS mathematics teachers participated and various data collection methods and procedures were applied (see tables 5.1, 6.1 and 7.1). The applications triangulation enhanced the reliability and internal validity of the findings (Nieveen, 1997; Miles & Huberman, 1994).

In the IndoMath study, the researcher had a mix role as a trainer and an evaluator for the same study, at the same time. As the trainer, the researcher wanted that the in-service program were achieved its goals. On the other hand, as an evaluator the researcher has to be objective. To overcome this dilemma, the researcher assigned a mathematics teacher educator as the assistant researcher, during the three field-works in Indonesia (from 1999 until 2002). The IndoMath study was also involved the target learners from the very beginning. The researcher was accompanied by five experienced JHS mathematics teachers who acted as the participants (and critical friends) of the in-service program in the first tryout, and then became assistant researchers in the second round of fieldwork in Indonesia. As results of their role in the study, the revision of the in-service course after the first tryout, although decided by the researcher, was strongly influenced by their comments and suggestions (Section 5.4.5).

The IndoMath study was challenged by the lack of RME curriculum materials in Indonesian and for the Indonesian context. Therefore, the development of curriculum material was also the main concern in the IndoMath study. Although this study had not resulted in a local instructional theory for a certain mathematics concept for junior high school level, from the process of adaptation of RME curriculum materials from MiC to the Indonesian context lessons are learned about how the adaptation can be handled. This aspect is discussed in the following section.

8.2.4 Indonesia RME: Is it realistic? *)

The orientation of education in Indonesia has characteristics: tend to treat students as objects, teacher role as the highest holder of the authority of science and indoctrinate, the materials are subject-oriented, and education management centralized in nature (Zamroni, 2000). According to Zamroni (2000) this type of education orientation isolates education from real life situation outside the schools, less relevant to the work needs, and too concentrated on the intellectual development that is not in accordance with human dignity and integrity. He

*) This section is rewritten (with some adjustment) from Hadi, (2001a).

proposes a new paradigm of education which is emphasizing on learning rather than on teaching, and education should be organized within flexible structure because of the premise that students are individual who have special character and who are autonomous. Moreover, education should has characteristic as a continued process and always interacts to human life and environment (Zamroni, 2000). In the framework of the above new paradigm, this research concludes that the theory of RME is relevant to the current thinking of education reform movement, particularly in mathematics education.

The implementation of RME in Indonesia is expected contribute to the improvement of students' achievement and performance in mathematics. From the attitude aspect, by using RME approach in mathematics instruction, we can expect that students will have the following characteristics (see Sections 5.3.2 and 5.3.3):

- during the lesson they are active in discussion, asking questions and delivering their arguments, and actively involve in searching for additional resources for their own learning;
- they are able to work as a team by creating learning groups;
- they have democratic behavior that is, they dare not only to deliver and defense their thoughts, but also to except the ideas from others;
- they have a high confidence in taking a decision.

However, the implementation of RME in Indonesia has some potential problems. First, the implementation cannot be done without the availability of RME curriculum materials that are suitable for characteristics of the Indonesian contexts. To develop such kind of materials will take a long time and need a series of systematic efforts such as:

- thought experiments (the developer designs RME lesson materials relevant to the current curriculum);
- small scale tryout by the developer himself;
- revision based on results of small scale tryout;
- tryout by the teachers in their own classroom setting;
- revision based on the results of classroom tryout.

If all the above evaluation and revision activities to the drafts of RME curriculum materials are well done, we can expect the result that is in the form of user-friendly materials for teachers as well as students. However, it is not guaranteed that the materials will directly improve students' mathematics achievement. The improvement of students' mathematics performance is not only influenced by the use of curriculum materials. There are several others factors that influence the success of the implementation, such as the goal of the instruction, content, learning activities, role of teachers, evaluation, and local situation (such as time constraint and class size). The impact of the use of RME lesson materials has to be proven in the course of time. In other words, we cannot expect immediate effects of RME curriculum materials to students' performance in a short period of time.

The development of RME curriculum materials should be grounded in the learning route of the way of thinking of students. Certain aspects should be considered such as the contexts chosen must be recognizable by the students, the language used must simple and clear, and pictures must support the mathematics concepts.

In case the efforts to develop RME curriculum materials for Indonesian are not realistic in a short period of time, an alternative can be chosen, that is adapting materials available from other contexts. This could be easier. However, the following aspects of adaptation should be taken into account:

- Not all the contexts can be adapted due to cultural differences and students' background. Even if the contexts are known by students, their previous experiences could influences their approach to solving the problems;
- If the context is perceived by the developer to be well known for most of Indonesian children and so potential to be adapted, the next effort is the translation of the text embedded in the contexts which should deliver the same meaning in order to avoid students' confusion in dealing with the problems;
- As much as possible the contexts should go without saying for the students. It is particularly important due to the fact of big class size in Indonesia (an average of 40 to 45 students per class). If the problems need oral explanation from the teacher, they have potential to distract the learning process, because too much time is used to narrate the problems before students engage in mathematical activity;
- Pictures have a potential role in attracting students towards meaningful learning. However, sometimes it can mislead students due to different interpretation between what is intended by the developer and the user.

The above conclusion confirms the same findings reported by de Figueiredo (1999) about the difficulties of ethnic minority students solving mathematical contextual problems. She mentioned three potential obstacles that were faced by the students from minority groups in the Netherlands in solving contextual problems, namely students' experiences, context influence on problem solving, and the familiarity with the context used.

The second potential obstacle in the RME implementation in Indonesia stems from teachers' point of view. Most of the teachers have positive perception about RME, because it is viewed as an alternative method that is needed for the current effort of reform movement in mathematics education. On the implementation of RME in Indonesia there are two types of teachers: those who support it, because they believe that RME is what they are really need, and those who do not support it, because they think that RME cannot be used for all mathematics topics in the curriculum.

In the try out, those who supported the implementation of RME in schools argued that mathematics teaching should be managed like as it is intended by RME. In fact, they had such kind of perception of the ideal model of teaching (Section 7.5.1). They said that they need this type teaching approach so that they could see students' process of learning of reinvention of mathematics ideas and concepts. RME also brings hope to teachers about the usefulness of mathematics. As already stated, there are many criticisms of present mathematics teaching in schools as it is considered meaningless because it is not related to every day life problems. The present teaching of mathematics in Indonesia tends to be very mechanistic: mathematics teachers tend to narrate mathematics formulas and procedures to their students. In this circumstance, the introduction of RME to the country can be considered useful to improve the situation in changing the current mechanistic teaching to be meaningful for both teachers and students.

On the other hand, those who are not fully supporting the implementation of RME in schools are thinking that this innovation is the same as other innovations that came before. Innovations come and go without any positive impacts. There remain many problems even until today. This fear and scepticism is also come to teacher's mind, particularly when they consider that one of RME tenets is that the teacher should be able to guide students in their process of learning to find mathematics concepts by themselves. They are questioning whether RME approach can really be used in the schools. Such a tenet of RME teaching is not easy to realize in the classroom, especially when considering the variety of students and teachers' ability, and they are not used to this kind of method. As a consequence of that perception, the teachers feel more secure if RME is used only for a certain mathematics topic in the curriculum (not for all topics). They are also considering the system of evaluation which is until now still using the centralized national examination using multiple choice problems, which in their point of view is contradictory to the ideas of RME in which students' process of learning is much more important to be assessed.

The third possible obstacle of RME implementation in Indonesia is the change of educational orientation from teacher-centered to student-centered learning. For some students, this is not easy and frustrating. For a long time, the teacher-centered approach has evolved students' attitude to be passive learners. They are used to being spoon-fed by the teachers. They are not used to think in critical way for self-learning. This, in fact, is a serious challenge to RME implementation in Indonesia. The behavior of passive learner is very likely to be a student factor that would hamper the success of the implementation.

The very negative reaction toward the RME lessons that comes from some students could also be caused by teachers' interpretation of one of RME tenets of reinvention process that teacher should totally withdraw their role in the learning process. This extreme change is experienced by student into two categories, *more demanding* (tends to be negative) and *more challenging* (tends to be positive). More demanding is experienced as forcing students to learn and work mathematics that rack their brains. On the other hand, more challenging is experienced as triggering motivation to learn because it is exciting. For the latter category, students' difficulty in dealing with contextual problems is not viewed as a 'ghost' which is always hanging over them (as experience of most Indonesian students if asked about mathematics subject matter), but that is precisely the opposite of the facts.

In summary, the success of RME implementation in Indonesia is, at least, influenced by three aspects:

1. the provision of RME curriculum materials and the implication to mathematics instruction;
2. the change of teachers' belief that teaching mathematics means guiding students to learn and doing mathematics; and
3. the change of students' attitude from passive receiver to active learners who have the ability think mathematically and to do mathematics.

Those three aspects confirm the findings reported by Blum and Niss (1989) about the potential implication of the implementation of mathematics problem solving, modeling, and application in mathematics instructions.

8.3 RECOMMENDATIONS

The IndoMath study was conducted in the Yogyakarta Province, Indonesia, involving 44 mathematics teachers from not less than 18 junior high schools (public and private schools, of urban, sub-urban, and rural areas). Compared to the huge number of schools, students and teachers in Indonesia (see Table 2.3), the sample covered by the IndoMath study is very small. Hence, it is rather unrealistic to expect significant impacts on the current education reform movement in Indonesia. However, as an initial effort of innovation in mathematics education, several findings of the IndoMath study seems to be useful to be considered for policy makers, and for further researches. In Section 8.3.1 the recommendations for policy makers are given, followed by recommendations for further researches in Section 8.3.2.

8.3.1 Recommendations for policy makers

As already mentioned in the discussion part of this chapter, there are two types of teachers in perceiving the implementation of RME, namely those who are supporting the implementation and those who are not fully supporting. The teachers who are not fully supporting the implementation of RME in schools argue (amongst other) that the centralized system of examination using multiple choice problems is not in line to RME principles. They even argue that this kind of examination contradict to RME theory in which students' process of learning is much more important to be assessed. It seems to be relevant for the government to take into account system of examination as a factor that should be considered in every measure in educational reform, especially in implementing RME in Indonesian schools. According to de Lange (1995) changing in mathematics education (such as implementation of new theories, new curriculum) should be followed by changing in assessment. He stated that assessment procedures should do justice to the goals of the curriculum and to the students (de Lange, 1995). The following guidelines for the development of assessment procedures in the Netherlands could be considered by policy makers in Indonesia (de Lange 1987):

- The first and primary purpose of testing is to improve learning and teaching.
- Methods of assessment should enable the students to demonstrate what they know rather than what they do not know.
- Assessment should operationalize all the goals of mathematics education.
- The quality of mathematics assessment is not determined by its accessibility to objective scoring.
- The assessment tools should be practical.

Participants of the IndoMath Program also mentioned three potential obstacles that should be considered by the government in the implementation of RME. The possible obstacles are: the difficulty in preparing or developing RME curriculum materials that cover the whole curriculum, the limitation of the budget for the reproduction of the student book and the teacher guide, and the need for additional time allocated for mathematics instruction. (For most of them 6 periods per week is not adequate). Those three problems can only be solved if the Indonesian government is willing to revise the current mathematics curriculum to become in favor of RME. There should be government commitment in the implementation of RME. In other words, the decision for implementing RME should not be left to the teachers alone. Building commitment for change, and ownership of the change at different levels, is considered critical and crucial (Verspoor, 1989; Ware, 1992). No major curriculum reform should be attempted if the need for reform is not clearly recognized by the stakeholders in the reform process (Ware, 1992).

At the moment and the coming years development research seems to be more relevant in Indonesia after the Regional Autonomy Law No. 22 of 1999 endorsed by DPR (House of Representatives) (*Di Era Otonomi, Mutu Pendidikan akan Hadapi Masalah Besar*, 2000). One of the consequences of this law is that the central government gives the authority and responsibility for education to regional governments (district and city governing bodies). The challenge faced by the regional government is whether they are ready to receive those responsibilities. There are 33 responsibilities to be delivered to regional governments in education. Some of them are the responsibility for: determining local content of curriculum, developing standard of competencies, preparing school textbooks, and using ICT for educational management. The study conducted by the Center of HRD (Human Resources Development) in three provinces, West Java, Bali, and North Sumatra, finds that that the education governing bodies in those provinces are pessimistic and in doubt whether they will be able to fulfill the responsibilities (*Menjelang Penerapan Otonomi Daerah, Jadikan Diklat Depdiknas Lembaga Penjamin Mutu*, 2000). Hence, there is a need for support for the regional education institutions to develop and apply research approaches that are relevant for regional contexts and that are promising in solving educational problems, especially in preparing the regional task forces to overcome the current and the future challenges. In this matter, development research seems to be a promising alternative, because it can narrow the gap between theory and practice.

8.3.2 Recommendations for further research

There were evidences of short-term impacts of IndoMath in-service program on teachers' understanding of RME. It may be interesting to study the long-term impacts of the program especially related to the use of RME ideas and materials on mathematics instruction. The three aspects of the use of innovation, namely the teachers' stage of concerns, the levels of use, and the changes in practice, can be investigated further after years introducing RME to Indonesian JHS mathematics teachers and implementation at schools.

The main reason for researching those aspects is that the implementation of innovation takes time, and research is needed to explore the change process toward RME to take place. The Concern-Based Adoption Model (CBAM) could be a good model in investigating the change process (Hall & Hord, 2001). According to this model, there are several elements in the change process, namely the individuals who implement a change, the change facilitators who provide assistance, and the resource systems from which support are drawn. The change facilitators can probe using three CBAM diagnostic tools: Stage of Concern, Levels of Use, and

Innovation Configuration. The resulting information can be used to match resources with the needs of users and thus provide interventions. Surrounding this system are the environmental factors, such as the school, district, community, and government that influence the change process in any setting (Hall & Hord, 2001).

The IndoMath Study has provided information about the change process from the perspective of the teachers (the individuals who implement a change). In other to get the whole ideas of the implementation of RME in Indonesian schools, further research can be done to the environmental factors as mentioned above. New ideas or innovations in education sometimes run counter to existing policies within the organization (Guskey, 2000). Teachers attempting to implement a new instructional approach like RME may discover that certain school policies contradict their effort. For example, teachers' effort to implement RME learning practices could be thwarted by school's policy to increase students' performance in Ebtanas (National Leaving Examination) by giving them tricks to answer mathematics problems (as much as possible) in short time and so avoiding the understanding. Supportive or conflicting environmental factors are important aspects to be investigated further in implementing change. Examples of research questions to these aspects such as:

- What is the key organizational unit for making change successful in the school?
- What are the materials (resources) necessary for the successful of implementation?
- What are the roles of school principal in the change process?
- What are the roles of high-level-administrators in the change process?
- What are the roles of pre-service teacher education in the change process?

Having been aware of the importance of the role of mathematics teachers pre-service education, as mentioned in the last question above, this research is interested in focusing the problem on the institutions that are responsible for preparing (prospective) teachers. Research could be needed to investigate the possibility to integrated RME in relevant courses in the curriculum of mathematics teacher training institutions (university's undergraduate level). In the mathematics education curriculum of *FKIP* (Faculty of Educational Sciences and Teacher Training) and *FPMIPA* (Faculty of Mathematics and Sciences Education) there are courses of *Calculus*, *Number Theory*, and *Differential Equations*, among others. How can RME approach be integrated to those courses? The conceptualization of RME approach has been investigated in the teaching and learning of *Ordinary Differential Equations* at Ewha Womans University, Korea. The result of this study indicates that RME design for a *Differential Equations* course can be successfully adapted to the university level (Kwon, 2002). By integrating RME in several relevant courses of the *FKIP* and *FPMIPA* curriculum we can expect that prospective mathematics teachers will have the ability to impelement RME theory before they start their professional works.

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ENGLISH SUMMARY

EFFECTIVE TEACHER PROFESSIONAL DEVELOPMENT FOR IMPLEMENTATION OF REALISTIC MATHEMATICS EDUCATION IN INDONESIA

INTRODUCTION

From the beginning of the implementation of mathematics teaching in schools (since 1973) many efforts have been done by the Indonesia government to improve the quality of mathematics instruction such as the development of curriculum materials, pre and in-service education for teachers, and provision of media of instruction. However, those endeavors have not yet resulted in satisfactory impacts at student level. Students' achievement in national leaving examinations remains low, and in the international comparative study like TIMSS Indonesian students have poor performance (Mullis et al., 2000). Even when comparing with their South East Asian neighbors (such as Singapore, Malaysia, and Thailand) Indonesian students perform relatively low in mathematics and in mastering science and technology. It appears that the implementation of mathematics teaching in Indonesia is far from being successful in achieving its aims.

Being aware of the situation of mathematics education in the country, Realistic Mathematics Education (RME) seems to be a promising approach for improving the teaching and learning of mathematics in Indonesia. In the concept of RME students should be given opportunity to develop their reasoning and logic through exposure of real life or contextual problems. This idea is in line with the current view in Indonesia. If we carefully listen to the messages coming from mathematics teachers in Indonesia, one of their concerns is how to make mathematics teaching relevant for students in dealing with the daily life problems. However, since RME is so new for many people in Indonesia (teachers, teacher educators, curriculum developers, and students) research is needed to investigate whether and how in can be translated and realized for the Indonesian context. This research is needed to reveal necessary components for a successful innovation on both curriculum and teachers' level. Given the willingness of those who are involved in mathematics education, we have reasons to expect a fruitful innovative curriculum for mathematics if we know how to adapt RME to Indonesian context and know what a proper implementation strategy is on the school level. In this matter, teachers are viewed as the key actors in education innovation. They need to be well trained in order to understand the philosophy of RME as reflected by the new curriculum materials and need to have appropriate competencies to put this into practice.

STAGES IN THE INDOMATH STUDY

The **IndoMath** (**In**-service education for **Indo**nesian **Math**ematics teachers) study was conducted through stages of *orientation*, *development and evaluation*, and *semi-summative evaluation*. In the orientation stage, it analyzed the literature on RME and the available RME lesson material relevant to the current Indonesian JHS mathematics curriculum and promising to be adapted to the Indonesian context. This analysis resulted in tentative RME exemplary lesson material adapted from Mathematics in Context (MiC) in Bahasa Indonesia (a student material and teacher guide), and the preliminary design guidelines for the development of in-service education program. Subsequently, in the development and evaluation stage, the adapted RME lesson material and the preliminary model of in-service program were formatively evaluated in the first fieldwork in Indonesia. After the first fieldwork in Indonesia, the activities focused on the reflective analysis of the process and outcomes of formative evaluation to the adapted curriculum material and the in-service model. This reflective analysis resulted in new adapted RME exemplary lesson materials for several other topics, and the revised model of in-service education program, which subsequently were formatively evaluated in the second fieldwork. Finally, in the semi-summative evaluation stage (the third fieldwork in Indonesia), evaluated the effectiveness of the IndoMath program in addressing its goals, namely to make teachers understand and effectively capable using RME lesson materials in their mathematics classes.

RESULTS

The study gave evidence that the IndoMath in-service program could be a good model for professional development efforts for mathematics teachers, particularly in introducing a new way of teaching. The data indicated that there was a positive change in teachers' professional works. They gained knowledge and understanding of RME that enriched their mathematics pedagogy know-how. More specific, the teachers understood the ideas of RME teaching and learning, such as the importance of using of contextual problems in teaching. The results of RCP-test (Realistic Contextual Problem test) gave evidences that the teachers gained knowledge about the role of contextual problems in mathematics instruction. Particularly, they were aware that open-ended nature of such problems can triggered interaction among students because one problem could have different correct and possible answers, especially when they use informal mathematics procedures. The increase of participants' scores from pre to posttest showed that most of them were familiar with this important tenet of RME theories. Teachers became also aware of the necessity to give students opportunities to explore their previous experiences and using informal strategies for building their own mathematical ideas and concepts.

Teachers' utilization of RME knowledge and the curriculum materials in their mathematics instruction appear to be important aspects in assessing the impacts of the IndoMath in-service program. Three aspects were measured, namely teachers' stage of concern, teachers' level of use, and the difference in practice (Guskey, 2000).

Most of the participants of IndoMath Program indicated the shift of their concern before and after the program. In the beginning of the program teachers had no knowledge of RME and so no interest in RME as a teaching method. At the end as well as three months after the program there were indications of they want to learn more about the innovation.

As the participants became familiar with and understood the ideas of RME they utilized the innovation in their mathematics instruction. Most of them had shifted from the nonusers to those who at least in the orientation level to use the innovation. The teachers who already in the mechanical level of use gave indication of their favor to RME because of the innovation is in accordance with their belief of the ideal model of mathematics teaching as well as its potential to increase students' achievement. Teachers who were on the preparation level of use, indicated that they liked very much the RME exemplary curriculum materials and that were in favor of getting more. Teachers on this level had delivered a strong message of the needs for RME lesson materials that cover all the mathematics topics in the curriculum.

There seems a shift in teachers' mathematics teaching practices toward meaningful learning. The observations three months later to teachers' classroom lessons indicated that there was a change from traditional telling method that put the teacher as the center of instruction toward more student centered learning. Teachers tried to organize their lesson such that students had enough time to explore how to solve the problems whether alone or in a group. Teachers also were more open to different responses come from students.

In summary, the IndoMath in-service program had achieved it goals in developing teachers' understanding of RME and preparing them for effective utilization of RME ideas in their mathematics instruction. The results of the IndoMath Study confirms the same findings reported by van den Berg (2001) that an introductory in-service course with good exemplary lesson materials can support teachers in their professional work by providing them a clear image of the change and accurate 'how-to' advice.

CHARACTERISTICS OF INDOMATH IN-SERVICE PROGRAM

The IndoMath Program is a 32 hours introductory in-service education course that consists of three main components: two one-day workshops, two times classroom practice, and two half-days reflection meetings. In the workshops the participants were given opportunity to learn RME in several sessions: doing mathematics, instruction of RME theories, video presentation of RME lesson, and preparation for classroom practice. In the classroom practice the participants worked in a collaborative way with their school colleague (observing each other lesson), and gained experiences of RME teaching in their classroom setting using RME exemplary lesson materials. In the reflection meetings the participants shared their experiences from lesson practice, discussed the results, and received feedback from the trainer.

How could a seemingly 'traditional' in-service course results in a significant impact on teachers' understand of the new method of teaching that is unknown by most of them beforehand? The IndoMath Program has been developed based upon the principles of effective strategies for teacher professional development that resulted from those researches. Those principles are: (1) teachers are the subject and not the object of professional development; (2) teachers must have the opportunity to learn and reflect about new instructional strategies and ideas in the context of their own classroom setting; (3) teachers should be given experiences with teaching approaches that are closely parallel to those to be used in the classroom; (4) teacher professional development should help teachers develop in-depth knowledge of their subject matters as well as pedagogical content knowledge; and (5) teachers must be provided with sustained time and support for reflection, collaboration, and continued learning (see e.g. Loucks-Horsley, et al., 1998; Ball & Cohen, 1996; Borko & Putnam, 1996; Joyce & Shower, 1988, 1995; van den Akker, 1988, 1998).

In addition to the above principles there must be conformity between the purpose of professional development and strategies chosen. Each in-service program has a specific purpose in line with the teachers' needs and educational demand. It is proposed that professional development could include combination of some strategies, such as immersion in inquiry and curriculum implementation, in order to enrich the professional learning of teachers, (Loucks-Horsley, et al., 1998; Higin & Leat, 1997).

The participants of the IndoMath Program indicated that the workshops were in accordance to their expectations. Meaning that the activities that consisted of 'doing mathematics,' 'instruction on RME theories,' 'video presentation,' and 'preparation for classroom practice' sessions met their hope to gain new knowledge and experiences of mathematics teaching. The participants positively appreciated the organization, the activities, and the materials delivered during the workshops.

The participants also positively perceived the classroom practice for their own benefit. They perceived that the classroom practices with collaboration with colleagues, and using RME exemplary lesson materials were useful sessions during the IndoMath Program.

Furthermore, the participants perceived the reflection meetings in accordance to their expectation in term of achieving its aims as a room from them to discuss their experiences in classroom practices. The activities in these meetings, such as structured sharing, and feedback and discussion, contributed to enhance their understanding about RME practices. The participants perceived the reflection meeting as instructive, useful, enjoyable, relevant, and informative. They valued both structured sharing and feedback and discussion as one of the most effective sessions during the IndoMath Program.

The important finding of the IndoMath Study is that professional development program should provide facilities that enhances teachers' content and pedagogical knowledge in a conducive environment that supports collaboration and reflection. The data confirmed Fennema and Franke (1992) and McLaughin's (1990) reports that there is an impact of teachers' content knowledge to their instructional practice (cf. Swafford, et al., 1999). However, teachers' content knowledge was not the sole factor that contributes to the difference in practice. Another factor seems to be the availability of exemplary lesson materials with procedural specification that give clear image to execute the lesson in practice. It can be argued that the workshops that gave teachers opportunities to be involved in an intensive experience in which they focus on learning mathematics content in depth and having sufficient opportunities for collaboration and reflection, all served as catalysts for transforming new knowledge into mathematics lesson practice. This result confirmed the same finding reported by Swafford, et al. (1999).

CONCLUSION

The implementation of RME in Indonesia has some potential problems. First, the implementation cannot be done without the availability of RME curriculum materials that are meeting characteristics of the Indonesian contexts. To develop such kind of materials will take a long time and need a series of systematic efforts such as:

- thought experiments (the developer designs RME lesson materials relevant to the current curriculum);
- small scale tryout by the developer himself;
- revision based on results of small scale tryout;
- tryout by the teachers in their own classroom setting;
- revision based on the results of classroom tryout.

If all the above evaluation and revision activities to the drafts of RME curriculum materials are well done, we can expect the result that is in the form of user-friendly materials for teachers as well as students. However, it is not guaranteed that the materials will directly improve students' mathematics achievement. The improvement of students' mathematics performance is not only influenced by the use of curriculum materials. There are several others factors that influence the success of the implementation, such as the goal of the instruction, content, learning activities, role of teachers, evaluation, and local situation (such as time constraint and class size). The impact of the use of RME lesson materials will also be proven in the course of time. In other words we cannot expect immediate effects of RME curriculum materials to students' performance in short period of time.

The development of RME curriculum materials should be grounded on the learning route of the way of thinking of students. Certain aspects should be considered such as the contexts chosen must well recognized by the students, the language used must simple and clear, pictures must support the mathematics concepts.

In case the efforts to develop RME curriculum materials for Indonesian are not efficient in short period of time, an alternative can be chosen that is adapting materials available from other contexts. This could be easier. However, the following aspects of adaptation should be taken into account:

- Not all the contexts can be adapted due to cultural differences and students' background. Even if the contexts are known by students, their previous experiences could influences their approach to solve the problems;
- If the context is perceived by the developer to be well known for most of Indonesian children and so potential to be adapted, the next effort is the translation of the text embedded in the contexts which should deliver the same meaning in order to avoid students' confusion in dealing with the problems;
- As much as possible the contexts should go without saying. It is particularly important due to the fact of big class size in Indonesia (an average of 40 to 45 students per class). If the problems need oral explanation from the teacher, they have potential to distract the learning process, because too much time is used to narrate the problems before students engage in mathematical activity;
- Pictures have a potential role in attracting students towards meaningful learning. However, sometimes it can mislead students due to different interpretation between what is intended by the developer and the user.

The above conclusion confirms the same findings reported by de Figueiredo (1999) about the difficulties of ethnic minority students solving mathematical contextual problems. She mentioned three potential obstacles were faced by the students from minority groups in the Netherlands in solving contextual problems, namely students' experiences, context influence on problem solving, and the familiarity with the context used.

The second potential obstacle of RME implementation in Indonesia is from teachers' point of view. Most of the teachers have positive perception about RME, because it is viewed as an alternative method that is needed for the current effort of reform movement in mathematics education. Considering implementation of RME in Indonesia there are two types of teachers: those who are supporting, because they believe that this is what they are really need, and those who are not fully supporting the implementation as they consider that RME cannot be used for all the topics in curriculum.

Those who support the implementation of RME in schools argue that mathematics teaching should be managed like as it is intended by RME. In fact, they had such kind of perception of the ideal model of teaching. They said that they need teaching approach so that they can see students' process of learning of reinvention of mathematics ideas and concepts. RME also brings hope to teachers about the usefulness of mathematics. As already stated, there are many criticism of present mathematics teaching in schools as it is considered meaningless because not related to every day life problems. Present teaching of mathematics in Indonesia tends to be very mechanistic: mathematics teachers tend to narrate mathematics formulas and procedures to their students. In this circumstance, the introduction of RME to the country can be considered useful to improve the situation in changing the current mechanistic teaching to be meaningful for both teachers and students.

On the other hand, those who are not fully supporting the implementation of RME in schools are thinking that this innovation is the same as other innovations that came before. Innovations come and go without any positive impacts. There are many problems remain exist even until today. This fear and scepticism is also come to teacher's mind, particularly when they consider that one of RME tenets is that the teacher should be able to guide students in their process of learning to find mathematics concepts by themselves. They are questioning whether RME approach really can be used in the schools. Such tenet of RME teaching is not easy to realize in the classroom, especially when considering the variety of students and teachers' ability, and they are not used to this kind of method. As consequence of that perception, the teachers feel more secure if RME is used only for a certain mathematics topic in the curriculum (not for all topics). They are also considering the system of evaluation which is until now still using the centralized national examination using multiple choice problems that in their point of view is contradict to the ideas of RME in which students' process of learning is much more important to be assessed.

The third possible obstacle of RME implementation in Indonesia is the change of educational orientation from teacher-centered to student-centered learning. For some students this is not easy and frustrating. For a long time the teacher-centered approach has evolved students' attitude to be passive learners. They used to be spoon-fed by the teachers. They are not used to think in critical way for self-learning. This, in fact, is a serious challenge to RME implementation in Indonesia. The behavior of passive learner can be considered as student factor that could hamper the successful of the implementation.

The very negative reaction toward the RME lessons that come from some students could also be caused by teachers' interpretation of one of RME tenets of reinvention process that teacher should totally withdraw their role in the learning process. This extreme change is experienced by student into two categories, *more demanding* (tends to be negative) and *more challenging* (tends to be positive). More demanding is experienced as forcing students to learn and work mathematics that rack their brains. On the other hand, more challenging is experienced as triggering motivation to learn because it is exciting. For the latter category students' difficulty in dealing with contextual problems is not viewed like a 'ghost' which is always hanging over them (as experience of most Indonesian students if asked about mathematics subject matter), but that is precisely the opposite of the facts.

In summary, the success of RME implementation in Indonesia is, at least, influenced by three aspects:

1. the provision of RME curriculum materials and its implication to mathematics instruction;
2. the change of teachers' belief that teaching mathematics means guiding students to learn and doing mathematics; and
3. the change of students' attitude from passive receiver to individuals who have ability to work and to think mathematics.

Those three aspects have confirmed the findings reported by Blum and Niss (1989) about the potential implication of implementation of mathematics problem solving, modeling, and application in mathematics instructions.

DUTCH SUMMARY

EFFECTIEVE PROFESSIONELE ONTWIKKELING VAN DOCENTEN VOOR DE IMPLEMENTATIE VAN REALISTISCH WISKUNDEONDERWIJS IN INDONESIË

INTRODUCTIE

Al vanaf het begin van de implementatie van wiskundeonderwijs (in 1973), heeft de Indonesische regering veel aandacht besteed aan kwaliteitsverbetering, zoals door de ontwikkeling van curriculummateriaal, pre- en in-servicetraining voor docenten en het verschaffen van hulpmiddelen.
Echter, dit streven heeft nog niet geleid tot bevredigende resultaten op leerling-niveau. De nationale examenresultaten van de schoolverlaters blijven laag en uit een internationaal vergelijkend onderzoek zoals TIMSS blijkt dat Indonesische leerlingen relatief slecht presteren, vergeleken met de zuidoost Aziatische buur-landen zoals Singapore, Maleisië en Thailand (Mullis e.a., 2000). Kortom, de implementatie van wiskundeonderwijs in Indonesië blijkt verre van succesvol in het bereiken van de gestelde doelen.

Gezien de huidige situatie, lijkt de aanpak van realistisch wiskundeonderwijs [in het vervolg zal de Engelse afkorting 'RME' worden gehanteerd: Realistic Mathematic Education] veelbelovend voor het verbeteren van wiskundeonderwijs en -leer-resultaten in Indonesië. In de RME-benadering krijgen leerlingen de mogelijkheid, om hun vaardigheden in redeneren en logisch denken te ontwikkelen, daarbij gebruik makend van realistische of contextuele problemen.
Deze benadering komt overeen met de huidige visie in Indonesië. Als je goed luistert naar de Indonesische wiskundedocenten, is één van hun zorgen hoe het wiskundeonderwijs relevant kan worden gemaakt voor leerlingen, dat wil zeggen relevant voor het aanpakken van problemen van alledag.
Echter, omdat RME voor Indonesische docenten, 'teacher educators', curriculum-ontwikkelaars en leerlingen een erg nieuw concept is, is onderzoek nodig om na te gaan of en hoe een aanpak zoals die van RME aangepast en gerealiseerd kan worden in Indonesië.

Zulk onderzoek moet uitwijzen wat nodig is voor een succesvolle innovatie zowel op curriculum- als op docentniveau. Gezien de bereidheid van de betrokkenen bij het wiskundeonderwijs, zijn er redenen om aan te nemen dat er een vruchtbaar innovatief curriculum voor wiskundeonderwijs kan komen, zodra we weten hoe het RME-concept aangepast kan worden aan de Indonesische context, alsook wat een geschikte implementatiestrategie is op schoolniveau. In dit verband worden docenten gezien als de sleutelfiguren bij onderwijsvernieuwing. Ze moeten goed getraind zijn, zodat ze de visie die aan RME ten grondslag ligt en die wordt gereflecteerd in het nieuwe onderwijsmateriaal begrijpen. Ook moeten zij de juiste competenties hebben om RME in praktijk te kunnen brengen.

FASES VAN DE INDOMATHSTUDIE

De IndoMathstudie (In-servicetraining voor Indonesische wiskundedocenten) is een studie betreffende in-service training in de RME-benadering voor Indonesische wiskundedocenten. De studie is opgebouwd uit de fases oriëntatie, ontwikkeling en evaluatie, gevolgd door een semi-summatieve evaluatie. In de oriëntatiefase is een literatuuronderzoek uitgevoerd over RME. Ook is bestaand RME-lesmateriaal bestudeerd, dat relevant is voor het wiskundecurriculum van de huidige Indonesische junior highschool (JHS) en waarvan verwacht werd dat het zou passen in de Indonesische context. Deze analyse heeft geresulteerd in RME-voorbeeld-lesmateriaal (leerlingenmateriaal en een docentenhandleiding) in de Indonesische taal ontleend aan de lesmethode 'Mathematics in Context' (MiC), die is ontwikkeld in de Verenigde Staten. Daarnaast zijn voorlopige ontwerprichtlijnen voor de ontwikkeling van het nascholingsprogramma opgesteld. Daaropvolgend, in de ontwikkel- en evaluatiefase, zijn het lesmateriaal en de voorlopige ontwerprichtlijnen formatief geëvalueerd tijdens een eerste veldexperiment in Indonesië. Na dit eerste veldexperiment bestonden de projectactiviteiten aanvankelijk uit een reflectieve analyse van het proces en de uitkomsten van de formatieve evaluatie van het curriculummateriaal (aangepast uit MiC) en van het in-service model. Deze analyse resulteerde in bijstelling van het curriculummateriaal, in nieuw RME-voorbeeldmateriaal voor verscheidene andere onderwerpen en in een herzien model van het in-service onderwijsprogramma. Deze zijn alle in een tweede veld-experiment formatief geëvalueerd. Tenslotte is in de semi-summatieve evaluatiefase (de derde periode van veldwerk in Indonesië) de effectiviteit van het

IndoMathprogramma geëvalueerd, teneinde vast te stellen of de doelen van het project zijn gerealiseerd, namelijk of docenten begrijpen wat RME is en of zij in staat zijn RME-lesmateriaal effectief in hun wiskundelessen te hanteren.

RESULTATEN

Het onderzoek wijst uit dat het IndoMath in-serviceprogramma een goed model kan zijn om de professionele ontwikkeling van wiskundedocenten te stimuleren, in het bijzonder bij de introductie van een nieuwe onderwijsbenadering. De gegevens laten zien dat er een positieve verandering optreedt in de activiteiten van de docenten. De verworven kennis en het begrip van RME heeft hun wiskundedidactische repertoire verrijkt. Meer specifiek, de docenten begrepen de principes van het lesgeven volgens de RME-benadering, zoals het belang van het gebruik van problemen met een rijke context. De resultaten van de RCP-toets (Realistic Contextual Problem test) wezen uit dat de kennis over de rol van contextrijke problemen in het wiskundeonderwijs was toegenomen. Docenten waren zich er met name van bewust dat het niet vast omschreven karakter van deze problemen interacties tussen leerlingen kan bevorderen, aangezien meerdere antwoorden correct en mogelijk kunnen zijn. Dit gold vooral als er gebruik wordt gemaakt van informele wiskundeprocedures. De hogere scores van de deelnemers op de posttest in vergelijking met de pretest laat zien dat de meesten zich dit belangrijke principe van de RME-theorie eigen hadden gemaakt. Docenten zijn zich ook bewust geworden van de noodzaak om leerlingen de mogelijkheid te geven hun voorgaande ervaringen verder te onderzoeken en informele strategieën te gebruiken om hun eigen wiskundige ideeën en concepten te ontwikkelen.

Het benutten door docenten van kennis van RME en het gebruik van het curriculummateriaal bij hun lessen, blijken belangrijke aspecten te zijn bij het meten van het effect van het IndoMath in-serviceprogramma. Er zijn drie aspecten onderzocht, namelijk de mate van betrokkenheid van de docenten, de mate van gebruik van het RME-materiaal, en verschillen in toepassing van het materiaal (Guskey, 2000).

De meeste deelnemers aan het IndoMath-programma gaven te kennen dat er een verandering is opgetreden in hun houding ten opzichte van het programma. Aanvankelijk hadden de docenten geen kennis van RME en dus ook geen interesse in RME als lesmethode. Aan het eind van het programma, evenals drie maanden daarna, waren er aanwijzingen dat ze meer wilden leren over de innovatieve lesmethode.

Naarmate de docenten die deelnamen aan het IndoMath-programma vertrouwd raakten met de principes van RME, gebruikten ze deze vaker bij hun wiskunde-lessen. De meeste van hen verschoven van de categorie niet-gebruikers naar de categorie van docenten die zich 'minimaal wilden oriënteren op de vernieuwing'. De docenten die al behoorden tot de 'mechanistische' gebruikers van RME zeiden een voorkeur te hebben voor deze benadering, aangezien het voldoet aan hun beeld van het ideale model voor wiskundeonderwijs, en omdat het de potentie heeft de prestaties van de leerlingen te verbeteren. De docenten die in de voorbereidingsfase verkeren, gaven aan dat ze het RME-voorbeeldmateriaal erg interessant vonden en dat zij graag meer materiaal wilden hebben. Docenten op dit gebruikersniveau lieten nadrukkelijk merken dat er behoefte is aan RME-lesmateriaal dat alle onderwerpen van het wiskundecurriculum dekt.

Er lijkt bij de deelnemers aan het Indomathprogramma in de praktijk van hun wiskundeonderwijs een verschuiving richting betekenisvol leren op te treden. De observaties drie maanden later in de klassen van de docenten die aan IndoMath deelnamen lieten een verandering zien van de traditionele 'chalk and talk' lesmethode in de richting van een lesmethode die meer leerlinggericht is. Docenten probeerden hun lessen zo in te richten, dat leerlingen genoeg tijd hadden om zelf te ontdekken hoe een probleem op te lossen, al dan niet individueel of in groepjes. Ook stonden docenten meer open voor afwijkende antwoorden van leerlingen.

Samengevat, het IndoMathnascholingsprogramma heeft een veelbelovende ontwikkeling doorgemaakt in de richting van het bereiken van zijn doelen, namelijk dat docenten RME begrijpen en voorbereid zijn de RME-principes effectief toe te passen in hun wiskundelessen. De resultaten van het IndoMathonderzoek bevestigen de bevindingen zoals beschreven door Van den Berg (2001), namelijk dat een in-servicecursus met goed voorbeeldlesmateriaal docenten professioneel kan ondersteunen, door ze een duidelijk beeld van de gewenste verandering en goede handelingsaanwijzingen te geven.

KENMERKEN VAN HET INDOMATH IN-SERVICEPROGRAMMA

Het IndoMathprogramma is een 32-urige inleidende nascholingscursus, bestaande uit drie hoofdcomponenten: twee workshops van een dag, twee keer praktijk-oefening in de klas en twee reflectiebijeenkomsten die elk een dagdeel duren.

Tijdens de workshop kregen de deelnemers in een aantal sessies de gelegenheid RME te leren en te ervaren: het doen van wiskunde, instructie in RME-theorieën, een videopresentatie van een RME-les en voorbereiding op de klassenpraktijk. Bij het toepassen in de klas, werkten de deelnemers samen met een collega (het observeren van elkaars lessen), en deden ervaringen op met RME-lesgeven in de eigen setting van hun klaslokaal, gebruik makend van het RME-voorbeeldmateriaal. In de reflectiebijeenkomsten wisselden de docenten de ervaringen die ze opgedaan hadden in de lespraktijk uit, discussieerden ze over de resultaten en ontvingen ze feedback van de opleider.

Hoe kan een schijnbaar 'traditionele' nascholingscursus een significante invloed hebben op het begrip van docenten van een nieuwe lesmethode die vooraf bij de meesten onbekend is? Het IndoMathprogramma is gebaseerd op principes waarvan uit onderzoek is gebleken dat het effectieve leerstrategieën voor de professionele ontwikkeling van docenten zijn. Deze principes zijn: (1) docenten zijn het onderwerp (subject) en niet het object van professionele ontwikkeling; (2) docenten moeten de mogelijkheid hebben om in de setting van hun eigen klas nieuwe instructiestrategieën te leren en daarop te reflecteren; (3) docenten moeten ervaringen met de aanpak van instructie krijgen aangereikt die vrijwel parallel zijn aan het lesgeven zoals zij dat zelf in hun eigen klassensituatie moeten gaan doen; (4) professionele ontwikkeling moet erop zijn gericht dat de docent zowel grondige kennis over het desbetreffende onderwerp opdoet, alsook vakdidactische kennis; en (5) docenten moeten extra tijd en ondersteuning krijgen om te kunnen reflecteren, samenwerken en hun leren na de nascholingactiviteit voort te zetten (zie bv. Loucks-Horsley, e.a., 1998; Ball & Cohen, 1996; Borko & Putnam, 1996; Joyce & Shower, 1988, 1995; Van den Akker, 1988, 1998).

In aanvulling op bovenstaande principes: het doel van de professionele ontwikkeling en de gekozen strategieën moeten op elkaar afgestemd zijn. Elk goed nascholingsprogramma heeft specifieke doelen, die overeenkomen met de behoeften van de docent en de onderwijskundige vraag. Verondersteld wordt dat professionele ontwikkeling om een combinatie van meerdere strategieën vraagt, waaronder verdieping in onderzoek en curriculumimplementatie om het professioneel leren van docenten te verrijken (Loucks-Horsley, e.a., 1998; Higin & Leat, 1997).

De docenten die hebben deelgenomen aan het IndoMathprogramma gaven aan dat de workshops voldeden aan hun verwachtingen. Dat houdt in dat de activiteiten die werden aangeboden tijdens de sessies, zoals 'het doen van wiskunde', 'instructie in RME theorieën', 'videopresentatie', en 'voorbereiding op de praktijk van de klas' hun de gelegenheid gaven nieuwe kennis en ervaringen met betrekking tot wiskundeonderwijs op te doen. De deelnemers hadden waardering voor de organisatie, de activiteiten en het tijdens de workshop aangeboden materiaal.

Ook hebben de deelnemers de praktijkoefening positief ervaren. Ze waren van mening dat het samenwerken met collega's en het gebruik van RME-voorbeeldmateriaal nuttige sessies van het IndoMathprogramma waren.

Verder gaven de deelnemers aan dat ook de reflectiebijeenkomsten aan de verwachtingen voldeden, vooral waar het gaat om het bereiken van de doelstelling ruimte te creëren voor discussie over ervaringen met de praktijkoefeningen in de klas. De activiteiten in deze bijeenkomsten, zoals het gestructureerd uitwisselen van ervaringen met feedback en discussie, droegen bij aan een beter begrip van toepassing van RME in de praktijk. De deelnemers ervoeren de reflectiebijeenkomsten als leerzaam, nuttig, prettig, relevant en informatief en waardeerden ze als een van de meest effectieve sessies van het IndoMathprogramma.

Een belangrijke conclusie van de IndoMath studie is dat een programma voor professionele ontwikkeling moet plaatsvinden in een omgeving waarin samenwerking en reflectie worden gestimuleerd, opdat verbetering van de inhoudelijke en (vak)didactische kennis van docenten kan worden gerealiseerd. De data bevestigen de conclusies van Fennema en Franke (1992) en van McLaughin's (1990), dat de inhoudelijke kennis van docenten van invloed is op de door hen gehanteerde wijzen van lesgeven (vgl. Swafford, e.a. 1999). De inhoudelijke kennis van de docent is echter niet de enige factor die verschil uitmaakt. Een andere factor lijkt de beschikbaarheid van voorbeeldlesmateriaal te zijn, met daarin specifieke procedures, die een duidelijk beeld geven van de uitvoering van de les in de praktijk. Op basis van dit onderzoek kan worden gesteld dat alle workshops die de docenten mogelijkheden gaven nieuwe wiskunde-inhouden en benaderingen intensief te ervaren en waarbij zij voldoende gelegenheid voor samenwerking en reflectie kregen, als katalysatoren werkten voor het toepassen van die nieuwe kennis in de praktijk van de wiskundeles. Dit resultaat bevestigt de bevindingen van Swafford, e.a. (1999).

CONCLUSIE

Er is een aantal potentiële problemen bij de implementatie van RME in Indonesië. Ten eerste is implementatie onmogelijk zolang er geen RME-curriculummateriaal beschikbaar is dat past bij de Indonesische context. De ontwikkeling van dat materiaal zal veel tijd kosten en vergt een reeks van systematische onderzoeks- en ontwikkelingsactiviteiten:

- gedachtenexperimenten (de ontwikkelaar ontwerpt RME-lesmateriaal, relevant voor het huidige curriculum);
- kleinschalig beproeven van het RME-lesmateriaal door de ontwikkelaar zelf;
- revisie gebaseerd op de resultaten van die kleinschalige try-out;
- beproeven door docenten in de setting van hun eigen klas;
- revisie op basis van de resultaten van de try-out in de klas.

Als alle bovenstaande evaluatie- en revisieactiviteiten goed zijn uitgevoerd, mag worden verwacht dat het resulteert in gebruiksvriendelijk materiaal voor zowel docent als leerling. Dat is echter nog geen garantie dat de materialen direct leiden tot een verbetering van de prestaties van de leerlingen, omdat deze niet alleen worden beïnvloed door het curriculummateriaal. Er zijn meerdere factoren die van invloed zijn op het succes van de implementatie, zoals de doelstellingen en inhouden van het onderwijs, de leeractiviteiten, de rol van de docent, evaluatie en de situationele factoren (zoals klassengrootte en tijdslimiet). Het effect van het gebruik van het RME-lesmateriaal kan daarom pas worden aangetoond op langere termijn. Met andere woorden: er kan op korte termijn geen onmiddellijk effect worden verwacht van het RME-curriclummateriaal op de prestaties van de leerlingen.

Bij de ontwikkeling van RME-curriculummateriaal moet rekening gehouden worden met hoe de leerlingen denken en leren. Aspecten waarop moet worden gelet zijn bijvoorbeeld: de keuze van de contexten (deze moeten herkenbaar zijn voor de leerlingen), het taalgebruik (dat eenvoudig en duidelijk moet zijn), en de plaatjes (die de wiskundige concepten moeten ondersteunen).

Als men er niet in slaagt op korte termijn RME-curriculummateriaal voor Indonesië te ontwikkelen, kan gekozen worden voor een alternatieve aanpak, namelijk het aanpassen en bewerken van bestaand materiaal dat al ontwikkeld is in andere landen. Daarbij moet dan wel rekening worden gehouden met de volgende aspecten:

- Vanwege verschillen in cultuur en de achtergrond van leerlingen komt niet elke context in aanmerking voor aanpassing. Maar ook als de context herkenbaar is voor leerlingen, kunnen hun eerdere ervaringen de manier waarop ze het probleem aanpakken beïnvloeden.
- Als een context door de ontwikkelaar wordt gezien als 'herkenbaar' voor de meeste Indonesische kinderen, en dus in aanmerking komt voor aanpassing, is het belangrijk dat de vertaling van de tekst die de context beschrijft dezelfde betekenis blijft houden. Dit is noodzakelijk om verwarring te voorkomen bij de leerlingen wanneer zij het wiskundeprobleem proberen op te lossen.
- Een context moet voor de leerlingen zo vanzelfsprekend mogelijk zijn. Dit is uitermate belangrijk, gezien de omvangrijke klassengroottes in Indonesië (een gemiddelde van 40 tot 45 leerlingen per klas). Als mondelinge uitleg van de docent noodzakelijk is voor het oplossen van het probleem, kan dat 'afleiden van' het leerproces, doordat er veel tijd verloren gaat aan de uitleg van de opdracht, voordat de leerlingen met de activiteit kunnen beginnen.
- Plaatjes kunnen leerlingen aanzetten tot betekenisvol leren. Soms kunnen ze echter verwarrend werken voor de leerlingen, doordat ze als 'gebruikers' de bedoeling ervan anders interpreteren dan de ontwikkelaar.

Bovenstaande conclusie komt overeen met de bevindingen van Figueiredo (1999) over de moeilijkheden van allochtone leerlingen bij het oplossen van wiskunde-problemen met een rijke context. Ze noemt drie mogelijke obstakels waar allochtone leerlingen in Nederland mee te maken hebben, namelijk hun ervaringen, de invloed van de context op het probleemoplossen en de bekendheid met de gebruikte context.

Het tweede mogelijke obstakel bij de invoering van RME in Indonesië vormen de opvattingen van docenten. De meeste docenten hebben een positief beeld van RME, omdat het wordt gezien als een alternatief dat noodzakelijk is om het wiskundeonderwijs te vernieuwen. In dit verband kunnen twee typen docenten worden onderscheiden in Indonesië. De ene groep bestaat uit enthousiaste docenten die de vernieuwing verwelkomen, omdat ze geloven dat de implementatie van RME noodzakelijk is. Het andere type docent ondersteunt de implementatie niet volledig, omdat ze denken dat RME niet gebruikt kan worden voor alle onderwerpen van het curriculum; deze groep is van mening dat RME slechts gebruikt moet worden voor bepaalde onderwerpen.

Degenen die achter de implementatie van RME staan zijn van mening dat het wiskundeonderwijs vormgegeven moet worden zoals bedoeld in de RME-benadering. Deze vorm van lesgeven komt in hun visie zelfs in de buurt van hun beeld van het ideale model voor lesgeven. Ze gaven aan dat deze vorm van lesgeven nodig is, opdat de docent kan zien hoe het proces van leren en herontdekken van wiskundige ideeën en concepten bij de leerlingen verloopt. RME geeft de docent ook handvatten om het nut van wiskunde te zien. Zoals eerder is gesteld, is er veel kritiek op het huidige wiskundeonderwijs, omdat het te weinig gerelateerd zou zijn aan situaties uit het dagelijkse leven. Het huidige wiskundeonderwijs is vaak erg mechanistisch: wiskundedocenten dragen mondeling wiskundige formules en procedures over op hun leerlingen. Gezien deze huidige situatie kan de introductie van RME in Indonesië een verbetering van de situatie betekenen, namelijk het veranderen van mechanistisch lesgeven naar betekenisvol onderwijs voor zowel de docent als de leerlingen.

Aan de andere kant denken de docenten die niet volledig achter de implementatie staan, dat deze onderwijsvernieuwing 'meer is van hetzelfde'. De ene na de andere innovatie wordt doorgevoerd, zonder enig positief resultaat. Veel problemen zijn tot op de dag van vandaag niet opgelost.
Omdat één van de basisprincipes van de RME-benadering is dat de docent in staat is de leerlingen te begeleiden bij hun leerproces, dat wil zeggen het zelfstandig vinden van wiskundige concepten, vragen zij zich af of het wel mogelijk is de RME-methode te gebruiken in de scholen. Een doelstelling als deze is moeilijk te realiseren in de klas, zeker als men de verscheidenheid aan leerlingen en in de kunde van docenten in ogenschouw neemt. Ook zijn docenten niet gewend aan een methode zoals deze. Als gevolg van deze gedachtegang achten ze het veiliger als RME alleen ingevoerd wordt voor bepaalde onderdelen van het curriculum, dus niet voor alle onderwerpen. Ook het systeem van leerlingevaluatie is een punt waar de docenten zich zorgen om maken. Tot nu toe wordt het nationale centrale examen, dat bestaat uit meerkeuzevragen, gebruikt voor leerlingevaluatie. Naar de mening van deze docenten is deze manier van toetsen tegengesteld aan de RME principes, waarbij het vooral belangrijk geacht wordt het leerproces van de leerlingen te beoordelen.

Het derde obstakel bij de implementatie van RME in Indonesië is de verandering van onderwijsoriëntatie van docentgecentreerd naar leerlinggericht leren. Voor sommige leerlingen is dit niet gemakkelijk maar frustrerend. De docentgecentreerde aanpak die lange tijd is toegepast, heeft de leerhouding van de leerlingen passief gemaakt. Ze zijn gewend de kennis voorgekauwd te krijgen. Ze zijn niet gewend de kritische denkwijze toe te passen, die nodig is voor zelfsturend leren. Hier ligt een serieuze uitdaging voor de RME-implementatie in Indonesië, omdat een passieve leerhouding van de leerlingen succesvolle implementatie in de weg kan staan.

De erg negatieve reacties van sommige leerlingen op de RME-lessen kunnen tevens worden veroorzaakt doordat docenten één van de basisprincipes van RME, die gericht op het proces van herontdekken, verkeerd interpreteren. Ze denken dat de docent zich tijdens het leerproces moet terugtrekken. Deze extreme verandering kan door studenten op twee manieren ervaren worden: als *veeleisender* (meestal negatief) of als *uitdagender* (meestal positief). De leerlingen die de nieuwe wiskundemethode als meer eisend ervaren, voelen zich gedwongen tot het leren en het doen van wiskunde waartoe ze niet goed in staat zijn. Aan de andere kant, blijkt dat bij de leerlingen die de RME-lessen als meer uitdagend ervaren de motivatie om te leren stijgt, omdat het hen prikkelt tot activiteit. Deze laatste categorie leerlingen ervaren de moeite die ze hebben met het oplossen van een wiskundig probleem niet als iets dreigends (zoals de meeste Indonesische leerlingen dat voelen, als ze iets gevraagd wordt over wiskunde), maar juist als het tegenovergestelde daarvan.

Samengevat kan worden gesteld dat het succes van de implementatie van RME in Indonesië door ten minste drie aspecten wordt beïnvloed:
1. de beschikbaarheid van RME-curriculummateriaal en de doorwerking ervan op de (wiskunde)lespraktijk.
2. de verandering van de opvatting van de docenten, namelijk dat het geven van wiskundeonderwijs inhoudt dat leerlingen moeten worden begeleid bij het leren en het doen van wiskunde; en
3. de verandering van de houding van de leerlingen van een passieve ontvanger naar een actieve lerende die in staat is tot wiskundig denken en handelen.

Deze drie aspecten ondersteunen de bevindingen van Blum en Niss (1989) over de mogelijke implicaties van de implementatie van wiskundeonderwijs gericht op probleemoplossen, modelvorming en toepassing.

APPENDIX A
EVALUATION QUESTIONNAIRE THE INDOMATH PROGRAM

Dear teachers,

You have participated in *The IndoMath Program* which consist of two Workshops, Classroom Practices and Reflection Meetings respectively. By means of this questionnaire we would like to gain insight in your opinion on various aspects of the program. The information you provide us will be used to generate suggestions for improvement of the IndoMath program.

Name: ________________________________

Name of school: ________________________

A. Overall impression of the program

1. What is your overall impression of the Workshop?

Not according to my expectations	1	2	3	4	5	According to my expectation
Not instructive at all	1	2	3	4	5	Very instructive
Not useful at all	1	2	3	4	5	Very useful
Not enjoyable at all	1	2	3	4	5	Very enjoyable
Very irrelevant	1	2	3	4	5	Very relevant
No new information at all	1	2	3	4	5	A lot of new information

Comments:

2. What is your overall impression of the Classroom Practice?

Not according to my expectations	1	2	3	4	5	According to my expectation
Not instructive at all	1	2	3	4	5	Very instructive
Not useful at all	1	2	3	4	5	Very useful
Not enjoyable at all	1	2	3	4	5	Very enjoyable
Very irrelevant	1	2	3	4	5	Very relevant
No new information at all	1	2	3	4	5	A lot of new information

Comments:

3. What is your overall impression of the Reflection Meeting?

Not according to my expectations	1	2	3	4	5	According to my expectation
Not instructive at all	1	2	3	4	5	Very instructive
Not useful at all	1	2	3	4	5	Very useful
Not enjoyable at all	1	2	3	4	5	Very enjoyable
Very irrelevant	1	2	3	4	5	Very relevant
No new information at all	1	2	3	4	5	A lot of new information

Comment:

4. What is your opinion on the following aspects of the program?

	Very poor	Poor	Just okay	Good	Excellent
Information before the program					
Pedagogical quality of the resources persons					
Methods used					
Materials used					
Learning atmosphere					
Technical organization					

5. How do you value the usefulness of the following sessions in the program:

Program sessions	**Not useful at all**	**Not useful**	**Neutral**	**Useful**	**Very useful**
Workshop I					
Doing mathematics					
RME theory					
Video session					
Preparation of classroom practice					
Classroom Practice I					
Classroom practice with RME exemplary material					
Peer collaboration and observation in classroom practice					
Reflection Meeting I					
Reporting classroom practice and collaboration					
Feedback and discussion					
Workshop II					
Doing mathematics					
RME theory					
Preparation of classroom practice					
Classroom Practice II					
Classroom practice with RME exemplary material					
Peer collaboration and observation					
Reflection Meeting II					
Reporting classroom practice and collaboration					
Feedback and discussion					

6. What is the most effective sessions of this program?

____

____

____

7. What is the least effective sessions of this program?

____

____

____

B. Understanding of RME

Note: 1 = Strongly disagree
2 = Disagree
3 = Neutral, not sure
4 = Agree
5 = Strongly agree

8. After participating in this program I understand that in RME the use of contexts is important.	1	2	3	4	5
9. After participating in this program I know that in RME method the lesson must be started with something real for the pupils.	1	2	3	4	5
10. After participating in this program I realize that in RME the lesson is structured by means of a set of contextual problems.	1	2	3	4	5
11. After participating in this program I understand that teacher should give his pupils opportunity to reinvent mathematical idea and concept by themselves.	1	2	3	4	5
12. After participating in this program I know that teacher should develop interactive instruction.	1	2	3	4	5
13. After participating in this program I realize that teacher should ask his pupils to use their informal way to understand and solve the problems.	1	2	3	4	5
14. After participating in this program I realize that every pupil has ability to understand mathematical idea and concept on his own level.	1	2	3	4	5

C. Implementing RME

15. The program has given me sufficient information and suggestions on how to implement RME in my lessons.	1	2	3	4	5
16. The program has provided me with a clear image of how to implement RME in my lessons.	1	2	3	4	5
17. The program has enhanced my confidence in implementing RME in my lessons.	1	2	3	4	5
18. My opinion about RME has changed as a result of the program.	1	2	3	4	5
19. I will structure my lessons in accordance with RME because of this program.	1	2	3	4	5

20. Do you intend to use the provided RME lesson materials?

    - O Yes, often
    - O Yes, as long as relevant to the current curriculum
    - O Yes, sometimes
    - O Not sure
    - O No, never

21. What is the obstacle of RME implementation in your lessons:

____
____
____
____
____
____
____
____
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Appendix B

Participants' Perception on the Aspects in the IndoMath Program (Second Fieldwork)

Table 1
Participants' perception on the aspects in the workshops (immediately after the workshops)

	Workshop I			Workshop II		
	*Mean**	*s.d.*	*n*	*Mean*	*s.d.*	*n*
The activity was carefully planned	4.6	.76	20	4.8	.43	18
The content was accurately and adequately delivered	4.1	.64	20	4.3	.46	18
The time was used effectively	4.3	.47	20	4.3	.59	18
The trainer was well prepared	4.9	.37	20	4.7	.46	18
Participants were active learners	4.2	.59	20	4.5	.51	18
The topic targeted was adequately covered	3.9	.93	20	4.2	.65	18
The materials are immediately useful	4.5	.61	20	4.6	.50	18
My understanding on RME is enhanched	4.3	.56	20	4.4	.62	18
My confidence in implementing RME is enhanced	3.9	.72	20	4.2	.62	18
The advice for classroom practice is concrete and clearly delivered	4.1	.45	20	4.2	.43	18
The lesson materials for classroom practice are sufficiently provided	4.0	.65	20	4.4	.50	18
The lesson materials are relevance with the SLTP curriculum content	4.3	.73	20	4.4	.61	18
I am confidence my students will enjoy the lesson material and approach of RME	3.9	.69	20	4.2	.55	18
I am confidence the RME lesson material and approach will improve student learning	4.2	.67	20	4.2	.62	18

Note: * 1 = strongly disagree; 5 = strongly agree.

Table 2
The best session in the workshop

Session	**Workshop I** *(n = 20)***	**Workshop II** *(n = 18)***
Video session	9x	-*
RME theory	2x	10x
Doing mathematics	8x	6x
Preparation for classroom practice	4x	3x

Note: * No video session in workshop II;
**Some participants chose two components.

Table 3
Overall impression of the workshop

Impression	Mean*	s.d.	n
According to my expectation	4.5	.61	19
Instructive	3.9	.91	19
Useful	4.5	.61	19
Enjoyable	4.5	.51	19
Relevant	4.1	.71	19
Informative	4.7	.45	19

Note: * 1 = highly negative; 5 = highly positive.

Table 4
Overall impression of the classroom practice

Impression	Mean*	s.d.	n
According to my expectation	4.1	.81	19
Instructive	4.0	.75	19
Useful	4.5	.61	19
Enjoyable	4.5	.69	19
Relevant	4.2	.63	19
Informative	4.8	.37	19

Note: * 1 = highly negative; 5 = highly positive.

Table 5
Overall impression of the reflection meeting

Impression	Mean*	s.d.	n
According to my expectation	4.4	.83	19
Instructive	3.5	.51	19
Useful	4.9	.32	19
Enjoyable	4.6	.69	19
Relevant	4.4	.77	19
Informative	4.7	.58	19

Note: * 1 = highly negative; 5 = highly positive.

Table 6

Opinion on the aspect of the program

Opinion	Mean*	s.d.	n
Information before the program	4.2	.71	19
Pedagogical quality of the resources persons	4.7	.45	19
Methods used	4.5	.51	19
Materials used	4.4	.49	19
Learning atmosphere	4.5	.51	19
Technical organization	4.4	.49	19

Note: * 1 = very poor; 5 = very good.

Table 7

The usefulness of the sessions in the program

Program sessions	Mean*	s.d.	n
Workshop I			
Doing mathematics	4.6	.49	19
RME theory	4.7	.46	18
Video session	4.7	.45	19
Preparation of classroom practice	4.6	.49	19
Classroom Practice I			
Classroom practice with RME exemplary curriculum material	4.5	.61	19
Peer collaboration and observation in classroom practice	4.8	.42	19
Reflection Meeting I			
Reporting classroom practice and collaboration	4.4	.51	19
Feedback and discussion	4.7	.49	18
Workshop II			
Doing mathematics	4.5	.61	19
RME theory	4.7	.58	19
Preparation of classroom practice	4.7	.45	19
Classroom Practice II			
Classroom practice with RME exemplary material	4.4	.68	19
Peer collaboration and observation	4.7	.58	19
Reflection Meeting II			
Reporting classroom practice and observation	4.4	.51	19
Feedback and discussion	4.7	.56	19

Note: * 1 = Not useful at all; 5 = very useful.

Table 8

The most effective session in the program

The most effective session	N = 19*
Feedback and discussion	6x
RME theory	5x
Doing mathematics	4x
Reporting the result of classroom practice	4x
Preparation of classroom practice	2x
Classroom practice	2x
Not decided	2x
All sessions effective	1x

Note: * Some participants chose more than one.

Table 9

The least effective session in the program

The least effective	N = 19
Not decided	13x
Preparation of classroom practice	4x
Doing mathematics	1x
None	1x

Table 10

Participants' understanding of RME tenet

RME tenet	Mean*	s.d.	n
The use of context is important	4.7	.48	19
The lesson must be started with something real for the pupils	4.8	.42	19
The lesson is structured by means of a set of contextual problem	4.6	.51	19
Teacher should give pupils opportunity to reinvent mathematical idea and concept by themselves	4.8	.37	19
Teacher should develop interactive instruction	4.8	.37	19
Teacher should ask pupils to use their informal way to understand and solve the problems	4.6	.51	19
Every pupil has ability to understand mathematical idea and concept on his own level	4.4	.59	19

Note: * 1 = strongly disagree; 5 = strongly agree.

Table 11

Program affect on teachers' perception about implementation of RME

Program effect	**Mean***	**s.d.**	**n**
The program has given sufficient information and suggestions on how to implement RME in the lesson	4.4	.51	19
The program has provided a clear image of how to implement RME in the lesson	4.3	.58	19
The program has enhanced confidence in implementing RME in the lesson	4.3	.73	19
Opinion about RME has enhanced as a result of the program	4.2	.60	19
I will structure my lesson in accordance with RME because of the program	4.1	.66	19

Note: * 1 = strongly disagree; 5 = strongly agree.

Table 12

Teachers' intention to use the provided RME lessons materials

Intention	**N = 19**
Yes, often	1x
Yes, as long as relevant to the current curriculum	16x
Yes, sometimes	2x

Table 13

The likely obstacle of RME implementation

Obstacle	**N = 19***
The material development	14x
Time constraint	12x
The copying of students' materials	12x
The difference of pupils' ability	1x
Pupils are not used to discuss	1x
The mismatch between the method and the test	1x

Note: * Respondents can write more than one aspect.

Appendix C
Participants' Perception of IndoMath In-service Program (Third Fieldwork)

Table 1
Participants' perception on the aspects in the workshops immediately afterward (N = 16)

	Workshop I		Workshop II	
	*Mean**	*s.d.*	*Mean**	*s.d.*
The activity was carefully planned	4.4	.62	4.5	.52
The content was accurately and adequately delivered	4.0	.52	4.4	.50
The time was used effectively	4.3	.60	4.1	.50
The trainer was well prepared	4.4	.89	4.6	.50
Participants were active learners	4.3	.48	4.4	.62
The topic targeted was adequately covered	3.9	.93	4.3	.58
The materials are immediately useful	4.4	.62	4.4	.63
My understanding on RME is enhanced	4.3	.48	4.4	.62
My confidence in implementing RME is enhanced	4.0	.63	4.1	.50
The advice for classroom practice is concrete and clearly delivered	4.1	.50	4.5	.52
The lesson materials for classroom practice are sufficiently provided	4.0	.75	4.2	.66
The lesson materials are relevance with the SLTP curriculum content	4.1	.50	4.2	.58
I am confidence my students will enjoy the lesson material and approach of RME	3.4	.68	3.9	.44
I am confidence the RME lesson material and approach will improve student learning	4.0	.82	4.2	.58

Note: * 1 = strongly disagree, 5 = strongly agree.

Table 2
The best session in the workshops (N = 16)

	Workshop I *	Workshop II
Session	*f*	*f*
Doing mathematics	8	6
Preparation for classroom practice	3	7
RME theory	2	3
Video session	1	-**

Note: * A participant chose two sessions, 3 participants did not decide;
**No video session in workshop II.

Table 3
Overall impression of the workshop (N = 16)

Impression	Mean*	s.d.
According to my expectation	4.3	.58
Instructive	4.4	.51
Useful	4.4	.58
Enjoyable	4.4	.73
Relevant	4.5	.63
Informative	4.5	.63

Note: * 1 = highly negative; 5 = highly positive.

Table 4
Overall impression of the classroom practice (N = 16)

Impression	Mean*	s.d.
According to my expectation	3.9	.77
Instructive	4.3	.68
Useful	4.5	.82
Enjoyable	4.4	.62
Relevant	4.4	.62
Informative	4.5	.63

Note: * 1 = highly negative; 5 = highly positive.

Table 5
Overall impression of the reflection meeting (N = 16)

Impression	Mean*	s.d.
According to my expectation	4.4	.63
Instructive	4.4	.72
Useful	4.7	.60
Enjoyable	4.6	.63
Relevant	4.5	.63
Informative	4.5	.52

Note: * 1 = highly negative; 5 = highly positive.

Table 6

Opinion on the aspect of the program (N = 16)

Opinion	Mean*	s.d.
Information before the program	4.0	.52
Pedagogical quality of the resources persons	4.6	.50
Methods used	4.6	.51
Materials used	4.4	.62
Learning atmosphere	4.4	.51
Technical organization	4.3	.45

Note: * 1 = very poor; 5 = very good.

Table 7

The usefulness of the sessions in the program (N = 16)

Program sessions	Mean*	s.d.
Workshop I		
Doing mathematics	4.5	0.52
RME theory	4.4	0.63
Video session	3.8	0.83
Preparation of classroom practice	4.3	0.48
Classroom Practice I		
Classroom practice with RME exemplary curriculum material	4.2	0.66
Peer collaboration and observation in classroom practice	4.3	0.48
Reflection Meeting I		
Reporting classroom practice and collaboration	4.4	0.51
Feedback and discussion	4.7	0.48
Workshop II		
Doing mathematics	4.5	0.52
RME theory	4.6	0.63
Preparation of classroom practice	4.4	0.51
Classroom Practice II		
Classroom practice with RME exemplary material	4.4	0.62
Peer collaboration and observation	4.3	0.70
Reflection Meeting II		
Reporting classroom practice and observation	4.5	0.52
Feedback and discussion	4.7	0.48

Note: * 1 = Not useful at all; 5 = very useful.

Table 8

The most effective session in the program (N = 16)

The most effective session	f
Feedback and discussion	5
Reporting the result of classroom practice (incl. Feedback and discussion)	5
Doing mathematics	3
RME theories	1
Preparation of classroom practice	1
Classroom practice	1

Note: * Some participants chose more than one.

Table 9

The least effective session in the program (N = 16)

The least effective	f
Not decided*	7
Video presentation	6
Reporting the results of classroom practice	2
Classroom practices	1

Note: * No session in the program being judged by participants as the least effective session.

Table 10

Participants' understanding of RME tenet (N = 16)

RME tenet	Mean*	s.d.
The use of context is important	4.7	.48
The lesson must be started with something real for the pupils	4.7	.48
The lesson is structured by means of a set of contextual problem	4.4	.50
Teacher should give pupils opportunity to reinvent mathematical idea and concept by themselves	4.7	.60
Teacher should develop interactive instruction	4.6	.51
Teacher should ask pupils to use their informal way to understand and solve the problems	4.5	.52
Every pupil has ability to understand mathematical idea and concept on his own level	4.3	.60

Note: * 1 = strongly disagree; 5 = strongly agree.

Table 11
Program effect on teachers' perception about implementation of RME (N = 16)

Program effect	Mean*	s.d.
The program has given sufficient information and suggestions on how to implement RME in the lesson	4.4	.62
The program has provided a clear image of how to implement RME in the lesson	4.3	.68
The program has enhanced confidence in implementing RME in the lesson	4.4	.72
Opinion about RME has enhanced as a result of the program	4.6	.51
I will structure my lesson in accordance with RME because of the program	4.0	.52

Note: * 1 = strongly disagree; 5 = strongly agree.

Table 12
Teachers' intention to use the provided RME lessons materials (N = 16)

Intention	F
Yes, often	2
Yes, as long as relevant to the current curriculum	13
Yes, sometimes	1

Table 13
The likely obstacle of RME implementation (N = 16)

Obstacle	F*
Time constraint	9
Materials development	8
Students' ability	7
Budget for student materials duplication	6
Teachers' competencies	3
Evaluation procedure	2

Note: * Participants can write more than one aspect.

APPENDIX D
PARTICIPANTS' REPORTS ON THE RESULT OF CLASSROOM PRACTICE (SECOND FIELDWORK)

Pair	Reflection Meeting I	Reflection Meeting II	Researcher's comment
DED-RUS	<u>Lesson</u> The teaching and learning process (TLP)was not going well. <u>Understanding</u> Teachers did not master the material. <u>Material</u> The numbers in the problem were too big; the contexts were unrealistic for pupils; <u>Time</u> Time allocation (3 x 45 minutes) was not enough. <u>Collaboration</u> Discussing before practice; observing each other.	<u>Lesson</u> TLP was going well; pupils were enthusiastic and experienced; pupils were dare to express ideas; group discussion and classroom discussion were happen. <u>Understanding</u> It seemed that teachers master the materials. <u>Material</u> Some problems were not understood by pupils. <u>Time</u> Time allocation (3 x 45 minutes) was not enough. <u>Collaboration</u> Discussing before and after practice; observing each other; teachers take benefit from observation.	There was some positive changes in Classroom Practice (CP) II: TLP was performed better; the obstacles were decrease.
WID-MUR	<u>Lesson</u> TLP was going well; pupils were enthusiastic to solve the problems by asking teachers many questions; group discussion was going well, but class discussion was not work because pupils were not use to. <u>Understanding</u> It seemed that teachers master the RME material and its approach. <u>Material</u> Some problems were not meaningfully clear for pupils that force them ask teachers very often. <u>Time</u> [not reported] <u>Collaboration</u> Scheduling for CP; making additional student work sheets.	<u>Lesson</u> TLP was going well; pupils were use to discuss in group. <u>Understanding</u> It seemed that teachers master the materials. <u>Material</u> [not reported] <u>Time</u> 2 x 45 minutes was not enough to finish all problems, the rest of problems were given as homework. <u>Collaboration</u> Scheduling for CP; observing; Mur failed to perform CP due to school meeting.	Teachers understanding on RME material and its approach helped the TLP to be performed as it's intended.

Pair	Reflection Meeting I	Reflection Meeting II	Researcher's comment
RIN-KAR	Lesson TLP was not going well; class discussion was not work; pupils were always demand the answers from teacher; pupils were shame to share ideas (influence of culture). Understanding Teachers left pupils to answer freely the problems in the materials -> it is a kind of their interpretation of "pupils solve the contextual problems by themselves and develop their own knowledge of mathematics." Material The numbers in the problems were too big; some problems were misinterpreted by pupils. Time Not reported, but it seemed that teachers could not finish all the problems in instruction. Collaboration Teachers came from two different schools that caused obstacle in collaboration due to distance and time.	Lesson TLP was performed a bit better than CP I, but still behind teachers' expectation of a good lesson. Understanding Teachers tried to change strategy by giving apperception and simpler examples which are pupils familiar with. Material [not reported] Time 2 x 45 minutes was not enough. Collaboration Collaboration was not performed well; Rin failed to come to Kar's school for observation. Note Researcher observed Kar' lesson.	TLP was not performed well in CP I, but was a bit improved in CP II. In CP II teachers were adequately understand the content as reflected by their ability to give alternative questions.

Pair	Reflection Meeting I	Reflection Meeting II	Researcher's comment
WAC-SID	Lesson TLP was not performed well. Understanding [not reported] Material The numbers in problems were too big; pupils were not use to discuss. Time 2 x 45 minutes not enough, only a few problems could be solved. Collaboration Determining date for CP; observing each other.	Lesson TLP was not performed well; teacher tried to motivated pupils involve actively in solving the problems and discussion. Understanding Teachers' mastery of materials content was limited. Material [not reported] Time Only 2 problems (out of 12) could be solved in 2 x 35 minutes. Collaboration Sid performed CP beyond the program schedule. Note Researcher observed Wac' lesson.	Two times CP were not performed well. Collaboration was not work. Teacher Wac liked RME very much, in the future she could be a good RME teacher.
SUW-YAY	Lesson TLP was not performed well. Understanding Teachers did not master the material. Material Pupils were not use to deal with open-ended questions; pupils were difficult to understand the sentences in the material (problems). Time Not all problems could be solved or discussed. Collaboration Suw and Yay came from two different schools that cause some problem due to time and distance. However they got time for learning the materials before practice and observing each other lesson.	Lesson TLP was performed a bit better than CP I; teachers tried to motivate pupils to comment; teachers gave alternative examples which is simpler. Understanding [not reported] Material Some sentences in problems were not understood by pupils. Time Not all problems could be solved or discussed. Collaboration Scheduling CP; learning the materials together; observing each other.	Experiences teachers got from CP I help them to use alternative strategy by giving additional examples and guiding pupils in solving problems. In CP II the obstacles in teaching were decreased.

Pair	Reflection Meeting I	Reflection Meeting II	Researcher's comment
Tuk-Sun	Lesson TLP was not performed well. Understanding Teachers had problem mastering the materials. Material Some sentences in problems were confusing; the numbers in the problems were too big. Time [not reported] Collaboration Observing each other.	Lesson TLP was performed a bit better; teachers as well as pupils enjoy the lesson. Understanding [not reported] Material Pupils were not correct understood the sentences. Time [not reported] Collaboration Observing each other.	CP II was performed better than CP I; teachers as well as pupils were starting familiar with RME approach.
Muk-Wih	Lesson TLP was not performed well; pupils were not use to discuss; teacher had problem in classroom management. Understanding [not reported]; it seemed that teachers had problem in mastering the materials. Material The numbers in problems were too big. Time [not reported] Collaboration Observing each other.	Lesson TLP was performed better than CP I; pupils were not use to discuss. Understanding It seemed that teachers master the materials. Material [not reported] Time 2 x 45 minutes was not enough. Collaboration Observing each other Note Researcher observed Muk' lesson.	Teachers performed better in CP II because had better understanding on material; teachers could give alternative questions to help pupils.

Pair	Reflection Meeting I	Reflection Meeting II	Researcher's comment
Sis-Rui	Lesson TLP was not performed well; teachers had problems in classroom management because passive nature of pupils and pupils were difficult to give reason for their answers. Understanding [not reported] it seemed that teachers did not have problems in mastering the materials. Material [not reported] Time [not reported] Collaboration Observing each other.	Lesson TLP was performed a bit better than CP I; teachers still had problem in classroom management. Understanding [not reported] it seemed that teachers did not have problems in mastering the materials. Material Some problems were confusing pupils, they could not be understood without teachers' explanation. Time [not reported] Collaboration Observing each other.	In CP I teachers left pupils freely to deal with the problems; in CP II teachers took an active role as facilitators that push pupils' interactivity.
Dwi-Ani	Lesson TLP was performed well; teachers tend to leave pupils to work in their own ways; pupils were not familiar with open-ended questions (problems). Understanding [not reported] it seemed that teachers were understand the materials. Material The numbers in the problems were too big. Time 2 x 45 minutes was not enough. Collaboration Observing each other and discussion after practice.	Lesson TLP was performed well; teachers took an active role as facilitators. Understanding [not reported] it seemed teachers had no problem in mastering the materials. Material [not reported] Time 3 x 45 minutes was used effectively by teachers. Collaboration Observing each other; discussion before and after practice; took benefit from observation.	TLP was performed well because teachers had a good understanding about material and its approach. In CP II teachers tried to solve time constraint by acting as a good facilitator.

Appendix E

Innovation Profile

The use of contextual problem as starting point	**Score*)**	**Explanation**
Threshold		
Start the lesson that enables pupils to engage immediately in meaningful mathematical activity.	7	▪ The starting points of instruction should be experientially real to pupils so that they can immediately involve in personally mathematical activity. The use of contextual problem not only as applications at the end of sequence, but also as starting points from which the intended mathematics can emerge.
*Ideal elements**)*		
a. Teacher asks questions/problems to the whole class.	2	▪ All pupils must think and work independently first. After pupils have adequate time to work independently, they are paired with partners or join small group.
b. Teacher gives pupils independent work time before the group or whole class discussion.	3	
c. Teacher asks open-ended questions those for which more than one way to solve the problem or more than one acceptable response may be possible.	3	
d. Pupils explain their thinking and becoming actively involve in classroom discussion.	4	
e. Teacher emphasises the importance of the use of pupils' own mathematics ideas and concepts in dealing with the problems.	2	
f. Teacher emphasises the importance of pupils' own effort to find the solutions.	1	
Unacceptable elements		
a. Teacher asks questions that just recalling a fact or reproducing a skill.	-1	▪ Good questions require more than recalling a fact or reproducing a skill. By asking good questions, teacher encourages pupils to think about, and reflect on, the mathematics they are learning.
b. Teacher gives wrong information about the subject-matter and/or does not answer simple questions correctly, which leads to confusion.	-3	
c. In the introductory phase, two third of pupils hardly involve in meaningful mathematics activities.	-3	

Notes: *) The score of 33% for threshold and 67% of the ideal elements are adapted from Van den Berg (1996) with some adjustment based upon RME philosophies. In the RME all components are relatively equally important;

**) The ideal elements in this profile are mostly adapted from Reinhart (2000) who summarised his reflection on problem-based student-centred teaching. Steve C. Reinhart is a mathematics teacher at Chippewa Falls Middle School. He is interested in the teaching of algebraic thinking at the middle school level and in the professional development of teachers.

Conceptual Mathematization: from concrete to abstract.	**Score**	**Explanation**
Threshold In addition to taking account of pupils' current mathematical ways of thinking, the learning arise from problem solving activities and subsequently can help to bridge the gap between the concrete level and the abstract level, or between the intuitive level and the level of subject-matter systematic.	6	▪ In this component, the potential end point of learning sequence can be realised through four level: 1. Situational level, where domain-specific, situational knowledge and strategies are used within the context of the situation; 2. Referential level or the level 'model of', where models and strategies refer to the situation described in the problem; 3. General level or the level 'model for', where a mathematical focus on strategies dominates over the reference to the context; and 4. Formal mathematics level, where one works with conventional procedures and notations.
Ideal elements		
a. Teacher replaces lectures with sets of contextual problems.	4	▪ The context is a situation in which the problem is placed, and from which pupils can produce mathematical activity as well as practice and apply their mathematical knowledge.
b. Teacher uses more process problems than product problems.	3	
c. The problems are discussed in various levels, from concrete to abstract, or from informal to formal mathematics procedures.	2	
d. Pupils apply their informal mathematics knowledge, explain their solution and actively involve in classroom discussion.	3	
Unacceptable elements		
a. When pupils are busy solving the problems, the teacher gives the solution right away, without having stimulated their thought process using questions and remarks.	-3	
b. One or several problems that are offered emphasised skills other than problem solving skills.	-1	
c. Teacher answers his/her own questions.	-2	

Pupil contribution	Score	Explanation
Threshold		
Instructional sequences involving activities in which pupils create and elaborate symbolic models of their informal mathematical activity. The constructive element is visible in the large contribution to lesson coming from pupils' own constructions and productions.	7	▪ Pupils should be asked to produce more concrete things. By asking free production pupils are forced to reflect on the path they themselves have taken in their learning process and at the same time to anticipate its continuation.
Ideal elements		
a. Teacher requires several responses to the same problem.	3	▪ Never accept only one response to a problem. Always ask for other comments, addition, clarification, solution, or method.
b. All pupils' statements are valuable to teacher, even if they are incorrect or show misconception.	3	
c. Teacher gives pupils more time to process their thought that result in more and better responses.	2	
d. Pupils' ideas are visible and clearly hear by the whole class, and teacher encourages pupils to comment on their friends' ideas.	3	
e. Pupils put their solution in their own worksheet and/or explain to other pupils in classroom discussion.	3	
Unacceptable elements		
a. Teacher carries a pencil or picks up pupil's pencil to do work for pupils.	-4	
b. Pupils cannot draw any idea of their mathematics learning.	-3	

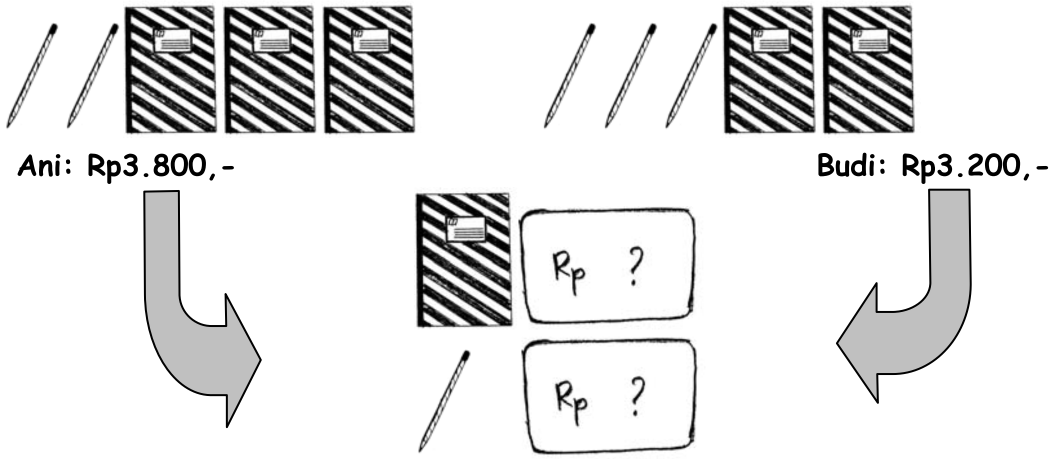
Interactivity	Score	Explanation
Threshold		
Interactive instruction: explaining and justifying solutions, understanding other pupil's solutions, agreeing and disagreeing, questioning alternatives, and reflecting afterward.	7	▪ The three previous components can only be effective if they are realised in interactive instruction. Explicit negotiation, intervention, discussion, cooperation, and evaluation are essential elements in a constructive learning process in which the pupil's informal methods are used as a lever to attain the formal ones.
Ideal elements		
a. Pupils like working together, discussing and sharing heir ideas and solutions to the contextual problems that teacher posed.	3	
b. Teacher creates classroom atmosphere in which pupils actively engaged in learning mathematics and feel comfortable in sharing and discussing ideas, asking questions, and taking risks.	3	
c. If pupils or group cannot answer a problem or contribute to the discussion in a positive way, they must ask a question of the class.	3	
d. Teacher always requires pupils to ask a question when they need help.	3	
e. Teacher emphasises pupils to explain their ideas and comments clearly heard by the whole class.	2	
Unacceptable elements		
a. Teacher repeats or clarifies what pupils said.	-3	
b. During interactivity more than 1/3 of the pupils looses attention.	-2	
c. Teacher embarrasses pupils by judgmental comment.	-2	

Intertwining	Score	Explanation
Threshold		
Intertwining of learning strands that is exploited in problem solving and application.	6	▪ Real phenomena in which mathematics structures and concepts manifest themselves lead to intertwining of learning strands cannot be dealt with separate entities, instead an intertwining of learning strands is exploited in problem solving.
Ideal elements		
a. Teacher summaries the lesson by posting problems that involves intertwining of learning strand or application.	3	
b. All pupils are actively involved in discussing and solving the summary problems.	3	
c. Teacher asks a pupil from each group to report on significant point discussed in the group.	3	
d. Pupils' solutions are formulated with regard to mathematics concept as learned earlier on.	3	
Unacceptable elements		
a. Less than half of the groups have completed their summary problems so that any conclusion about the lesson cannot be drawn.	-2	
b. Not all the solutions in the summary problems are discussed because not enough time is spent on this summary phase.	-2	
c. More than 1/3 of the pupils quits during the summary phase.	-2	

APPENDIX F
RCP-TEST AND SCORING CRITERIA

Context 1: Pencils and Books

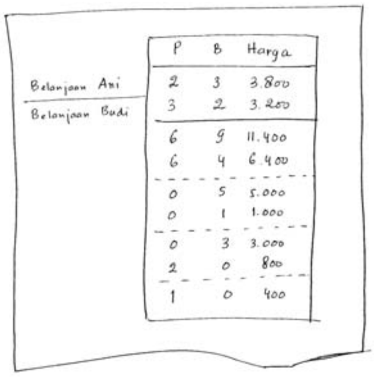
Student Store at SLTP Realita sells school supplies. Students prefer to buy their school supplies in the store because each supply has the same price. Each pencil, although has different brand, has the same price, as well as book, etc. Ani bought 2 pencils and 3 books for Rp3.800,- and Budi bought 3 pencils and 2 books for Rp3.200,-



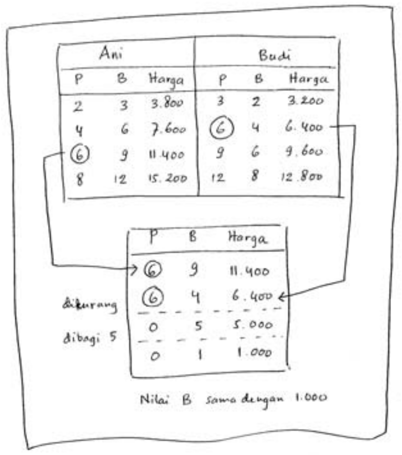
1. By using the above information decide the price of a pencil and a book (use formal as well as informal mathematics procedures).
2. What mathematics concept can be explained using the above context? Explain your answer (be more specific).
3. On which topic of the current SLTP mathematics curriculum that context is match?

Answers

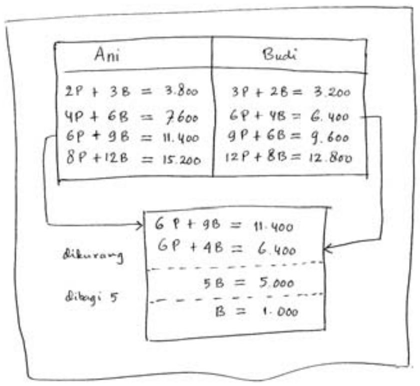
1. Teacher can determine the price of a pencil and a book using one of the following ways:
   1.1 Notebook Notation (2 points)



   1.2 Table (2 points)



   1.3 Table using equations (2 points)



   1.4 Formal procedure using equations: 2P + 3B = 3.800 and 3P + 2B = 3.200 (1 point)

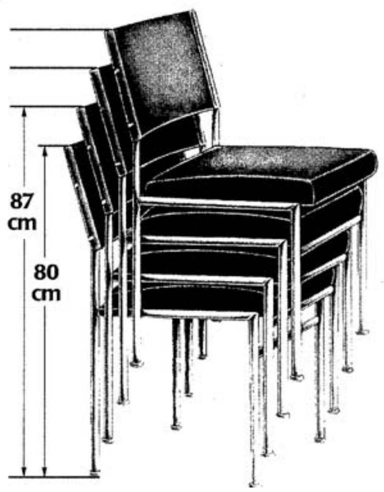
2. The context gives information about the total price of combination of pencils and books. The context facilitates mathematics thinking of organizing the new combination that are created by manipulating the known combinations of items. Students can add, subtract, multiply, and divide to find new combinations with new prices. Eventually they can find the price of the individual item. (2 points)

3. In the current SLTP mathematics curriculum there is a topic of **solving linear equations**. That context can be used to facilitate pupils' learning the **substitution** and **elimination** methods in solving linear equations systems with two variables. (1 point).

Scoring

1. If teacher using the informal ways (1.1, 1.2 or 1.3 or others informal way) to solve the problem, she/he gets 2 points. If teacher use the formal procedure (1.4) she/he gets 1 point. If teachers solve using both way (formal and informal), she/he gets 3 points.
2. If teacher can explain mathematics ideas and concepts related to the context as the above sample answer, she/he gets 2 points. If teacher gives a short answer closely related to the concept behind the context (such as addition, subtraction multiplication and division, or the concept of substitution and elimination) he/she get 1 point. If teacher gives wrong answer or gives no answer she/he get 0.
3. Teacher get score 1 if she/he answers as the above sample answer and get score 0 for others or no answer.
   Total score for context 1 is 3 + 2 + 1 = 6

Context 2: Stacking Chairs



4. By using the above information decide the high of 8 chairs (use formal as well as informal mathematics procedure).
5. What mathematics concept can be explained using the above context? Explain your answer (be more specific).
6. On which topic of the current SLTP mathematics curriculum that context is match? Explain your answer.

Answers

4. Teacher can use informal procedure using arrows formula to solve the problem as the following example (2 points):

$$\text{Number of chairs} \xrightarrow{-1} \underline{\quad} \xrightarrow{\times 7} \underline{\quad} \xrightarrow{+80} \text{height}$$

Using the above formula, the height of 8 chairs is

$$8 \xrightarrow{-1} 7 \xrightarrow{\times 7} 49 \xrightarrow{+80} 129 \text{ cm}$$

Teacher can use inductive way to solve the problem as the following (2 points):

- Height of 1 chair = 80 cm
- Height of 2 chairs = 87 cm = (80 + 7) cm
- Height of 3 chairs = 94 cm = (80 + 2 x 7) cm
- Height of 4 chairs = 101 cm = (80 + 3 x 7) cm

:

:

- Height of n chairs = (80 + (n – 1) x 7) cm
- So, height of 8 chairs = (80 + 7 x 7) cm = 129 cm

Teacher can use others informal ways such as counting from 1 chair (80 cm), 2 chairs (87 cm), 3 chairs (94 cm) and so until 8 chairs. This is actually the simplest way that pupils usually use. (2 points).

Teacher can use formal procedure using formula: Sn = a + (n – 1) b,
where

Sn = height of n chairs
n = number of chairs
a = height of 1 chair
b = height of 2 chairs – height of 1 chair

(1 point).

5. By using this context, pupils learn about building formula from informal (using arrow string notation) to formal mathematics formula. Although mathematical formulas are usually written with the output to the left of the equal sign, the arrow string notation written in the reverse order (with the output on the right). The order of operations is implicitly introduced. According to the order of operations, subtraction and addition can be done in any order. Multiplication and division can also be done in any order. However, when combining these operations, multiplication and division are calculated before addition and subtraction. The formula in this context uses the height of the chair (80 cm) and the addition of 7 cm for each chair added in the stack. (2 points)

6. In the current SLTP mathematics curriculum there is a topic of Pattern and Sequences of Numbers. The context matches to that topic, particularly to explain the formula of sum of n-th first terms of arithmetic number sequence. (1 point).

Scoring

4. If teacher uses the informal way using arrow formula or other informal approaches, she/he gets 2 points If teacher uses formal procedure as example above, then she/he get 1 point. If teacher gives wrong or no answer, then she/he gets 0 point. If teacher uses both way, she/he gets 3 points.

5. Teacher will get 2 points if his/her answer is in line with the above sample answers. Teacher will get 1 point if she/he just mention the mathematics concept using one or two word similar to topic title in the syllabus. Teacher will get 0 point if she/he gives wrong or no answer.

6. Teacher will get 1 point if she/he answer as the above sample answer, and get no point (0) if gives wrong or no answer.
   Total score for context 2: 3 + 2 + 1 = 6

Context 3: Kijang and Colt L-300

Second grade students from SLTP Realita are going to a camping trip. There will be 96 people going, including the students and teachers. All the luggage, gear, and supplies are already packed into 64 equal-sized boxes. Now the organizers want to rent the right number of vehicles to take everyone to the campsite. They can choose between two different types of vehicles from a car rental agency:

Kijang

Seats: 6 people
Cargo space: 5 boxes

Colt L-300

Seats: 8 people
Cargo space: 4 boxes

7. What combination of vehicles would you recommended to the camping organizers? (Use formal as well as informal mathematics procedure).
8. What mathematics concept can be explained using the above context? Explain your answer (be more specific).
9. On which topic of the current SLTP mathematics curriculum that context is match? Explain your answer.

Answers

7. Teacher can use the following informal way to solve the problem.

   First, think about just the number of people and not the number of boxes. For exactly 96 people, there are several possibilities for renting kijang and colt. One solution is 16 kijang, 0 colt. When considering just the people, a fair exchange for this problem is to change 4 kijang for 3 colt. Because four kijangs carry 24 people and three colts also carry 24 people. So, if you exchange four kijangs for three colts, the total number of people that you can carry remains the same. The list all the possible combinations of kijangs and colts that carry exactly 96 people are

Transporting 96 people

Kijangs	*Colts*
16	0
12	3
8	6
4	9
0	12

Second, think about just the number of boxes and not the number of people. For exactly 64 boxes, there are several possibilities for renting kijangs and colts. One solution is 0 kijang, 16 colts. A fair exchange if four kijangs for five colts, since four kijangs can caryy 20 bixes and five colts also can carry 20 boxes. The list all the possibilities of kijangs and colts that can carry 64 boxes are

Transporting 64 boxes	
Kijangs	*Colts*
0	16
4	11
8	6
12	1

By combining the above combination of kijangs and colts, there is one pair of numbers that is included in both lists: eight kijangs and six colts. This combination carries exactly 96 people and 64 boxes and does not have any empty spaces. (2 points)

Teacher can also use formal procedure to solve the problem using equations:
$6K + 8C = 96$
$5K + 4C = 64$
where K = the number of kijangs and C = the number of colts.

$10K + 8C = 128$

$4K = 32$
$K = 8$

$4C = 24$
$C = 6$
(1 point)

8. The principle of fair exchange (or fair trade) states that while the total value of a combination of two (or more) items remains the same, the combination can change. For example, when A has a value of Rp1.000,- and item B has a value of Rp400,- two items A's can be replaced with five items B's without changing the total value. In this context, the items are vehicles that can hold people and boxes; thus the value is the total number of boxes or the total number of people.

   When solving a complex problem, it is often easier to simplify the situation first, and then analyze and solve the simplified situation. At this point, the problem of the number of vehicles has been divided into two parts, first dealing with the people only, and then dealing with the boxes only. In the remaining problems, both parts are combined. (2 points)

9. In the current SLTP mathematics curriculum there is a topic of **Graphing of a Linear Function**. The concept of fair exchange can be used to facilitate pupils' learning about the idea of making graph of a linear function using fair exchange concept. Moreover, pupils also learn about solving linear equations systems using method of graphing. (1 point)

Scoring

7. If teacher uses an informal way like the above sample answer, she/he gets 2 points. If teacher uses formal procedure using equations as the above example, then she/get 1 point. If teacher gives wrong or no answer, then she/he gets 0 point. If uses formal and informal procedure, she/he gets 3 points.

8. For this question teacher should explain about the concept of fair exchange. He/she who explain this concept in his/her answer gets 2 points. If teacher just mentions the fair exchange using one or two words, she/he gets 1 point. If teacher gives wrong or no answer, she/he gets 0 point.

9. If teacher mentions about graphing of a linear function, or method of graphing for solving linear equations systems, she/he gets 1 point. If she/he gives wrong or no answer, she/he gets 0 point.
   Total score for context 3 is 3 + 2 + 1 = 6

Context 4: Telephones and Populations

The table below shows the population and the total number of telephones for 14 different countries.

Country	Population	Number of Telephones
Bolivia	8 million	200,000
China	1,200 million	16 million
Denmark	5 million	3 million
Ecuador	11 million	550,000
Finland	5 million	4 million
France	58 million	31 million
India	940 million	7 million
Indonesia	210 million	5 million
Japan	125 million	57 million
Nauru	10,000	1,700
Solomon Islands	399,000	8,700
South Africa	45 million	6 million
Sudan	30 million	112,000
United States	264 million	203 million

10 a. Based on the table above, in which countries do you think people rely the most on the use of telephones for communication? Explain.
   b. In which countries do people rely less on the use of telephones for communication? Note: Use formal as well as informal mathematics procedure.

11. What mathematics concept can be explained using the above context? Explain your answer (be more specific).
12. On which topic of the current SLTP mathematics curriculum that context is match? Explain your answer.

Answers

10. a. Answers and explanation will vary. Sample answer
    Denmark, France, and United States rely most on the use of telephones. In all of these countries, there is more than one telephone for every two people.
    b. Answers and explanations will vary. Sample answer
    Sudan relies less on the use of telephones. There is one telephone for every 267 people.

11. Pupils are informally introduced to the concepts of absolute and relative comparisons. With absolute comparisons, numbers of telephones are compared without considering the numbers of people using them. Looking only at the numbers of telephones is not helpful in understanding how the distribution of telephones varies for different countries; you need both the number of telephones and the size of the population.

An extreme case helps pupils see that just having a larger of telephones does not mean that more people have assess to telephones. For example, suppose country A has 1,000 telephones and 100,000 people (100 people per telephone), and country B has 500 telephones but only 1,000 people (two people per telephone).

When large numbers are expressed in million or billion, as in the table, then calculations can be made by using these units without writing all the zeros. For example
2 million + 3 million = 5 million. Or,
6 million : 2 million = 3 million.

When different units are used, then the numbers have to be changed into the same units. For example:
3 billion + 400 million = 3,000 million + 400 million = 3,400 million.
Or,
8 million + 200,000 = 8 million + 0.2 million = 8.2 million

12. In the current SLTP mathematics curriculum there is a topic of **Comparison**. This context can be used as introduction to this topic. Moreover, this can also be used for the topic of **Statistic** as the topic for grade 3 SLTP pupils. Using this context you can explain about the informal way to deal with big numbers, or the concept of ratio or arithmetic mean.

Scoring

10. If teacher gives answer like the above sample, or gives other answers with a reasonable explanation, then she/he gets 3 points. If teacher use division directly to find the answer, she/he gets 2 points. If teacher gives correct answer without explanation (for instance Denmark, France and United States, for questions 9a; and Sudan for question 9b), then she/he gets 1 point. If teacher gives wrong or no answer, then she/he gets 0 point.

11. If teacher gives answer more or less similar to one of the above sample arguments, then she/he get 2 points. If teacher gives answer just mentioning two or three word (like absolute and relative comparison), she/he gets 1 point. If teacher gives wrong or no answer, she/he gets 0 point.

12. Teacher gets 1 point if she/he has similar answer as the above sample answer; or has different answer with sound explanation; and gets 0 point if she/he has wrong or no answer. Total score for context 4 is 3 + 2 + 1 = 6.

Discussion of Decision Criteria of Teacher Understanding about RME

For each context there are three similar questions (items), that is

- First, the problem embedded in the context;
- Second, question about the mathematics concept addressed in the context; and
- Third, the relevance or relation of the context to the current SLTP mathematics curriculum.

In general the scoring for each context using the following criteria (Table 2). It is assumed that mathematics teachers have prerequisite knowledge to become mathematics teachers. They got the knowledge from preservice education at Teacher College (FKIP or IKIP). All the questions in the test are on the level of SLTP pupils' knowledge, and quite simple for teachers (as concluded from tryout). Moreover, all the mathematics concepts from which the questions have their basis are relevant to the current SLTP mathematics content. So, for mathematics teacher those questions are solvable. However, the test is not merely assesses teachers' ability to solve the questions, but also the ability to solve the problems using informal procedures. Equally important, test also explores teachers' knowledge about the concepts behind the contexts, and the relevance of the contexts to the current SLTP Mathematics curriculum.

Table 2
Criteria for scoring for each context

Question in the context	**Score**	**Criteria**
First	0	Can not answer the problem or has incorrect answer
	1	Solve the problem directly or using formal mathematics procedure
	2	Solve the problem using informal procedure which sound mathematical basis on the level of pupils' mathematical thinking
	3	Solve the problem using formal and informal procedure
Second	0	Has no idea about mathematical concept addressed in the context
	1	Give raw information of mathematical concept addressed in the context without detail or specific explanation
	2	Give information of mathematical concept addressed in the context accompanied by detail or specific explanation
Third	0	Has no idea or wrong idea about the relation of the context to the current SLTP mathematics curriculum
	1	Has idea about the relation of the context to the current SLTP mathematics curriculum

Based on the result of tryout of the questions in each context (except context 3), SLTP mathematics teachers who has knowledge of general mathematics school but no knowledge about RME can answer the questions in each context, that is

1. giving correct answer using formal procedures or directly without explanation (1 point);
2. explaining the mathematics concept addressed in the context in two or three words (1 point); and
3. know the relevance of each context in the current SLTP mathematics curriculum (1 point).

Then understandable to have 12 as critical score, that is the entry level score for this test of RME understanding (Table 3).

Table 3
Scoring table for each question per context

Context	Question	Highest Score	Entry level score (general school mathematics knowledge)
I	1	3	1
	2	2	1
	3	1	1
II	4	3	1
	5	2	1
	6	1	1
III	7	3	1
	8	2	1
	9	1	1
IV	10	3	1
	11	2	1
	12	1	1
	Total Score	24	12

Using this fact, then we have two general decision criteria for understanding, that is
1. If Teacher Score (TS) ≤ 12, then teacher has no understanding of RME; and
2. If TS > 12, then teacher understand RME.

By definition "understand RME" means teacher has knowledge
- to solve contextual problem using informal as well as formal mathematics procedure;
- about mathematics concepts and ideas addressed using the contexts; and
- about the relevance or relation of the context to the current SLTP mathematics curriculum.

Furthermore, if teacher's correct answer for each context is 25%, that is teacher has correct answer on 1 out 4 contexts, or his/her score ranged between 13 – 15, then his/her understanding is categorized as preliminary. If teacher's correct answer for each context is between 25% and 75%, or his/her score ranged between 16 – 20, then his/her understanding is categorized as mediocre. If teacher's correct answer for each context is more than 75%, or his/her score more than 20 (or between 21 and 24), then his/her understanding is categorized as good. (Table 4).

Table 4
Three categories of teachers' understanding of RME

Score	Category
13 – 15	Preliminary
16 – 20	Mediocre
21 – 24	Good

For teacher who fall in the criteria of "has no understand about RME" or TS $\leq$ 12, can be divided as the following categories. If teacher can only solve less than 50% of the questions in the level of SLTP mathematics content, then she/he could have serious problem of 'SLTP mathematics content knowledge.' If teacher can solve more than 50%, then she/he has knowledge of general SLTP mathematics.

In summary, the decision criteria is given in the following table 5.

Table 5
Categories of teacher' after the RME contextual problems test

No.	Score	Category
1	0 – 6	Has serious problem in mathematics content knowledge
2	7 – 12	Has knowledge of general school mathematics
3	13 – 15	Has preliminary understanding about RME
4	16 – 20	Has mediocre understanding about RME
5	21 – 24	Has good understanding about RME

The above categories only valid for testing using the test mentioned in the beginning of this paper (Revised Version). Before being used in the next field -work the test will be tried-out again to figure out its validity and reliability.

Appendix G
Indonesian Version of Stages of Concern Questionnaire (SoCQ) (Adapted from Hall & Hord, 2001)

Kuesioner Tingkat Kepedulian

Nama/Instansi ____

Tanggal Pengisian____

Demi kelanjutan pengolahan data kami memerlukan nomor yang selalu dapat anda ingat. Mohon tuliskan:

Tempat/tanggal lahir anda_____________________________________

Kegunaan kuesioner ini adalah untuk menentukan kepedulian orang yang sedang menggunakan atau sedang mempertimbangkan untuk menggunakan berbagai macam program pada waktu yang berbeda-beda selama proses adopsi inovasi. Item-item dalam kuesioner ini dikembangkan dari respon para guru dan dosen. Mereka itu ada yang tidak memiliki pengetahuan sama sekali tentang berbagai macam program, ada pula yang telah berpengalaman bertahun-tahun dalam menggunakan program-program tersebut. Oleh karena itu, *beberapa item dalam kuesioner ini mungkin hanya sedikit sesuai atau tidak sesuai bagi anda pada saat ini*. Untuk item yang samasekali tidak sesuai, mohon dilingkari “0” pada skala. Item-item yang lain menyatakan kepedulian yang anda *miliki*, dengan berbagai tingkat intensitasnya, sehingga harus ditandai lebih tinggi pada skala, sesuai dengan penjelasan pada bagian atas setiap halaman berikut.

Misalnya:

Pernyataan ini sangat benar untuk saya saat ini.	0 1 2 3 4 5 6 7
Pernyataan ini agak benar untuk saya sekarang.	0 1 2 3 4 5 6 7
Pernyataan ini tidak semua benar untuk saya saat ini.	0 1 2 3 4 5 6 7
Pernyataan ini tidak sesuai untuk saya.	0 1 2 3 4 5 6 7

Mohon diisi item-item berikut sesuai dengan *kepedulian anda saat ini*, atau bagaimana perasaan anda tentang keterlibatan anda atau kemungkinan keterlibatan anda dalam **RME (Realistic Mathematics Education)**. Kami tidak mempunyai definisi tertentu tentang program ini, jadi mohon ini dipandang sesuai dengan persepsi anda. Karena kuesioner ini digunakan untuk berbagai macam bentuk inovasi, istilah **RME** tidak pernah ditulis. Namun, frase seperti “inovasi ini,” “pendekatan ini,” dan “sistem yang baru ini” semuanya merujuk pada **RME**. Ingatlah dalam memberikan jawaban untuk setiap item harus merupakan *kepedulian anda saat ini* tentang keterlibatan anda atau kemungkinan keterlibatan anda dalam **RME**.

Terimakasih atas waktu yang anda luangkan untuk melengkapi kuesioner ini.

0	1 2	3 4	5 6 7
Tidak sesuai	Tidak benar untuk Saya saat ini	Agak benar untuk saya saat ini	Sangat benar untuk saya saat ini

1.	Saya peduli tentang sikap siswa terhadap inovasi ini.	0 1 2 3 4 5 6 7
2.	Sekarang saya mengetahui beberapa pendekatan lain yang mungkin lebih baik.	0 1 2 3 4 5 6 7
3.	Saya bahkan tidak mengetahui tentang inovasi ini.	0 1 2 3 4 5 6 7
4.	Saya sadar bahwa saya tidak mempunyai waktu yang cukup untuk mengatur diri saya setiap hari.	0 1 2 3 4 5 6 7
5.	Saya ingin membantu pihak lain dalam menggunakan inovasi ini.	0 1 2 3 4 5 6 7
6.	Saya mempunyai pengetahuan yang sangat terbatas tentang inovasi ini.	0 1 2 3 4 5 6 7
7.	Saya ingin mengetahui pengaruh pengaturan kembali ini terhadap status profesional saya.	0 1 2 3 4 5 6 7
8.	Saya sadar akan adanya pertentangan antara kepentingan dan tanggung jawab saya.	0 1 2 3 4 5 6 7
9.	Saya peduli tentang perlunya merevisi penggunaan inovasi ini yang selama ini saya gunakan.	0 1 2 3 4 5 6 7
10.	Saya ingin mengembangkan hubungan kerja, baik dalam kelompok saya maupun dengan kelompok lain dalam menggunakan inovasi ini.	0 1 2 3 4 5 6 7
11.	Saya sadar akan pengaruh inovasi ini terhadap siswa saya.	0 1 2 3 4 5 6 7
12.	Saya tidak peduli tentang inovasi ini.	0 1 2 3 4 5 6 7
13.	Saya ingin mengetahui siapa yang akan membuat keputusan tentang sistem yang baru ini.	0 1 2 3 4 5 6 7
14.	Saya ingin mendiskusikan tentang kemungkinan penggunaan inovasi ini.	0 1 2 3 4 5 6 7
15.	Saya ingin mengetahui sumber-sumber apa yang telah tersedia jika kami memutuskan untuk menggunakan inovasi ini.	0 1 2 3 4 5 6 7
16.	Saya sadar tentang ketidakmampuan saya untuk mengelola semua persyaratan yang diperlukan dalam inovasi ini.	0 1 2 3 4 5 6 7
17.	Saya ingin mengetahui bagaimana seharusnya perubahan cara saya mengajar ataupun pengaturannya.	0 1 2 3 4 5 6 7
18.	Saya ingin mengenal kelompok lain atau orang lain yang berhasil dalam menggunakan pendekatan ini.	0 1 2 3 4 5 6 7
19.	Saya sadar bahwa evaluasi dan perubahan peran saya berpengaruh terhadap para siswa.	0 1 2 3 4 5 6 7
20.	Saya ingin merevisi pendekatan mengajar yang digunakan dalam inovasi ini.	0 1 2 3 4 5 6 7
21.	Saya benar-benar sibuk dengan hal lain.	0 1 2 3 4 5 6 7

0	1 2	3 4	5 6 7
Tidak sesuai	Tidak benar untuk Saya saat ini	Agak benar untuk saya saat ini	Sangat benar untuk saya saat ini

22.	Saya ingin memodifikasi cara kami menggunakan inovasi ini berdasarkan pengalaman para siswa.	0 1 2 3 4 5 6 7
23.	Walaupun saya tidak mengetahui tentang inovasi ini, saya peduli tentang hal-hal lain pada bidang ini.	0 1 2 3 4 5 6 7
24.	Saya ingin siswa ikut merasa senang dengan peran mereka dalam pendekatan ini.	0 1 2 3 4 5 6 7
25.	Saya sadar bahwa di luar kegiatan akademis, saya banyak menggunakan waktu berkaitan dengan inovasi ini.	0 1 2 3 4 5 6 7
26.	Saya ingin mengetahui persyaratan yang diperlukan apabila ingin menggunakan inovasi ini segera pada waktu yang tidak terlalu lama.	0 1 2 3 4 5 6 7
27.	Saya ingin mengkoordinasikan usaha saya dengan pihak lain untuk memaksimalkan hasil inovasi ini.	0 1 2 3 4 5 6 7
28.	Saya ingin mengetahui lebih banyak informasi tentang waktu dan komitmen daya-upaya yang dibutuhkan dalam inovasi ini.	0 1 2 3 4 5 6 7
29.	Saya ingin mengetahui apa yang dilakukan kelompok lain dalam bidang ini.	0 1 2 3 4 5 6 7
30.	Pada saat ini, saya tidak tertarik untuk mempelajari inovasi ini.	0 1 2 3 4 5 6 7
31.	Saya ingin mencari cara untuk melengkapi, memperkaya atau mengganti inovasi ini.	0 1 2 3 4 5 6 7
32.	Saya ingin menggunakan masukan dari para siswa untuk mengubah program ini.	0 1 2 3 4 5 6 7
33.	Saya ingin mengetahui sejauh mana peran saya berubah ketika saya menggunakan inovasi ini.	0 1 2 3 4 5 6 7
34.	Mengkoordinasikan orang dan tanggung jawab terlalu banyak menyita waktu saya.	0 1 2 3 4 5 6 7
35.	Saya ingin mengetahui sejauh mana inovasi ini lebih baik daripada apa yang telah kami gunakan saat ini.	0 1 2 3 4 5 6 7

MOHON DILENGKAPI:

36. Apakah kepedulian lain, jika ada, yang anda rasakan saat ini? (Mohon dijelaskan dengan kalimat yang lengkap.)

37. Penjelasan ringkas tentang pekerjaan anda:

APPENDIX H
TEACHER REFLECTION FORM

Teacher Reflection Form

Please try to write down below your inner feelings and impressions about this whole lesson, as you would share the experience with your colleagues. The aspects you could think are instruction, students' work, materials, and your work in general. Please do not hesitate to give your opinion, be it positive or negative.

Lesson: ____

A. General impression

1. What was your general impression about the lesson?

a.	O	Useful	O	A bit useful	O	A bit useless	O	Useless
b.	O	Ran smoothly	O	Ran quite smoothly	O	Were some problems	O	Were many problems
c.	O	Time allocation realistic	O	Time allocation less realistic	O	Time allocation a bit not realistic	O	Time allocation not realistic
d.	O	Students learned a lot	O	Students learned some	O	Students learned a bit	O	Students learning nothing
e.	O	I gained a lot of new experiences	O	I gained some new experiences	O	I gained few new experiences	O	I gained no new experience

B. Preparing the lesson

2. What was your total preparation time for this lesson (beyond the inservice program):

O Less than 15 O 15 O 30 O 45 O 60 O 90 O More than 90 minutes

3. Which of the activities did you carry out for the preparation of the lesson and how long did each take? (it is possible that you did this during school time or in your spare time. Take both into account)

Activity	**time**	
Reading relevant pages on the background information	……….	minutes
Reading relevant pages on the textbook	……….	minutes
Reading relevant pages on reference books	……….	minutes
Collecting materials	……….	minutes
Thinking about classroom management	……….	minutes
Arranging materials in the classroom	……….	minutes
Others, (please specify)	……….	minutes

4. Tick one or more of the following if you agree with them:

 - O The preparation was complicated
 - O The preparation was more complicated than my usual lessons
 - O The teacher guide helped me a lot with the preparation of my lesson
 - O Not all required materials needed for this lesson were mentioned in the teacher guide, namely (*list the ones left out*) …………………………………………………………………………….
 - O Not all required materials needed for this lesson were easily to find, these were ……………………………………………………………………………………………
 - O Instead of (*name of the material*) ……………………………..…………………., I used (*name of material*) …………………………………………………………………………….

5. Tick one or more of the following if you agree with them:

 - O I would have given a completely different lesson without the teacher guide
 - O I have achieved more with the learners during this lesson than I do during my usual lessons
 - O I have achieved more with the students during this lessons than I would have without the use of the teacher guide
 - O I followed the teacher guide closely during the lesson
 - O I used the teacher guide as a general guide during my lesson
 - O I did not follow the teacher guide at all during my lesson

6. Is the background information sufficient for the lesson? O Yes O No

If no, what information would you like to be added/changed
……………………………………………………………………………………………
……………………………………………………………………………………………
……………………………………………………………………………………………

7. After reading the teacher guide, did you have clear idea how this lesson would look like?
 O Yes O No
 If yes, was the lesson you taught different from the idea you had developed from the teacher guide before the lesson? O Yes O No
 If yes, describe the difference,
 ……………………………………………………………………………………………
 ……………………………………………………………………………………………
 ……………………………………………………………………………………………

8. Are there sections in the teacher guide, which were less useful? O Yes O No
   If yes, which sections and why?
   …………………………………………………………………………………………
   …………………………………………………………………………………………
   …………………………………………………………………………………………
   …………………………………………………………………………………………

9. Which sections of the teacher guide did you find very useful and why?
   …………………………………………………………………………………………
   …………………………………………………………………………………………
   …………………………………………………………………………………………

10. Does the teacher guide provide enough and clear information for this lesson? O Yes O No

    If no, what kind of information did you miss or would you like to have changed?
    …………………………………………………………………………………………
    …………………………………………………………………………………………
    …………………………………………………………………………………………
    …………………………………………………………………………………………

11. (Tick one or more of the options below) What was your role and the students' role during the lesson?

Teacher's role

O Assessor of students
O Lecturer
O An interested spectator
O Instructor
O Active participant
O Explainer
O Guider of students which difficulties
O Other, (please specify) ………………

Students' role

O Active learner
O Passive learner
O Discusser
O Listener
O Group worker
O Individual worker
O Self-reliant student
O Other, (please specify) ………………

12. Did anything take you by surprise during this lesson (e.g. particular problem)? O Yes O No

    If yes, what was it and how did you manage it?

    ……………………………………………………………………………………………
    ……………………………………………………………………………………………

13. Do you feel the aims of this lesson were achieved? O Yes O No

    If no, indicate which aims were not met and why not?

    ……………………………………………………………………………………………
……………….………………………………………………………………………………
…………………………………………………………………………………………………

C. Students' participation

14. Ho would you describe the behavior of the students during this lesson?

a.	O	Active	O	A bit active	O	A bit passive	O	Passive
b.	O	Undependen t	O	A bit undependent	O	A bit dependent	O	Dependent
c.	O	Interested	O	A bit interested	O	A bit uninterested	O	uninterested

How would you describe the learning outcome for the students of activity' realistic problem solving for the topic Probability (uncertainties). I think the students who did the activity in this lesson learn

……………...…………………………………………………………………………
……………………………..………………………………………………………………
…………………………………………………………………………………………………
…………………………………………………………………………………………………

15. What changes in the set-up of this lesson could increase the participation, motivation and learning outcome of students?

    ……………………………………………………………………………………………
    ……………………………………………………………………………………………
    ……………………………………………………………………………………………
    ……………………………………………………………………………………………

APPENDIX I
RME EXEMPLARY LESSON MATERIAL
PERSAMAAN BELANJAAN (PENSIL AND BUKU) – *TEACHER GUIDE*

PERSAMAAN BELANJAAN (SHOPPING EQUATIONS)

Tentang Materi Pelajaran

- Topik: Menyelesaikan Persamaan Linear
- Kelas: 2 (dua) SLTP
- Waktu: 2 atau 3 kali 45 menit
- Alat/bahan: -

Kegiatan Siswa

Siswa membuat dan menyelesaikan **persamaan belanjaan** (*shopping equations*) untuk menentukan harga barang yang dibeli berdasarkan total harga dari kombinasi barang-barang belanjaan. Dengan menggunakan cara aljabar, siswa menentukan harga pensil dan buku, dan peubah x dan y.

Tujuan

Siswa dapat:

- Menentukan sebuah penyelesaian bersama dari sepasang persamaan secara aljabar;
- Menafsirkan dan menyusun informasi yang terdapat dalam cerita ke dalam bentuk matematika (menggunakan persamaan);
- Mengerti dan mampu menggunakan kekuatan aljabar untuk menampilkan dan memecahkan masalah.

Tentang Matematika

Pelajaran ini menyajikan beberapa metode untuk menentukan "penyelesaian bersama" dari sepasang persamaan dengan dua peubah. Contoh-contoh yang diberikan meliputi metode pertukaran, diagram kombinasi, menggunakan kelipatan dari persamaan, dan notasi 'notebook.' Pada setiap contoh, konteks yang diberikan mampu membuat siswa memahami metode aljabar. Semua cara yang dijelaskan di sini didasarkan pada pemikiran atau ide untuk membuat persamaan baru menjadi persamaan dengan satu peubah, kemudian menggunakan persamaan tersebut untuk mendapatkan harga barang yang ditanyakan. Dengan memanipulasi persamaan dengan cara mengalikan dan mengurangkan akan membantu siswa memahami lebih baik bagaimana persamaan dibentuk dan digunakan untuk menyelesaikan masalah.

Rencana Pelajaran

- Selama pelajaran biarkan siswa menyelesaikan setiap persamaan dengan cara mereka sendiri. Lebih baik bagi mereka menggunakan satu cara saja daripada memaksa mereka menggunakan seluruh cara yang diperkenalkan dalam pelajaran ini. Munculnya bermacam-macam cara dalam diskusi kelas akan membangkitkan rasa ingin tahu mereka untuk mencoba cara-cara lain.
- Anda dapat memulai pelajaran dengan meminta siswa membentuk kelompok-kelompok kecil (4 atau 5 siswa setiap kelompok) untuk menyelesaikan soal 1 sampai dengan 6, dan soal 10. Ajak siswa diskusi kelas mengerjakan soal 12. Soal 13 dan 14 dapat dikerjakan siswa berpasangan. Soal-soal yang lain (7, 8, 9 dan 11) dapat dikerjakan sendiri-sendiri.

Halaman 1 Buku Siswa

PERSAMAAN BELANJAAN (*SHOPPING EQUATIONS*)

PENSIL dan BUKU

Koperasi Siswa di **SLTP Realita** menjual perlengkapan alat tulis. Setiap siswa di sekolah tersebut lebih senang membeli perlengkapan belajar di koperasi mereka, sebab setiap jenis barang mempunyai harga yang sama. Misalnya, semua pensil (walaupun mereknya beda-beda) mempunyai harga yang sama, semua buku tulis mempunyai harga yang sama, dlsb.

Ani membeli 2 pensil dan 3 buku seharga Rp3.800,- Di sini kita belum tahu pasti harga sebuah pensil dan sebuah buku yang dibeli Ani.

1. a. Berapakah (kira-kira) harga sebuah pensil dan sebuah buku?
   b. Adakah harga yang lain untuk pensil dan buku selain jawaban soal a di atas? Jelaskan jawaban Anda.
   c. Apakah mungkin harga sebuah buku Rp1.300,-? Jika mungkin, mengapa? Jika tidak mungkin, mengapa?
2. a. Berapakah harga 4 buah pensil dan 6 buah buku?
   b. Sebutkan beberapa jumlah belanjaan yang lain (pensil dan buku) yang dapat diketahui harganya.

Anda dapat menulis sebuah **persamaan belanjaan** untuk barang-barang yang dibeli Ani. Jika P menyatakan harga pensil dan B menyatakan harga buku, maka persamaannya dapat dinyatakan dengan:

$$2P + 3B = 3800$$

Persamaan belanjaan di atas adalah contoh persamaan dengan dua peubah.

3. Tuliskanlah persamaan yang menyatakan harga 4 buah pensil dan 6 buah buku.

Contoh Jawaban Siswa

1. a. Ada banyak jawaban yang mungkin. Misalnya:
      - Sebuah pensil berharga Rp 400,- dan sebuah buku berharga Rp 1.000,-
      - Sebuah pensil berharga Rp 700,- dan sebuah buku berharga Rp 800,-
      - Sebuah pensil berharga Rp 1.000,- dan sebuah buku berharga Rp 600,-

   b. Ya, terdapat banyak kemungkinan kombinasi harga pensil dan buku sehingga dua buah pensil dan tiga buah buku berharga Rp 3.800,-

   c. Tidak, jika harga sebuah buku adalah Rp 1.300,- maka tiga buah buku sama dengan Rp 3.900,- lebih dari Rp 3.800,- (harga 2 buah pensil dan 3 buah buku).

2. a. Rp 7.600,- Caranya bermacam-macam. Siswa harus menyadari bahwa kombinasi 4 buah pensil dan 6 buah buku adalah dua kali 2 buah pensil dan 3 buah buku. Jadi harga yang baru sama dengan 2 x Rp 3.800,- = Rp 7.600,-

   b. Jawaban bisa bermacam-macam. Misalnya:
      - 6 buah pensil dan 9 buah buku berharga Rp 11.400,-
      - 8 buah pensil dan 12 buah buku berharga Rp 15.200,-
      - 10 buah pensil dan 15 buah buku berharga Rp 19.000,-

3. $4P + 6B = 7.600$

Komentar Tentang Soal

1. Mungkin ada siswa yang berpendapat bahwa jika harga pensil naik Rp 150,- maka harga buku turun Rp 100,- Mintalah siswa untuk membandingkan jawaban-jawaban mereka.
2. Sementara siswa bekerja menyelesaikan soal 2a, periksalah pemahaman mereka tentang notasi persamaan. Pastikan bahwa mereka mengerti bagaimana membaca dan menulis persamaan. Penting bahwa siswa mengerti arti dari angka dan huruf yang terdapat dalam persamaan dengan kata-kata mereka sendiri.
   Jika ada siswa yang menggunakan harga yang mereka peroleh untuk soal 1a, pastikan bahwa mereka juga mengerti hubungannya (mengalikan dua). Karena apabila jumlah barang dilipatduakan, maka harganya juga menjadi dua kali lipat.

3. Ketika Anda memperkenalkan istilah 'persamaan dengan dua peubah,' tanyakan kepada siswa "Mengapa persamaan tersebut dinamakan persamaan dengan dua peubah?" "Apa yang dimaksud dengan peubah?" [Disebut *persamaan* dengan dua peubah karena persamaan tersebut mempunyai dua bilangan yang tidak diketahui, yaitu P (harga sebuah pensil) dan B (harga sebuah buku)].

Halaman 2 Buku Siswa

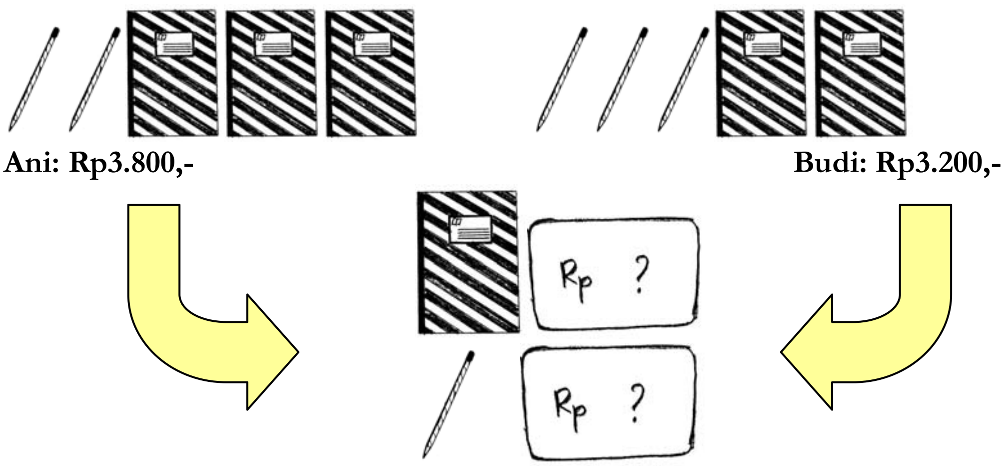
Kita dapat mencari beberapa nilai untuk P dan B yang membuat persamaan 2P + 3B = 3.800 bernilai benar.

4. Periksalah apakah pasangan bilangan P = 550 dan B = 900 membuat persamaan tersebut bernilai benar. Tentukan dua pasangan bilangan P dan B yang lain yang cocok untuk persamaan tersebut.

5. Pasangan bilangan P = -200 dan B = 1400 juga cocok untuk persamaan tersebut. Jelaskan mengapa nilai-nilai untuk P dan B tersebut tidak masuk akal.

6. Budi membeli 3 pensil dan 2 buku. Total harganya adalah Rp3.200,-
   a. Tuliskanlah sebuah persamaan untuk belanjaan Budi.
   b. Tentukan dua penyelesaian untuk persamaan tersebut dengan tidak melihat pada belanjaan Ani.

7. Lihatlah kembali pada informasi tentang belanjaan Ani dan Budi. Dengan menggabungkan informasi dari belanjaan Ani dan Budi, tentukan harga sebuah pensil dan harga sebuah buku.



Contoh Jawaban

4. (2 x Rp 550) + (3 x Rp 900) = Rp 3.800,-
   Pasangan angka yang digunakan siswa mungkin bervariasi. Salah satu kemungkinan yang membuat harga tidak berubah (Rp 3.800,-) adalah menambah harga sebuah pensil sebesar Rp 150,- dan mengurangi harga sebuah buku sebesar Rp 100,- Contoh jawaban:

Pensil	Buku
Rp 700,-	Rp 800,-
Rp 850,-	Rp 700,-
Rp 1000,-	Rp 600,-

5. Harga tidak mungkin negatif, misalnya sebuah pensil berharga – Rp 200,- (minus 200 rupiah) meskipun mungkin ada siswa yang memberikan alasan bahwa ada sebuah toko yang menawarkan 2 buah pensil gratis dengan diskon Rp 200,- kepada siswa yang membeli 3 buah buku.

6. a. 3P + 2B = 3200
   b. Jawaban akan beragam. Misalnya:
      - Tiga buah pensil berharga masing-masing Rp 1000,- dan dua buah buku berharga masing-masing Rp 100,-
      - Tiga buah pensil berharga masing-masing Rp 600,- dan dua buah buku berharga masing-masing Rp 700,-

7. Sebuah pensil berharga Rp 400,- dan sebuah buku berharga Rp 1000,- Cara mendapatkannya bervariasi. Salah satunya adalah:
   2P + 3B = 3800
   3P + 2B = 3200

dengan menukarkan sebuah buku dengan sebuah pensil, total harga berkurang Rp 600,- Siswa dapat meneruskan cara ini hingga:
   4P + 1B = 2600
   5P + 0B = 2000

Persamaan 5P = 2000 dapat diselesaikan untuk memperoleh P = 400, selanjutnya disubstitusikan pada salah satu persamaan untuk mendapatkan B.

Komentar Tentang Soal

4. Soal ini memberikan kesempatan kepada siswa untuk menemukan cara mereka sendiri mencari pasangan bilangan yang membuat persamaan bernilai benar. Kalau mereka berhasil mungkin akan menggunakan cara tersebut sampai soal terakhir. Berikan kesempatan kepada siswa untuk mencari penyelesaian dengan cara mereka sendiri. Diskusikan cara-cara yang digunakan siswa dengan seluruh kelas. Salah satu cara yang mungkin adalah dengan mempertukarkan harga pensil dan buku. Berdasar pada nilai +Rp 150,- untuk pensil dan dan – Rp 100,- untuk buku, maka akan diperoleh banyak pertukaran yang lain.

5. Untuk soal 5 ini, secara matematika penyelesaian (-200, 1400) adalah benar. Tetapi dalam konteks di soal ini, penyelesaian tersebut tidak masuk akal.

6. Pada soal 6b, siswa harus mampu mencari pasangan bilangan tersebut dengan usaha mereka sendiri. Berikan kesempatan kepada mereka untuk menemukannya sebisa mungkin.

Halaman 3 Buku Siswa

TABEL

Salah satu cara untuk menyelesaikan soal yang berkaitan dengan menghitung belanjaan adalah "notasi notebook" dengan informasi disusun dalam sebuah tabel.

Hanna menyelesaikan soal 7 menggunakan notasi notebook seperti ditunjukkan di sebelah kanan.

8. Jelaskan cara yang digunakan Hanna tersebut.

9. Salinlah tabel Hanna itu dengan menuliskan sebuah persamaan untuk setiap baris pada tabel.

	P	B	Harga
Belanjaan Ani	2	3	3.800
Belanjaan Budi	3	2	3.200
	6	9	11.400
	6	4	6.400
	0	5	5.000
	0	1	1.000
	0	3	3.000
	2	0	800
	1	0	400

Nisa menemukan cara khusus untuk menyelesaikan soal 7.

Ani			Budi		
P	B	Harga	P	B	Harga
2	3	3.800	3	2	3.200
4	6	7.600	6	4	6.400
6	9	11.400	9	6	9.600
8	12	15.200	12	8	12.800

	P	B	Harga
	6	9	11.400
dikurang	6	4	6.400
dibagi 5	0	5	5.000
	0	1	1.000

Nilai B sama dengan 1.000

10. a. Jelaskan cara yang digunakan Nisa.
    b. Jelaskan bagaimana Anda bisa menemukan nilai B.

Contoh Jawaban

8. Pertama-tama Hanna menulis belanjaan atau barang yang dibeli Ani dan Budi pada sebuah tabel. Selanjutnya, membuat belanjaan yang baru dengan cara melipat-tigakan belanjaan Ani dan melipatduakan belanjaan Budi. Pada baris ke-5, Hanna mengurangkan belanjaan baru yang telah dibuat. Pada baris ke-6 dia membagi baris ke-5 dengan lima untuk memdapatkan harga sebuah buku. Kemudian Hanna menggunakan harga sebuah buku (Rp 1000,-) untuk memperoleh harga tiga buku. Pada dua baris terakhir, dia menggunakan belanjaan Ani untuk mendapatkan harga sebuah pensil.

9. $2P + 3B = 3800$
$3P + 2B = 3200$

$$\begin{array}{rcr} 6P + 9B &=& 11400 \\ \underline{6P + 4B} &\underline{=}& \underline{6400} \\ 0P + 5B &=& 5000 \\ 1B &=& 1000 \\ 3B &=& 3000 \\ 3P + 0B &=& 800 \\ 1P &=& 400 \end{array}$$

10.a. Penjelasan akan beragam. Misalnya, Nissa membuat kolom dengan cara berturut-turut menambahkan belanjaan sebelumnya. Kemudian dia memilih dua baris dari setiap tabel yang terdapat 6 pensil dalam belanjaan. Dengan mengurangkan kedua belanjaan tersebut dia memperoleh harga lima buah buku sebesar Rp 5.000,- Kemudian membaginya dengan lima untuk memperoleh harga sebuah buku.

b. Uraiannya mungkin bervariasi. Misalnya, untuk mendapatkan harga pensil, substitusikan B = 1000 pada salah satu dari dua persamaan mula-mula:
$3P + 2(1000) = 3200$
$3P + 2000 = 3200$
$3P = 1200$
$P = 400$
Jadi, sebuah pensil berharga Rp 400,-

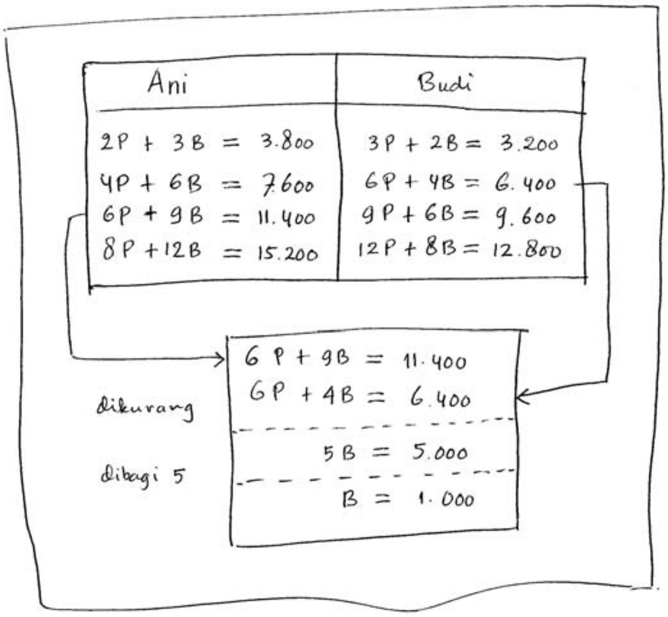
Komentar Tentang Soal

8-9. Pada soal 8 dan 9, siswa mempelajari notasi ‘notebook’ untuk menyelesaikan soal. Jika siswa mengalami kesulitan, Anda dapat melakukan diskusi dengan seluruh siswa. Menguasai metode ‘notebook’ tidak penting bagi siswa. Biarkan mereka menggunakan cara-cara yang masuk akal buat mereka. Namun, pastikan bahwa mereka mengerti sebagian cara yang dipakai dalam metode notebook.

10. Soal ini sangat penting karena siswa mulai belajar cara baru untuk menyelesaikan sebuah sistem persamaan linear dengan dua peubah. Jika siswa mengalami kesulitan maka ajaklah mereka untuk membahasnya bersama-sama dalam diskusi kelas.

Halaman 4 Buku Siswa

Di bawah ini adalah cara lain untuk melihat pekerjaan Hanna. Walaupun cara ini menggunakan persamaan, caranya masih tetap sama.



11. a. Anda dapat menentukan nilai P dengan menggabungkan persamaan
$4P + 6B = 7600$ dan $9P + 6B = 9600$
Bagaimana caranya? Tunjukkan!
b. Kalau sudah mendapatkan nilai $B = 1000$, ada cara lain untuk mendapatkan nilai P. Bagaimanakah caranya? Tunjukkan!

Pada soal 11, Anda menemukan sepasang bilangan yang memenuhi kedua persamaan. Sepasang bilangan tersebut disebut **penyelesaian besama** untuk kedua persamaan tersebut.

Contoh Jawaban

11. a. Dengan mengurangkan persamaan:

$$\begin{array}{ll} 9P + 6B &= 9600 \\ \underline{4P + 6B} &\underline{= 7600} \\ 5P &= 2000 \\ P &= 400 \end{array}$$

b. Substitusi harga sebuah buku pada salah satu persamaan yang memuat P dan B,

$2P + 3B = 3800$
$2P + 3000 = 3800$
$2P = 800$
$P = 400$

Komentar Tentang Soal

11. Soal ini dapat digunakan bersama-sama dengan soal 10. Jika Anda menggunakannya maka diskusikan perbedaan dan persamaan dari kedua soal tersebut.

Halaman 5 Buku Siswa

12. a. Tentukan penyelesaian bersama untuk dua persamaan
   $X + 2Y = 95$ dan $X + Y = 55$.
   Apakah terdapat lebih dari satu penyelesaian bersama?
   b. Apakah persamaan
   $X + 2Y = 95$ dan $3X + 6Y = 290$
   mempunyai sebuah penyelesaian bersama?
   c. Apakah ada sebuah penyelesaian bersama untuk tiga persamaan:
   $X + 2Y = 95$, $X + Y = 55$, dan $3X + Y = 110$?
   Jelaskan jawaban Anda!
   d. Yasmina mengatakan bahwa tiga persamaan tidak akan mungkin mempunyai penyelesaian bersama. Setuju atau tidak dengan Yasmina? Jelaskan!

Contoh Jawaban

12. a. Satu-satunya penyelesaian bersama untuk persamaan tersebut adalah X = 15 dan Y = 40. Caranya bisa beragam. Misalnya, kurangkan kedua persamaan untuk mendapatkan nilai Y:

$$\begin{array}{l} X + 2Y = 95 \\ \underline{X + Y = 55} \\ Y = 40 \end{array}$$

Jika Y = 40, maka
X + 2(40) = 95
X + 80 = 95
X = 15

b. Tidak. Penjelasan bisa beragam, misalnya, kalikan persamaan pertama dengan 3:

X + 2Y = 95
3X + 6Y = 285

Selisih antara persamaan 3X + 6Y = 285 dan persamaan 3X + 6Y = 290
menunjukkan bahwa tidak ada penyelesaian bersama yang mungkin.

c. Tidak. Penjelasan mungkin macam-mcam. Misalnya, dari soal 12a, kita mengetahui bahwa dua persamaan X + 2Y = 95 dan X + Y = 55 mempunyai penyelesaian bersama: X = 15 dan Y = 40. Dengan menggunakan nilai-nilai tersebut, maka 3X + Y sama dengan 85 (45 + 40), bukan 110.

d. Apa yang dikatakan Yasmina tidak benar, sebab jika persamaan ketiga diubah menjadi 3X + Y = 85, maka X = 15 dan Y = 40 adalah penyelesaian bersama dari ketiga persamaan tersebut.

Halaman 6 Buku Siswa

Ringkasan

Pada pelajaran ini, anda menyelesaian persamaan linear. Anda menggunakan dua cara, yaitu dengan tabel (notasi notebook) dan menggunakan persamaan.

Persamaan 2X + 5Y = 100 mempunyai dua peubah, jadi persamaan tersebut mempunyai banyak penyelesaian. Apabila sepasang bilangan memenuhi dua buah persamaan dengan dua peubah, maka pasangan bilangan tersebut disebut **penyelesaian bersama.**

Pertanyaan Ringkasan

Berikut ini ada dua buah persamaan dengan dua peubah:

$$2X + 5Y = 100$$
$$3X + 8Y = 156$$

13. Sepasang persamaan tersebut mempunyai sebuah penyelesaian. Tentukan penyelesaianya dengan menggunakan cara yang telah dibahas pada pelajaran ini.

14. Apakah setiap pasang persamaan dengan dua peubah pasti mempunyai penyelesaian bersama? Berikan contoh untuk mendukung argumen anda.

Contoh Jawaban

13. X = 20 dan Y = 12. Cara mendapatkannya bisa macam-macam. Misalnya,

$$\begin{array}{ll} (3X + 8Y = 156) \times 2 & 6X + 16Y = 312 \\ (2X + 5Y = 100) \times 3 & \underline{6X + 15Y = 300} \\ & \qquad\quad Y = \ \ 12 \end{array}$$

Substitusikan Y = 12 ke dalam persaman pertama, diperoleh:

2X + 5(12) = 100
2X + 60 = 100
2X = 40
X = 20

14. Tidak. Penjelasan bisa macam-macam. Misalnya,
Dua persamaan mungkin menyatakan hal yang sama. Seperti dua persamaan berikut:

2X + 3Y = 520
4X + 6Y = 1040

Kemungkinan lain, dua persamaan menyatakan dua hal yang saling bertentangan. Misalnya,
2X + 3Y = 10.000 dan 2X + 3Y = 15.000
Mungkin persamaan tersebut berasal dari hasil belanjaan dari dua toko yang berbeda dan dengan harga yang berbeda pula.

Komentar Tentang Soal:

Soal 13 dan 14 dapat Anda gunakan untuk menilai kemampuan siswa (secara aljabar) untuk mencari penyelesaian bersama dari sepasang persamaan. Boleh juga mendiskusikan dengan mereka cara-cara yang mereka gunakan dalam seluruh pelajaran. Berikan kesempatan kepada siswa untuk mencatat jawaban mereka untuk soal 14 pada buku catatan mereka.

APPENDIX J
RME EXEMPLARY LESSON MATERIAL
MENGGAMBAR GRAFIK DENGAN PERTUKARAN SEIMBANG
(KIJANG DAN COLT) – *TEACHER GUIDE*

MENGGAMBAR GRAFIK DENGAN *PERTUKARAN SEIMBANG*

Tentang Materi Pelajaran

- Topik: Persamaan Linear
- Kelas: 2 (dua) SLTP
- Waktu: 2 atau 3 kali 45 menit
- Alat/bahan: - kertas gambar (2 lembar untuk setiap siswa)
  - penggaris (1 buah untuk setiap siswa)

Kegiatan Siswa

Dengan menggunakan konteks menyewa mobil untuk keperluan pergi berkemah siswa belajar mengenai prinsip *pertukaran seimbang* (fair exchange), yaitu bagaimana mengatur atau menentukan mobil yang akan disewa sesuai dengan jumlah orang yang ikut dalam perkemahan. Siswa juga akan belajar bagaimana mencari penyelesaian sistem persamaan linear dengan menggunakan grafik, serta menggunakan metode aljabar.

Tujuan

Siswa dapat:

- Mengerti dan menggambar grafik persamaan AX + BY = C;
- Menentukan penyelesaian bersama dari sepasang persamaan linear secara grafik dan secara aljabar;
- Mengerti dan menggunakan hubungan antara persamaan, pertidaksaamaan, dan grafik;
- Menafsirkan dan menggunakan informasi yang diberikan dalam cerita ke dalam bentuk matematik (menggunakan persamaan, pertidaksamaan, dan grafik).

Tentang Matematika

Sebuah persamaan berbentuk AX + BY = C mempunyai sebuah grafik yang disebut garis. Himpunan dari seluruh penyelesaian untuk sebuah persamaan tunggal dapat diperoleh dengan menemukan satu penyelesaian saja kemudian menggunakan *pertukaran seimbang* (fair exchange) untuk mendapatkan seluruh penyelesaian yang lain. Penyelesaian pertama dapat dicari dengan metode terka-dan-periksa (guess-and-check) atau dengan menentukan titik potong dengan salah satu sumbu (yaitu dengan memasukkan nol pada salah satu peubah). Menggambar grafik dengan menggunakan titik potong dengan sumbu x dan y merupakan cara yang sangat berguna, tapi tidak dibicarakan di sini. Pada bagian ini, fokusnya adalah bagaimana memahami *pertukaran seimbang* dan hubungannya dengan grafik.

Rencana Pelajaran

- Untuk memulai pelajaran ini Anda dapat menanyakan kepada siswa berapa banyak tas yang dibawa jika siswa berpergian bersama orangtua. Ajukan pertanyaan seperti: *Apakah masuk akal, 96 orang yang akan pergi berkemah membawa 64 dus berisi perlengkapan berkemah?* dan *Apakah menurut pendapat kamu jumlah orang dan jumlah dus sesuai dengan kendaraan yang akan digunakan?*
- Anda boleh membimbing siswa secara ringkas pengertian pertukaran seimbang, sebelum mereka mulai bekerja.
- Siswa dapat bekerja sendiri untuk soal-soal: 1 dan 2 serta 14, 15 dan 16. Soal-soal 4 dan 5 dapat diberikan sebagai PR, Soal-soal 3, 6 sampai dengan 13 dapat dikerjakan siswa dalam kelompok kecil terdiri dari 4 hingga 5 orang.

Halaman 1 Buku Siswa

Menggambar Grafik dengan *Pertukaran Seimbang*

Kijang dan Colt

Siswa dan siswi kelas 2 **SLTP Realita** akan pergi berkemah. Ada **96** orang yang akan ikut, terdiri dari siswa-siswi dan guru pembimbing. Semua tas, bagasi dan perlengkapan dimasukkan ke dalam **64** kotak (dus) yang ukurannya sama. Panitia ingin menyewa mobil yang akan membawa mereka ke lokasi perkemahan. Ada dua pilihan, yaitu mobil kijang dan colt L-300.

Kijang

Tempat duduk: 6 orang
Bagasi: 5 kotak (dus)

Colt L-300

Tempat duduk: 8 orang
Bagasi: 4 kotak (dus)

1 a. Jika panitia memutuskan untuk menyewa mobil ***colt*** saja, berapa buah yang mereka perlukan? Catatan: demi keselamatan dalam perjalanan tidak ada dus yang diletakkan di atas jok mobil.
   b. Jika panitia memutuskan untuk menyewa mobil ***colt*** saja, bagaimana cara mengatur pembagiannya agar peserta bisa lebih lapang selama perjalanan?

2. Bagaimana seandainya panitia menyewa mobil ***kijang*** saja, apa perbedaannya? Apa persamaannya?

Untuk setiap mobil tentu diperlukan seorang sopir. Panitia ingin mengurangi jumlah mobil yang disewa. Mereka berpikir untuk menyewa ***sekaligus*** mobil kijang dan colt.

Contoh Jawaban

1. a. Mereka memerlukan 16 colt. Siswa akan menghitung 96 : 8 = 12 colt untuk orang, dan 64 : 4 = 16 colt untuk dus. Jadi, mereka memerlukan sekurang-kurangnya 16 colt.

   b. Dengan 16 colt anda dapat membagi 96 orang secara merata, yaitu 6 orang untuk setiap colt.

2. Jika mereka hanya menyewa kijang, mereka tetap memerlukan 16 mobil. Mereka memerlukan 96 : 6 = 16 kijang untuk orang, dan 64 : 5 ≈ 13 kijang (satu mobil tidak penuh) untuk dus. Jadi, mereka memerlukan sekurang-kurangnya 16 kijang. Ke 64 dus dibagi secara merata dengan 4 (empat) buah dus pada setiap kijang.

Komentar Tentang Soal

Aturan yang ditetapkan oleh agen penyewaan mobil tidak boleh meletakkan barang di atas jok. Hal ini perlu diperhatikan dalam menentukan penempatan dus dalam setiap mobil.

Halaman 2 Buku Siswa

Untuk membantu panitia menyelesaikan masalah di atas, yaitu menentukan jumlah mobil kijang dan colt yang harus disewa, kita dapat menggunakan metode ***pertukaran seimbang***. Langkah pertama yang harus dilakukan adalah menghitung jumlah orang yang ikut tanpa memperhatikan jumlah dus yang harus dibawa.

Untuk 96 orang peserta yang ikut, terdapat beberapa kemungkinan, misalnya menyewa 16 buah mobil colt dan tanpa menyewa mobil kijang (untuk ringkasnya bisa kita sebut menyewa 16 colt dan 0 kijang).

3. a. Kalau hanya menghitung jumlah orang yang ikut (tanpa mem-perhatikan jumlah dus), maka pertukaran seimbang untuk soal ini adalah *menukar 4 kijang dengan 3 colt*. Mengapa ini bisa dilakukan?
   b. Buatlah daftar kombinasi yang mungkin tentang jumlah kijang dan colt untuk mengangkut 96 orang.
   c. Ambilah dua kombinasi, dan periksalah apakah kombinasi tersebut dapat mengangkut 96 orang.

Contoh Jawaban

3. a. Empat kijang membawa 24 orang, dan tiga colt membawa 24 orang. Jadi, jika anda menukarkan empat kijang dengan 3 colt, jumlah orang yang dapat dibawa tetap sama.

   b.

Mengangkut 96 Orang	
Kijang	*Colt*
16	0
12	3
8	6
4	9
0	12

   c. iswa mungkin memeriksa salah satu dari kombinasi di atas.

Misalnya,

Untuk pasangan pertama:
(6 x 16) + (8 x 0) = 96 + 0 = 9
Untuk pasangan kedua:
(6 x 12) + (8 x 3) = 72 + 24 = 96

Halaman 3 Buku Siswa

Sekarang hitung jumlah dus yang harus dibawa.

4. a. Tentukan suatu pertukaran seimbang antara kijang dan colt untuk mengangkut dus?
   b. Buatlah daftar kombinasi yang mungkin untuk kijang dan colt sehingga bisa mengangkut seluruh 64 dus.

5. Bandingkan penyelesaian untuk orang dan dus. Bagaimana saran kamu kepada Panitia Pelaksana tentang kombinasi yang paling baik (berapa buah kijang dan berapa buah colt yang semestinya disewa)?

Contoh Jawaban

4. a. Pertukaran seimbang adalah 4 (empat) kijang dengan 5 (lima) colt, karena 4 kijang dapat mengangkut 20 dus dan 5 colt juga dapat mengangkut 20 dus.

   b.

Mengangkut 64 dus	
Kijang	*Colt*
0	16
4	11
8	6
12	1

5. Jawaban akan beragam. Misalnya, Ada sebuah pasangan bilangan yang termasuk dalam daftar: 8 kijang dan 6 colt. Kombinasi ini mengangkut tepat 96 orang dan 64 dus tanpa ada tempat yang tersisa.

Komentar Tentang Soal

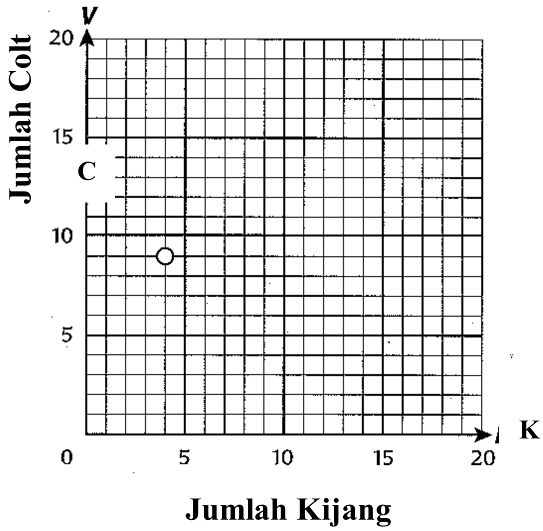
Soal 4 dan 5 ini dapat anda berikan sebagai PR. Pada soal ini siswa menggunakan cara-cara yang masuk akal untuk menemukan kombinasi yang paling efisien.

Halaman 4 Buku Siswa

Di antara Titik-titik

Menggunakan pertukaran seimbang menjadi sukar jika bilangannya besar. Cara lain selain itu adalah menggunakan grafik. Perhatikan bahwa salah satu penyelesaian untuk mengangkut 96 orang adalah pasangan bilangan: (K, C) = (4, 9). K menyatakan jumlah mobil kijang dan C menyatakan jumlah mobil colt. Pada diagram di bawah ini, titik (4, 9) ditandai dengan sebuah lingkaran kecil.

6. a. Apakah arti kombinasi (4, 9)?
   b. Gambarlah sebuah grafik dan gunakan lingkaran kecil untuk menandai kombinasi yang lain yang memenuhi jumlah orang yang diangkut. (Lihat kembali soal 3).
   c. Bagaimana pertukaran seimbang digunakan untuk menggambar titik-titik?
   d. Semua titik-titik tersebut terletak pada sebuah garis. Jelaskan mengapa banyak titik-titik yang lain pada garis tersebut tidak bisa digunakan untuk menyelesaikan soal.



7. Pada grafik yang sama, gunakan tanda "x" untuk menandai kombinasi yang bisa digunakan untuk mengangkut dus. (Lihat kembali soal 4).

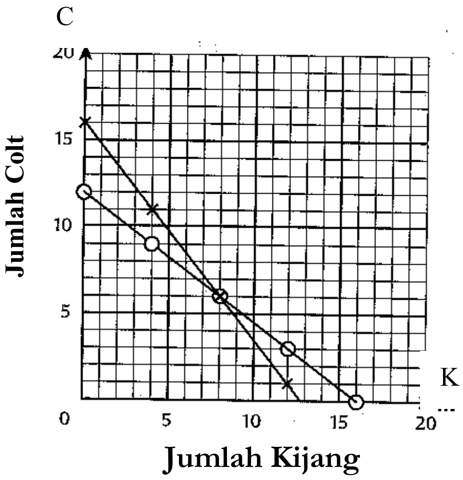
8. Jelaskan, apa yang dapat diperoleh dari grafik tersebut tentang transportasi ke lokasi perkemahan.

9. Seorang siswa berkata: "Kita harus menyewa 14 mobil." Apakah pernyataannya benar?

Contoh Jawaban

6. a. Artinya, menyewa 4 (empat) kijang dan 9 (sembilan) colt.

   b.



   c. Mulai dari (4, 9) naik ke atas tiga (menambah jumlah colt sebanyak tiga buah) dan bergerak ke kiri empat (mengurangi jumlah kijang sebanyak empat buah). Bisa juga, bergerak ke bawah tiga dan ke kanan empat.

   d. Penjelasan beragam, tapi siswa harus ingat bahwa mereka tidak bisa menyewa sebagian kendaraan. Misalnya, 6 kijang dan 7,5 colt terletak pada sebuah garis tetapi kita tidak bisa menyewa 7,5 colt.

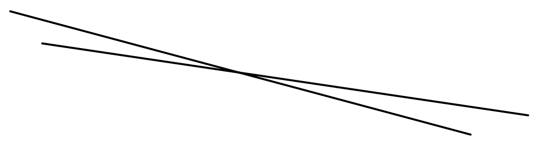
7. Lihat penyelesaian grafik untuk soal 6b.

8. Penjelasan akan beragam. Garis dengan tanda x menunjukkan semua kombinasi untuk mengangkut dus tanpa memperhatikan jumlah orang. Sementara garis dengan tanda o menunjukkan semua kombinasi untuk mengangkut orang. Titik potong (8, 6) menunjukkan kombinasi untuk mengangkut orang dan dus.

9. Ya benar. Penjelasan macam-macam. Misalnya, selain semua kombinasi lain memenuhi kedua persyaratan (dus dan orang), paling tidak diperlukan 14 kendaraan. Lebih sedikit dari itu tidak mungkin, karena sebagaimana jawaban soal-soal sebelumnya kita ketahui 16 buah colt atau 16 kijang dapat mengangkut orang dan dus.

Halaman 5 Buku Siswa

Ketika menggunakan grafik untuk menyelesaikan problem pertukaran seimbang, kadang-kadang koordinat penyelesaian tersebut bukan bilangan bulat, atau kadang-kadang berupa sudut kecil seperti berikut:



Berdasarkan alasan tersebut, mungkin agak sukar untuk menentukan penyelesaian yang tepat melalui grafik, sehingga lebih baik menggunakan persamaan. Untuk persoalan tansportasi yang diuraikan di sini, sebuah persamaan yang menyatakan persyaratan untuk *mengangkut* orang adalah:

$$K \times 6 + C \times 8 = 96$$

10. Jelaskan makna seluruh angka dan simbol pada persamaan di atas.

Rafika menulis 6K + 8C = 96

11. Apakah persamaan yang ditulis Rafika sama dengan persamaan di atas (soal 10)?

12. a. Sekarang pikirkan persyaratan untuk *mengangkut* dus. Tulislah sebuah persamaan untuk soal ini.
    b. Jelaskan makna angka-angka dan simbol-simbol pada persamaan tersebut.

Jika kamu menulis persamaan seperti Rafika, kamu memperoleh dua persamaan yang kelihatannya mirip dengan persamaan yang digunakan untuk memecahkan *persamaan belanjaan*. Kamu dapat menggunakan cara yang sudah kamu kenal untuk menyelesaikan persamaan tersebut.

13. Carilah penyelesaian bersama untuk kedua persamaan tersebut. Periksalah bahwa penyelesaian tersebut sama dengan penyelesaian menggunakan grafik.

Contoh Jawaban

10. 6 artinya enam orang untuk setiap kijang.
    K artinya jumlah kijang.
    8 artinya delapan orang untuk setiap colt.
    C artinya jumlah colt
    98 adalah jumlah seluruh peserta (orang) yang harus diangkut.

11. Ya, sama. Siswa harus menjelaskan bahwa kedua persamaan tersebut menggambarkan tentang 96 orang yang harus diangkut, masing-masing enam orang pada setiap kijang dan delapan orang pada setiap colt.

12. a. $5K + 4C = 64$
    b. Setiap kijang dapat mengangkut 5 (lima) dus, dan setiap colt dapat mengangkut 4 (empat) dus. K adalah jumlah kijang dan C adalah jumlah colt. Bersama-sama, colt dan kijang harus dapat mengangkut 64 dus.

13. (K, C) = (8, 6). Caranya beragam. Misalnya,

    Cara 1

    $$(5K + 4C = 64) \times 2$$
    $$\begin{array}{l} 10K + 8C = 128 \\ \underline{\ \ 6K + 8C = \ \ 96} \\ 4K \ = 32 \\ K \ = 8 \end{array}$$

    Substitusikan K = 8 ke dalam persamaan kedua diperoleh:

    $$6(8) + 8C = 96$$
    $$48 + 8C = 96$$
    $$8C = 48$$
    $$C = 6$$

    Cara 2

    Dengan melanjutkan pola: turunkan K dengan satu dan C dengan empat maka jumlahnya berkurang sebanyak 32.

    $$6K + 8C = 96$$
    $$5K + 4C = 64$$
    $$4K + 0C = 32$$
    $$K = 8$$

    Substitusi K = 8 ke dalam persamaan pertama, diperoleh:

    $$6(8) + 8C = 96$$
    $$48 + 8C = 96$$
    $$8C = 48$$
    $$C = 6$$

Halaman 6 Buku Siswa

Ringkasan

Pada bagian ini, kamu telah menemukan penyelesaian terhadap masalah penyewaan mobil. Salah satu caranya adalah, kamu menentukan beberapa kombinasi colt dan kijang yang memenuhi dua persyaratan (dus dan orang). Kombinasi-kombinasi tersebut dapat dicari dengan menggunakan prinsip *pertukaran seimbang*. Kemudian kamu menggunakan dua garis untuk mencari penyelesaian bersama. Cara lain adalah dengan membuat dua persamaan masing-masing untuk dus dan orang kemudian menyelesaikan persamaan tersebut seperti *persamaan belanjaan*.

Pertanyaan Ringkasan

14. Apakah arti pertukaran seimbang? Gunakan sebuah contoh untuk menjelaskan.

Perhatikan persamaan: $2X + 5Y = 100$.

15. a. Carilah beberapa kombinasi (X, Y) yang merupakan penyelesaian persamaan tersebut.
    b. Gambarlah grafik persamaan tersebut. Jelaskan bagaimana cara kamu menggambar.
    c. Jelaskan pertukaran seimbang dengan grafik yang kamu buat.

16. a. Gambarlah sebuah grafik untuk persamaan $5X + 2Y = 82$ pada gambar yang sama dengan soal 15.
    b. Berapakah penyelesaian bersama untuk kedua persamaan tersebut?

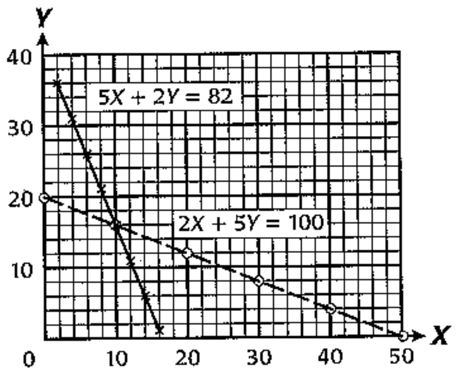
Contoh Jawaban

14. Penjelasan akan beragam. Misalnya, *Pertukaran seimbang* artinya bahwa kita dapat menukarkan jumlah kijang dan colt sedemikian sehingga jumlah orang yang dapat diangkut tetap sama. Misalnya, empat kijang dapat mengangkut 24 orang dan tiga colt dapat mengangkut 24 orang, jadi empat kijang dapat ditukar dengan tiga colt.

15. a. Jawaban akan beragam. Misalnya,

X	Y
0	20
10	16
20	12
30	8
40	4
50	0

b.



Penjelasan akan beragam. Misalnya, untuk X = 0, Y = 20; untuk X = 20, Y = 12. Kedua titik tersebut, yaitu (0, 20) dan (20, 12) sudah cukup untuk menentukan garis yang diminta.

c. Penjelasan akan beragam. Misalnya, pertukaran seimbang untuk persamaan tersebut adalah 5 X untuk 2 Y, yaitu jika X bertambah dengan 5 (bergerak ke kanan sebanyak 5 pada grafik), maka kita harus mengurangi Y dengan 2 (menurunkan 2 pada grafik).

16. a. Lihat grafik untuk jawaban soal 15b.

X	Y
0	41
2	36
4	31
6	26
8	21
10	16
12	11
14	6
16	1

b. (10, 16)

APPENDIX K
RME EXEMPLARY LESSON MATERIAL
POLA DAN BARISAN BILANGAN – *TEACHER GUIDE*

POLA DAN BARISAN BILANGAN
(Mencari Rumus Jumlah Suku ke-n)

Tentang Materi Pelajaran

- Topik: Pola dan barisan bilangan
- Kelas: 1 (satu) SLTP
- Waktu: 2 atau 3 kali 45 menit
- Alat/bahan: - Cangkir plastik yang bisa disusun (minimal 4 buah)
  - Penggaris (satu untuk setiap kelompok)

Kegiatan Siswa

Siswa menyusun cangkir dan menentukan tinggi susunan dengan menggunakan rumus rangkaian panah. Berikanlah kesempatan kepada siswa untuk melakukan kegiatan ini secara benar (mungkin diperlukan 20 hingga 30 menit). Siswa bekerja dalam kelompok kecil terdiri dari 4 hingga 5 orang per kelompok.

Tujuan

Siswa dapat:
- Menuliskan kembali bilangan untuk memudahkan perhitungan.
- Menyusun dan menafsirkan rumus sederhana.
- Menarik kesimpulan berdasarkan serangkaian perhitungan rumus informal dengan rangkaian panah.
- Menggunakan peubah kalimat (kata) untuk menjelaskan sebuah rumus atau prosedur.

Tentang Matematika

Kebanyakan rumus dapat dinyatakan dengan lebih dari satu cara. Rumus biasanya dinyatakan (ditulis) sesuai dengan kegunaannya. Pada pelajaran ini siswa membandingkan beberapa rumus yang berbeda untuk menentukan tinggi susunan cangkir dan kursi. Dua buah rumus mungkin kelihatannya berbeda. Namun, apabila besaran-besaran yang digunakan pada kedua rumus tersebut berasal dari sumber yang sama, maka kedua rumus tersebut ekivalen.

Rencana Pelajaran

- Berikan kesempatan kepada siswa melakukan kegiatan menyusun cangkir secara benar dalam kelompok kecil terdiri dari 4 atau 5 orang. Kegiatan ini mungkin membutuhkan 20 hingga 30 menit. Soal-soal 1 hingga 6 dapat dikerjakan dalam kelompok kecil tersebut.
- Siswa dapat melanjutkan bekerja dalam kelompok kecil untuk soal-soal 7 hingga 10.
- Soal-soal 11 sampai dengan 13 dapat Anda berikan sebagai PR.
- Bimbinglah siswa untuk mendiskusikan soal-soal 14 dan 15, dan menarik kesimpulan bersama-sama tentang pelajaran ini.

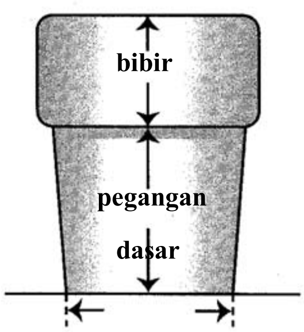
Halaman 1 Buku Siswa

Pola dan Barisan Bilangan (Mencari Rumus Jumlah Suku ke-n)

Menyusun Cangkir

Bahan-bahan:

Masing-masing kelompok perlu penggaris dan sekurang-kur empat buah cangkir yang sama. Cangkir plastik seperti yang digunakan pada even olahraga atau rumah makan *fast-food* sang dipakai sebagai bahan dalam kegiatan ini.

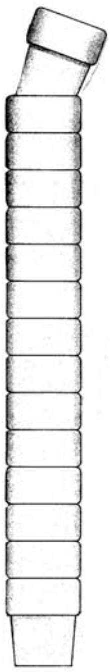


1. Ukur dan catat:
   - Tinggi cangkir seluruhnya
   - Tinggi bibir cangkir
   - Tinggi pegangan cangkir

   (Catatan: Pegangan cangkir adalah jarak dari dasar cangkir ke bibir cangkir bagian bawah.)

2. Susunlah dua buah cangkir. Ukurlah tinggi susunan tersebut.

3. a. Tanpa mengukur, perkirakan tinggi susunan empat buah cangkir.
   b. Tuliskan bagaimana anda melakukan perkiraan. Bicarakan hal tersebut dengan seorang teman yang ada di dekat anda.
   c. Buatlah susunan empat buah cangkir dan ukurlah. Apakah perkiraan Anda tepat.



4. Gunakan cara yang anda temukan pada soal 3 untuk menghitung tinggi susunan 17 buah cangkir. Jelaskan perhitungan tersebut dengan rangkaian tanda panah.

5. Pilih dua susunan cangkir yang berbeda. Untuk masing-masing susunan tersebut, hitung tingginya. Kemudian gabungkan kedua susunan tersebut menjadi satu dan hitung tingginya. Bandingkan dengan hasil yang pertama.

6. a. Di bawah rak ada ruang kosong dimana cangkir cangkir tersebut disimpan. Tinggi ruang tersebut adalah 50 centimeter. Berapa banyak cangkir dapat disusun pas di bawah rak tersebut?

   b. Gunakan bahasa panah untuk menjelaskan hasil yang anda peroleh.

Contoh Jawaban

1. Jawaban beragam tergantung cangkir yang digunakan. Misalnya, tinggi cangkir 7,5 cm dengan bibir 2,5 cm dan pegangan 5 cm.

2. 10 cm (berdasarkan jawaban soal 1). Tinggi susunan diukur berdasarkan dua kali tinggi bibir ditambah tinggi pegangan, atau 2 x 2,5 cm + 5 cm = 10 cm.

3. a. Jawaban beragam.
   b. Jawaban beragam. Misalnya, berdasarkan jawaban soal 1:

"Saya membayangkan ada empat bibir dengan tinggi masing-masing 2,5 cm berarti 10 cm, dan satu pegangan yaitu 5 cm. Karena 10 cm + 5 cm = 15 cm, saya menduga tinggi susunannya adalah 15 cm."

   c. Jawaban beragam. Perbedaan kecil mungkin terjadi disebabkan kesalahan pengukuran. Kadang-kadang susunan lebih tinggi dari perkiraan karena susunan cangkir tidak melekat secara baik.

4. Jawaban beragam. Misalnya, berdasarkan jawaban soal 1:

$$2{,}5\text{ cm} \xrightarrow{\times 17} 42{,}5\text{ cm} \xrightarrow{+5} 47{,}5\text{ cm}$$

5. Jawaban beragam. Misalnya, berdasarkan jawaban soal 1:

Jumlah Cangkir	Tinggi (cm)
1	7,5
2	10
3	12,5
4	15

6. a. Jumlah cangkir yang dapat disimpan pas di bawah rak adalah 18 buah (berdasarkan jawaban soal 1). Beberapa siswa mungkin menjawab 17 agar memudahkan cangkir diambil dari tempatnya. Untuk menyelesaikan soal ini siswa dapat menggunakan cara terka-dan-periksa, tabel, atau menggunakan penjumlahan dan pengurangan berulang.
   b. Jawaban beragam. Misalnya berdasarkan jawaban soal 1:

$$50\text{ cm} \xrightarrow{-5} 45\text{ cm} \xrightarrow{:2{,}5} 18$$

Komentar Tentang Soal

1. Beberapa siswa mungkin memerlukan penjelasan mengenai pengertian pegangan dan bibir.

2. Anda mungkin perlu mencontohkan kepada siswa cara mengukur tinggi susunan.

3. Beberapa siswa mungkin menghitung secara tepat, sementara yang lain hanya menerka-nerka.

4. Jika siswa perlu bantuan, Anda dapat meminta mereka untuk membuat tabel untuk memudahkan menemukan polanya.

5. Soal ini dapat digunakan untuk menilai kemampuan siswa dalam menulis bilangan. Jika siswa mengalami kesulitan, Anda dapat menjelaskan bahwa dengan mengetahui tinggi bibir dan pegangan dapat membantu menentukan tinggi susunan.

6. Soal ini dapat digunakan untuk menilai kemampuan siswa dalam menulis bilangan. Dalam soal ini siswa dapat bekerja terbalik atau menggunakan tabel terus-menerus sampai mendapatkan tinggi 50 cm. Beberapa siswa yang lain mungkin menduga jumlah cangkir, kemudian memeriksa dugaan tersebut sampai mereka mendapatkan jawaban yang benar.

Halaman 2 Buku Siswa

Kadang-kadang sebuah rumus bisa membantu untuk menyelesaikan soal. Anda dapat menyusun sebuah rumus untuk menentukan tinggi susunan cangkir jika jumlah cangkirnya diketahui.

7. Lengkapilah tanda panah di bawah ini sebagai sebuah rumus dengan masukan (input) jumlah cangkir dan keluaran (output) tinggi susunan cangkir.

$$\text{Jumlah cangkir} \xrightarrow{?} \underline{\;?\;} \xrightarrow{?} \text{Tinggi susunan cangkir}$$

Anggaplah bahwa kelas yang lain mempunyai cangkir yang berbeda. Siswa di kelas tersebut menggunakan rumus di bawah ini untuk menentukan tinggi susunan cangkir mereka:

$$\text{Jumlah cangkir} \xrightarrow{-1} \underline{\quad} \xrightarrow{\times 3} \underline{\quad} \xrightarrow{+15} \text{Tinggi susunan cangkir}$$

8. a. Berapakah tinggi susunan 10 buah cangkir?
   b. Berapakah tinggi susunan 5 buah cangkir?
   c. Buatlah sketsa sebuah cangkir dari kelompok ini. Tandailah tinggi cangkir sesungguhnya dari sketsa yang anda buat.

Sekarang perhatikan rumus berikut:

$$\text{Jumlah cangkir} \xrightarrow{\times 3} \underline{\quad} \xrightarrow{+12} \text{Tinggi susunan cangkir}$$

9. Dapatkah rumus tersebut digunakan sebagaimana soal 8? Jelaskan.

10. Cangkir-cangkir tersebut disimpan pada sebuah ruangan yang tingginya 50 centimeter. Berapa banyak cangkir yang dapat diletakkan dalam satu susunan? Jelaskan bagaimana anda mendapatkan jawaban tersebut.

Contoh Jawaban

7. Rangkaian panah berikut dilengkapi berdasarkan jawaban soal 1.

Jumlah cangkir $\xrightarrow{\text{x } 2,5}$ Tinggi bibir $\xrightarrow{+ 5 \text{ cm}}$ Tinggi susunan cangkir

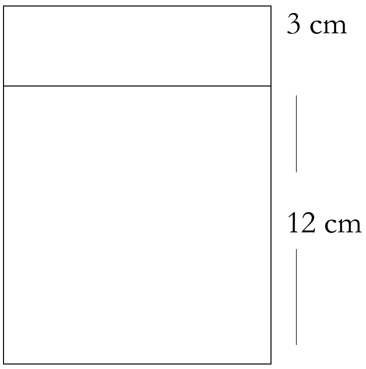
8. a. 42 cm

$10 \xrightarrow{-1} 9 \xrightarrow{\text{x } 3} 27 \xrightarrow{+15} 42$

b. 27 cm

$5 \xrightarrow{-1} 4 \xrightarrow{\text{x } 3} 12 \xrightarrow{+15} 27$

c.



d. Jawaban beragam. Siswa harus belajar dari jawaban a dan b sampai mereka menyadari bahwa setiap cangkir tingginya 15 cm yang terdiri dari 12 cm pegangan dan 3 cm bibir.

9. Ya. Penjelasannya beragam, namun siswa boleh beralasan bahwa rumus tersebut hanya untuk cangkir yang sama karena keduanya memberikan hasil yang sama.

10. 12 buah cangkir akan pas ditempatkan pada ruang yang tingginya 50 cm. Penjelasan beragam, misalnya:

50 cm $\xrightarrow{-12}$ 38 cm $\xrightarrow{:3}$ 12 2/3 cangkir atau 12 cangkir

Komentar Tentang Soal

Kebanyakan rumus dapat dinyatakan dengan lebih dari satu cara. Rumus biasanya dinyatakan (ditulis) sesuai dengan kegunaannya. Pada halaman ini siswa membandingkan dua macam rumus untuk jenis cangkir yang sama. Rumus pada soal 8 menggunakan tinggi cangkir (15 cm) dan bibir cangkir (3 cm). Sementara rumus pada soal 9 menggunakan pegangan cangkir (12 cm) dan bibir cangkir (3 cm). Karena kedua rumus tersebut menggunakan ukuran yang berbeda, rumusnya kelihatan berbeda. Namun, karena besaran-besaran yang digunakan dalam kedua rumus tersebut berasal dari cangkir yang sama, maka kedua rumus tersebut ekivalen.

8. Untuk soal 8c, dalam menggambar cangkir siswa mungkin mengalami kesukaran dengan bilangan – 1 seperti yang tertulis pada rumus rangkaian panah. Pertama-tama arahkan siswa untuk memahami makna bilangan 15.

9. Doronglah siswa untuk menggunakan contoh untuk menjelaskan hubungan antara kedua rumus.

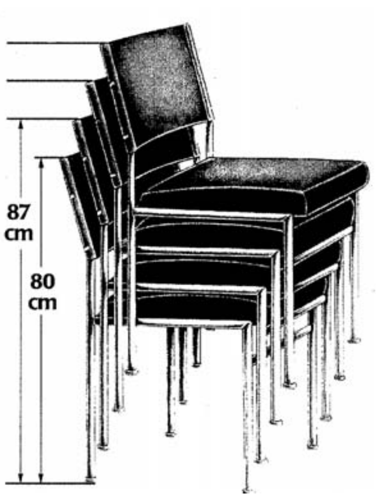
Halaman 3 Buku Siswa

Menyusun Kursi

Gambar di bawah menunjukkan susunan kursi. Perhatikan bahwa tinggi sebuah kursi adalah 80 centimeter, dan susunan dua buah kursi adalah 87 centimeter.
Donny berpendapat bahwa rumus di bawah ini dapat digunakan untuk menentukan tinggi susunan kursi:

Jumlah kursi $\xrightarrow{-1}$ ___ $\xrightarrow{\times 7}$ ___ $\xrightarrow{+80}$ Tinggi susunan kursi

11. Jelaskan makna dari setiap angka pada rumus tersebut.



12. Albar berpendapat bahwa rumus tersebut dapat disederhanakan sebagai berikut:

Jumlah kursi $\xrightarrow{\times \ldots}$ ___ $\xrightarrow{+\ldots}$ Tinggi susunan

a. Sebutkan angka-angka yang digunakan oleh Albar pada rumus tersebut? Jelaskan bagaimana anda memperoleh angka-angka tersebut.
b. Albar berpikir untuk membuat rumus sebagai berikut:

Jumlah kursi $\xrightarrow{+\ldots}$ ___ $\xrightarrow{\times \ldots}$ Tinggi susunan

Apakah rumus tersebut bisa digunakan? Jika bisa, mengapa? Jika tidak, mengapa?

13. Kursi-kursi tersebut digunakan di auditorium dan kadang-kadang harus disimpan di bawah panggung. Ruang penyimpanan tersebut tingginya adalah 116 centimeter.
    a. Berapa banyak kursi dapat diletakkan pada ruang penyimpanan tersebut?
    b. Jelaskan jawaban anda dengan rumus tanda panah.

Contoh Jawaban

11. 80 menyatakan tinggi kursi yang pertama. 7 cm adalah tinggi yang ditambahkan untuk setiap tambahan satu kursi. – 1 artinya satu dikurangkan dari jumlah kursi, yaitu jumlah kursi yang ditambahkan pada kursi yang pertama.

12. a. Albar mungkin menggunakan bilangan x 7 dan + 73 pada rumus rangkaian panah tersebut. Penjelasannya beragam. Misalnya, "Saya menulis "x 7" di depan rumus karena setiap tambahan satu kursi tingginya bertambah 7 cm. Selanjutnya saya menulis "+ 73" untuk menunjukkan bahwa tinggi kursi yang pertama (80 cm) dikurang 7 cm yang sudah ditambahkan pada langkah yang pertama."

    b. Tidak, hasilnya beda karena urutan penjumlahan dan perkalian ditukar.

13. a. 6 kursi. Caranya beragam. Beberapa siswa mungkin menghitung terbalik yaitu mengurangkan 73 cm dari 116 cm dan membagi dengan 7.

    116 cm – 73 cm = 43 dan 43 : 7 sama dengan 6 kursi lebih sedikit. Dibulatkan menjadi 6 sebab lebih dari 6 kursi terlalu tinggi untuk ditempatkan di bawah panggung.

    b. Jawaban dan caranya beragam. Misalnya,

$$80 \text{ cm} \xrightarrow{+7 \text{ cm}} 87 \text{ cm} \xrightarrow{+7 \text{ cm}} 94 \text{ cm} \xrightarrow{+7 \text{ cm}}$$

$$101 \text{ cm} \xrightarrow{+7 \text{ cm}} 108 \text{ cm} \xrightarrow{+7 \text{ cm}} 115 \text{ cm}$$

Komentar Tentang Soal

Soal-soal pada halaman ini (11 s.d. 13) dapat Anda berikan sebagai PR.

12. Soal ini dapat digunakan untuk menilai kemampuan siswa dalam menggunakan dan menafsirkan rumus sederhana, menarik kesimpulan dari serangkaian perhitungan untuk menjelaskan rumus informal, dan menggunakan peubah kalimat (kata) untuk menyatakan suatu rumus atau prosedur.

13. Soal ini dapat digunakan untuk menilai kemampuan siswa dalam menggunakan dan menafsirkan rumus sederhana, menggunakan operasi terbalik untuk menentukan input dari output yang diberikan, menarik kesimpulan dari serangkaian perhitungan untuk menjelaskan rumus informal, menggunakan peubah kalimat (kata) untuk menyatakan suatu rumus atau prosedur. Doronglah siswa untuk menjelaskan cara mereka kepada siswa-siswa yang lain di kelas.

Halaman 4 Buku Siswa

Ringkasan

Pada pelajaran ini anda telah menemukan rumus sendiri untuk menentukan tinggi susunan cangkir dan susunan kursi. Cara yang anda gunakan adalah rangkaian panah.

Jumlah kursi $\xrightarrow{-1}$ ______ $\xrightarrow{\times 7}$ ______ $\xrightarrow{+80}$ Tinggi susunan kursi

Angka 80 menyatakan tinggi sebuah kursi. Angka 7 menyatakan tambahan tinggi susunan kursi setiap tambahan satu buah kursi. Jumlah kursi dikurang 1 (atau -1) menyatakan jumlah kursi yang ditambahkan pada kursi yang pertama.

Pertanyaan Ringkasan

Misalkan:

n = jumlah cangkir;
a = tinggi sebuah cangkir;
b = selisih tinggi susunan n cangkir dengan susunan n+1 cangkir;
Sn = tinggi susunan n cangkir.

14. Nyatakanlah rumus tinggi susunan n cangkir dengan notasi di atas.

15. Sebuah cangkir tingginya 15 cm. Susunan dua buah cangkir tingginya 18 cm. Hitunglah
    a. Tinggi susunan 6 buah cangkir.
    b. Tinggi susunan 12 buah cangkir.

Contoh Jawaban

14. Jawaban beragam. Dengan menggunakan rumus rangkaian panah yang telah dipelajari siswa pada soal 7:

$$n \xrightarrow{-1} \_\_\_ \xrightarrow{\times b} \_\_\_ \xrightarrow{+a} Sn$$

siswa mungkin menuliskan rumus sebagai berikut:

(n – 1) x b + a = Sn

atau

Sn = a + (n – 1) x b

15. Dari soal diketahui bahwa a = 15 dan b = 18 – 15 = 3.

a. Tinggi susunan 6 buah cangkir:

S6 = 15 cm + (6 – 1) x 3 cm
= 15 cm + 5 x 3 cm
= 15 cm + 15 cm
= 30 cm

b. Tinggi susunan 12 buah cangkir:

S12 = 15 cm + (12 – 1) x 3 cm
= 15 cm + 11 x 3 cm
= 15 cm + 33 cm
= 48 cm

Komentar Tentang Soal

Soal-soal pada halaman ini merupakan rangkuman dari soal-soal yang telah dikerjakan siswa sebelumnya. Soal ini dapat digunakan untuk menilai proses belajar matematika yang telah dilakukan siswa dalam menentukan tinggi susunan cangkir dan kursi, yaitu dari prosedur atau rumus informal dengan rangkaian panah kepada rumus formal.

APPENDIX L
RME EXEMPLARY LESSON MATERIAL
PERBANDINGAN MUTLAK DAN RELATIF (TELEPON DAN PENDUDUK) – *TEACHER GUIDE*

PERBANDINGAN MUTLAK DAN RELATIF

Tentang Materi Pelajaran

- Topik: Perbandingan
- Kelas: 2 SLTP
- Waktu: 3 kali 45 menit
- Alat/bahan: Kalkulator (satu untuk setiap siswa)

Kegiatan Siswa

Siswa membandingkan jumlah telepon di beberapa negara. Ketika mereka menggunakan jumlah penduduk untuk membandingkan, mereka membuat perbandingan relatif. Siswa mulai memikirkan rasio sebagai rata-rata dengan menyatakan rasio antara jumlah penduduk dan jumlah telepon sebagai sebuah bilangan tunggal. Mereka kemudian menggunakan ide tentang perbandingan relatif dan perbandingan mutlak untuk menganalisis data dari negara-negara yang berbeda. Siswa juga didorong untuk berpikir tentang hal-hal lain di luar konsep rasio itu sendiri, seperti mempertimbangkan faktor politik, ekonomi dan budaya yang terkait dengan konteks yang dibicarakan di sini.

Tujuan

Siswa dapat:

- Menghubungkan antara rasio dengan pecahan, persen, dan desimal;
- Menggunakan cara untuk membagi atau mengalikan desimal;
- Mengerti hubungan antara rasio, laju, dan rata-rata, serta dapat menggunakan untuk memecahkan masalah;
- Menganalisis dan menyelesaikan masalah yang berkaitan dengan perbandingan mutlak dan perbandingan relatif;
- Menentukan apakah dan bagaimana rasio dapat digunakan untuk menyelesaikan masalah.

Tentang Matematika

Memperkenalkan kepada siswa dua cara untuk membandingkan besaran, yaitu secara mutlak dan relatif. Konteks yang digunakan adalah jumlah telepon di beberapa negara. Misalnya, China mempunyai lebih banyak telepon daripada Denmark (16 juta berbanding 3 juta): ini adalah perbandingan mutlak. Denmark mempunyai lebih banyak telepon per orang (0,6 telepon per orang berbanding 0,01 telepon per orang): ini adalah contoh perbandingan relatif (atau rasio). Jadi seseorang mempunyai akses lebih besar untuk menggunakan telepon di Denmark. Penting bagi siswa untuk mampu membedakan kedua jenis perbandingan ini dan menentukan perbandingan apa yang lebih cocok. Bagi perusahaan jasa telepon, mereka lebih tertarik pada jumlah telepon untuk masing-masing negara.

Rencana Pelajaran

- Jika siswa tidak familiar dengan bilangan besar seperti jutaan dan milyar, dan bagaimana cara menuliskan dan mengucapkan bilangan tersebut, Anda dapat memulai pelajaran dengan diskusi singkat tentang bilangan tersebut.
- Siswa dapat bekerja dalam kelompok kecil untuk soal-soal 1 sampai dengan 7. Untuk soal-soal yang lain mereka dapat bekerja secara perorangan.
- Jika waktu tidak cukup, soal-soal 9 dan 10 bisa diberikan sebagai PR.

Halaman 1 Buku Siswa

PERBANDINGAN MUTLAK dan RELATIF

Telepon & Penduduk

Kira-kira berapa jumlah telepon di kota tempat anda tinggal saat ini? Ada berapa banyak tempat di muka bumi ini yang menggunakan telepon? Sebutkan alat-alat komunikasi lainnya yang digunakan orang selain telepon?

Tabel berikut menunjukkan jumlah penduduk dan jumlah telepon di 14 negara.

Negara	Jumlah Penduduk	Jumlah Telepon
Bolivia	8 juta	200.000
China	1.200 juta	16 juta
Denmark	5 juta	3 juta
Ekuador	11 juta	550.000
Finlandia	5 juta	4 juta
Perancis	58 juta	31 juta
India	940 juta	7 juta
Indonesia	210 juta	5 juta
Jepang	125 juta	57 juta
Nauru	10.000	1.700
Kepulauan Solomon	399.000	8.700
Afrika Selatan	45 juta	6 juta
Sudan	30 juta	112.000
Amerika Serikat	264 juta	203 juta

1. Negara mana yang mempunyai paling banyak telepon?

Contoh Jawaban

1. Amerika Serikat, dengan 203 juta telepon.

Komentar Tentang Soal

1. Tujuan dari soal ini adalah untuk mendorong siswa berpikir tentang arti "paling banyak" berdasarkan konteks yang diberikan. Sebagian besar siswa akan melihat pada kolom ketiga dari tabel tersebut dan memilih Amerika Serikat. Beberapa siswa yang lain mungkin membuat perbandingan relatif berdasarkan jumlah penduduk, bahkan sebelum Anda meminta mereka untuk membuat perbandingan tersebut.

   Anda dapat meminta siswa untuk membandingkan jumlah penduduk di setiap negara. Doronglah siswa untuk berpikir kreatif dalam menjawab soal. Misalnya, dengan pernyataan seperti "Perancis mempunyai jumlah penduduk kurang lebih sepuluh kali jumlah penduduk Finlandia," kita mengetahui pemahaman siswa tentang bilangan.

Halaman 2 Buku Siswa

2. a. Berdasarkan tabel di halaman 1, di negara mana yang penduduknya *paling tergantung* pada telepon sebagai alat komunikasi? Jelaskan.

   b. Di negara mana yang penduduknya *paling tergantung* pada telepon sebagai alat komunikasi?

Catatan: *Paling tergantung* artinya lebih sering menggunakan telepon sebagai alat komunikasi dibandingkan alat komunikasi yang lainnya.

Lusi menggunakan angka-angka untuk negara Perancis untuk menghitung rata-rata. Dia menghitung 58 juta : 31 juta.

3 a. Apakah hasil perhitungan yang dilakukan Lusi menyatakan rata-rata jumlah orang per telepon atau menyatakan rata-rata jumlah telepon per orang?

  b. Bagaimana cara Lusi mendapatkan hasil pembagian tersebut?

4. Bandingkanlah jumlah telepon di Perancis dengan jumlah telepon di Kepulauan Solomon.

Contoh Jawaban

2. a. Jawaban dan penjelasan akan beragam. Misalnya, Denmark, Perancis dan Amerika Serikat adalah negara-negara yang sangat tergantung pada telepon sebagai alat komunikasi. Di keempat negara tersebut, lebih dari satu telepon untuk setiap dua orang penduduk.
   b. Jawaban akan beragam. Misalnya, Sudan kurang tergantung pada telepon sebagai alat komunikasi. Terdapat satu telepon untuk setiap 268 penduduk.

3. a. Hasil yang diperoleh adalah rata-rata jumlah penduduk per telepon. Penjelasan mungkin beragam. Siswa harus menyadari bahwa Lusi membagi jumlah penduduk dengan jumlah telepon.
   b. Lusi dapat menggunakan tabel rasio atau kalkulator.

4. Perbandingan akan beragam. Misalnya,
   - Terdapat lebih banyak telepon per penduduk di Perancis (0,53 telepon per penduduk) dibanding Kepulauan Solomon (0,02). Jika keduanya dibandingkan secara mutlak, Perancis tetap mempunyai telepon lebih banyak.
   - Tabel rasio menunjukkan bahwa di Perancis ada 1,9 orang untuk setiap telepon:

Jumlah Penduduk	58.000.000	58	1,9
Jumlah Telepon	31.000.000	31	1

Di Kepulauan Solomon terdapat 46 orang untuk setiap telepon:

Jumlah Penduduk	399.000	3990	45,9
Jumlah Telepon	8.700	87	1

Komentar Tentang Soal

2. Siswa harus menggunakan perbandingan relatif secara informal untuk soal ini.

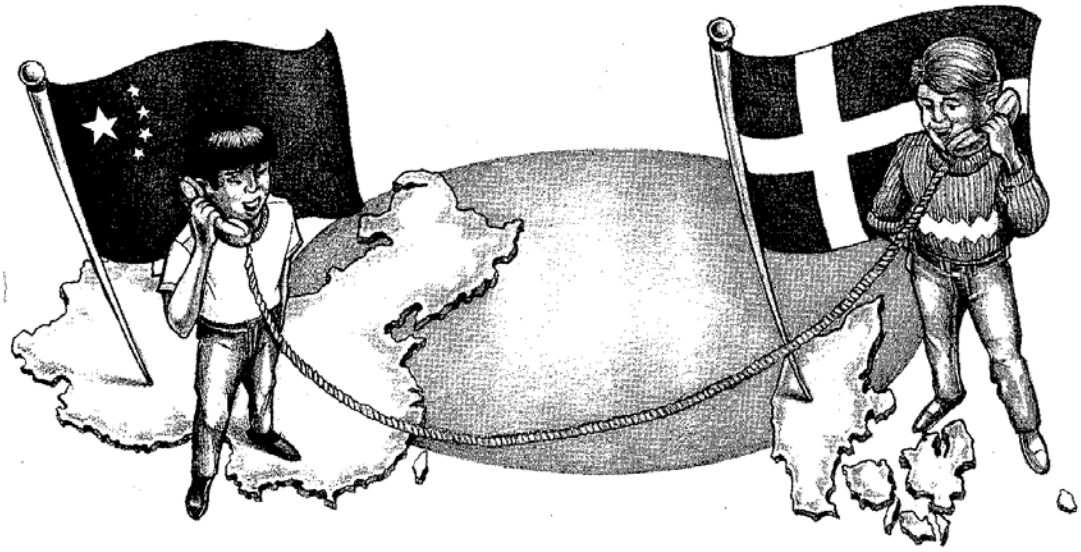
3. Soal 3a sangat penting. Siswa harus mampu mencocokkan urutan bilangan dalam pembagian dan makna hasil pembagian tersebut.

4. Siswa mungkin perlu menulis bilangan dengan seluruh angka nol atau mengeliminasi jutaan sebagai satuan untuk menyederhanakan perhitungan.

Halaman 3 Buku Siswa

Perhatikan angka-angka untuk China dan Denmark.

5. a. Dari dua negara tersebut, negara mana yang mempunyai lebih banyak telepon?
   b. Dari dua negara tersebut, di negara mana anda harus mengantri lebih panjang jika ingin menggunakan telepon?



Jika anda membandingkan jumlah telepon tanpa mempertimbangkan jumlah orang yang menggunakan telepon tersebut, maka perbandingan tersebut dinamakan *perbandingan mutlak*.

Jika anda membandingkan jumlah telepon dengan mempertimbangkan jumlah orang yang menggunakan telepon tersebut, maka perbandingan tersebut dinamakan *perbandingan relatif*, yaitu membandingkan telepon per orang.

6. Dalam membandingkan China dan Denmark, menurut anda perbandingkan mutlak atau perbandingan relatif yang paling baik menggambarkan penyebaran telepon terhadap penduduk di negara masing-masing? Mengapa?

7. Pada saat apa perbandingan mutlak paling baik digunakan? Pada saat apa perbandingan relatif merupakan pilihan yang lebih baik?

Contoh Jawaban

5. a. China mempunyai telepon lebih banyak (16 juta). Denmark mempunyai 3 juta telepon.

   b. Jawaban akan beragam. Beberapa siswa akan memberikan alasan bahwa di China antrian lebih panjang, karena Denmark mempunyai lebih banyak telepon per orang: di Denmark terdapat 1,7 orang per telepon (5 : 3). Di China terdapat 75 orang per telepon (1.200 : 16).

6. Perbandingan relatif memberikan gambaran yang lebih baik karena menjelaskan akses orang terhadap telepon.

7. Jawaban akan beragam. Misalnya, Jika ingin membandingkan, misalnya, ketebalan buku telepon di berbagai negara, maka perbandingan mutlak yang digunakan.

   Jika ingin membandingkan bagaimana *sesuatu* dibagi terhadap jumlah penduduk, maka perbandingan relatif yang digunakan.

Komentar Tentang Soal

5. Soal ini memperkenalkan perbedaan antara perbandingan mutlak dan perbandingan relatif. Untuk China jumlah penduduknya lebih dari 1 milyar, namun di sini dinyatakan dalam jutaan agar sama dengan jumlah telepon yang juga dinyatakan dalam jutaan.

6. Istilah mutlak dan relatif mulai digunakan di sini. Jika siswa tidak familiar dengan istilah tersebut, mungkin Anda perlu mendefinisikannya lebih dahulu. Perbandingan mutlak adalah membandingkan besaran-besaran bilangan, sementara perbandingan relatif menggunakan rasio.

7. Jika siswa mengalami kesulitan, Anda dapat meminta siswa untuk menggunakan konteks untuk menggambarkan situasi pada saat apa perbandingan relatif lebih baik, demikian pula sebaliknya.

   Anda dapat memberikan kesempatan kepada siswa untuk mencatat jawaban mereka untuk soal 6 dan 7 pada buku catatan mereka.

Halaman 4 Buku Siswa

Tabel berikut diambil dari tabel yang sama pada halaman 1 dengan mengambil beberapa negara saja, dan dengan menambahkan jumlah radio di setiap negara (kolom keempat).

Negara	Jumlah penduduk	Jumlah telepon	Jumlah radio
Bolivia	8 juta	200.000	4 juta
Finlandia	5 juta	4 juta	5 juta
Nauru	10.000	1.700	4.000
Kepulauan Solomon	399.000	8.700	44.000
Amerika Serikat	264 juta	203 juta	526 juta

2. Bandingkanlah jumlah telepon dan radio untuk masing-masing negara yang didaftarkan pada tabel di atas. Perbandingan apakah yang anda gunakan, mutlak atau relatif?

Contoh Jawaban

8. Jawaban akan beragam. Misalnya,
   - Jika perbandingan di antara negara-negara adalah mutlak, maka Nauru mempunyai paling sedikit telepon dan radio, sementara Amerika Serikat mempunyai paling banyak.
   - Perbandingan relatif menunjukkan bahwa Finlandia dan Amerika Serikat mempunyai paling banyak telepon, sementara Kepulauan Solomon mempunyai paling sedikit telepon. Amerika Serikat mempunyai radio paling banyak (0,5 penduduk per radio, atau dua radio untuk setiap orang).
   - Beberapa siswa mungkin menunjukkan suatu perbandingan relatif dengan sebuah tabel:

Negara	Jumlah Penduduk	Penduduk per telepon	Penduduk per radio
Bolivia	8 juta	40	2
Finlandia	5 juta	1,25	1
Nauru	10.000	5,88	2,5
Kepulauan Solomon	399.000	45,86	9,06
Amerika Serikat	264 juta	1,3	0,5

Komentar Tentang Soal

8. Soal ini dapat digunakan untuk menilai kemampuan siswa dalam menganalisis dan menyelesaikan soal yang berkaitan dengan perbandingan relatif dan perbandingan mutlak. Soal ini dapat juga diberikan sebagai PR. Berbagai perbandingan yang berbeda dapat digunakan. Misalnya, kita dapat membandingkan radio per orang. Dalam hal ini, untuk Amerika Serikat rasionya adalah dua radio per orang.

Halaman 5 Buku Siswa

PENDUDUK

Paris berpenduduk kurang lebih 2 juta jiwa, dan terdapat 52 telepon untuk setiap 100 orang Paris. Sementara kota New York, berpenduduk kurang lebih 16 juta jiwa, dan 65 telepon untuk setiap 100 penduduk. Tokyo berpenduduk 8 juta jiwa, dan 66 telepon untuk setiap 100 penduduk.

Alenia di samping diambil dari artikel yang ditulis Brian. Ia membandingkan jumlah sambungan telepon di beberapa kota besar di dunia.

9. a. Bagaimana cara Brian mendapat- kan angka 52 telepon per 100 orang Paris.

   b. Dapatkan anda menentukan jumlah telepon untuk setiap orang Paris? Jelaskan jawaban anda?

   c. Berapakah jumlah seluruh telepon di Paris. Jelaskan bagaimana anda mendapatkan jawaban tersebut.

10. a. Hitunglah jumlah seluruh telepon di kota New York.
    b. Hitunglah jumlah seluruh telepon di Tokyo.

Contoh Jawaban

9. a. Jawaban akan beragam. Misalnya, beberapa siswa mungkin mengatakan bahwa Brian dapat membagi jumlah seluruh telepon dengan jumlah penduduk, yang akan memberikan dia hasil 0,52 telepon untuk setiap orang.

   Siswa yang lain mungkin mengatakan bahwa Brian mengetahui perbandingan relatif dan menggunakan tabel rasio:

X 100

Jumlah Telepon	0,52	52
Orang	1	100

   Siswa dapat mengalikan 0,52 dengan 100 dan 1 dengan 100 untuk mendapatkan jumlah telepon 52 untuk setiap 100 penduduk.

   b. Ya, Anda dapat membagi 52 dengan 100 untuk mendapatkan jumlah telepon 0,52 untuk setiap penduduk Paris.

   c. 1,14 juta telepon. Caranya akan beragam. Misalnya, Paris mempunyai 0,52 telepon per orang, dan terdapat 2,2 juta orang tinggal di Paris, jadi terdapat 2,2 juta x 0,52 ≈ 1,14 juta sambungan (nomor) telepon.

10. a. Kurang lebih 10,5 juta nomor telepon. Caranya beragam. Misalnya,

- Menggunakan tabel rasio:

X 16,1

Jumlah nomor telepon	65	650.000	10.465.000
Orang	100	1.000.000	16.100.000

X 16,1

- New York mempunyai 65 nomor telepon per 100 orang, sama dengan 0,65 nomor telepon per orang. Jadi, 16,1 juta x 0,65 sama dengan kurang lebih 10,5 juta.

   b. Kurang lebih 5,5 juta nomor telepon. Caranya beragam. Misalnya, di Tokyo terdapat 66 nomor telepon per 100 penduduk, sama dengan 0,66 nomor per penduduk.

Komentar Tentang Soal

9 – 10. Soal 9 dan 10 dapat digunakan untuk menilai kemampuan siswa menganalisis dan memecahkan soal yang berkaitan dengan perbandingan relatif dan mutlak. Soal ini juga dapat digunakan untuk menilai kemampuan siswa menentukan apa dan bagaimana rasio dapat digunakan untuk memecahkan masalah. Soal ini dapat pula diberikan sebagai PR.

Jawaban yang diberikan siswa dapat juga mengungkapkan kemampuan dia menggunakan hubungan antara rasio, desimal dan pecahan. Jika ada siswa yang mengalami kesulitan, Anda bisa menyarankan mereka menggunakan tabel rasio dan perkiraan.

Halaman 6 Buku Siswa

Ringkasan

Bilangan dapat digunakan untuk membuat perbandingan.

Perbandingan dapat bersifat mutlak, yaitu perbandingan langsung sejumlah bilangan seperti perbandingan jumlah telepon di beberapa negara.

Perbandingan dapat bersifat relatif, yaitu membandingkan sejumlah bilangan atas pertimbangan tertentu, misalnya jumlah telepon per jiwa. Perbandingan relatif dapat dinyatakan sebagai rasio atau sebagai bilangan tunggal (rata-rata).

Pertanyaan Ringkasan

11. Jumlah penduduk Afrika Selatan adalah 45 juta jiwa, dan terdapat 6 juta telepon di negara tersebut.
    a. Jelaskan bagaimana telepon disebarkan terhadap penduduk?
    b. Anang mengatakan bahwa Afrika Selatan mempunyai 13 telepon untuk setiap 100 penduduk. Apakah yang dikatakan Anang benar? Jelaskan.

12. Negara mana di antara tiga negara berikut yang paling banyak penduduknya? Bagaimana anda menentukan jawaban tersebut?

Negara	Luas daerah (dalam km persegi)	Jumlah penduduk
Argentina	1,65 juta	34 juta
Jepang	220.000	125 juta
Brasil	5 juta	160 juta

Contoh Jawaban

11. a. Terdapat kurang lebih 0,13 telepon per orang di Afrika Selatan. Caranya beragam. Misalnya, siswa mungkin membagi 6 dengan 45 atau menggunakan tabel rasio.

    b. Ya, Anang benar. Penjelasan bisa beragam. Misalnya, siswa harus ingat bahwa jika Anda membagi jumlah nomor (sambungan) telepon dengan jumlah penduduk, $6 : 45 = 0{,}133 \ldots \approx 0{,}13 = 13/100$, yaitu sama dengan 13 telepon per 100 penduduk.

12. Jawaban akan beragam. Misalnya,
    Perbandingan relatif:
    Jepang adalah negara dengan penduduk paling padat, yaitu lebih dari 568 orang per km persegi.

Negara	Luas daerah (dalam km persegi)	Jumlah Penduduk	Penduduk per km persegi
Argentina	1,65 juta	34 juta	20,6
Jepang	220.000	125 juta	568,18
Brasil	5 juta	160 juta	32

Perbandingan mutlak:
Brasil adalah negara dengan penduduk terbesar, yaitu 160 juta orang.

Komentar Tentang Soal

11 – 12. Soal 11 dan 12 dapat diberikan sebagai PR. Soal 11 ini dapat digunakan untuk menilai kemampuan siswa menghubungkan antara rasio, pecahan dan desimal, serta memahami hubungan antara rasio, laju, dan rata-rata, dan bagaimana menggunakan hubungan tersebut untuk memecahkan masalah.

Soal 12 juga dapat digunakan untuk menilai kemampuan siswa untuk menganalisis dan memecahkan soal yang berkaitan dengan perbandingan mutlak dan relatif.

Perhatikan bahwa beberapa siswa mungkin menghitung rasio km persegi per orang. Lihatlah apakah mereka mampu memberikan alasan yang masuk akal untuk sampai pada jawaban yang benar.

Anda dapat menilai siswa dalam menulis jawaban mereka untuk soal 12 pada buku catatan mereka.

APPENDIX M
RME EXEMPLARY LESON MATERIAL
APAKAH PELUANG ITU? – *TEACHER GUIDE*

APAKAH PELUANG ITU?

Kegiatan Siswa

Siswa memulai kegiatan dengan meramal apakah suatu peristiwa bakal terjadi atau tidak. Kemudian mereka menduga peluang beberapa peristiwa dan menandai tangga "peluang" dengan peristiwa tersebut. Dengan menggunakan konteks lompat katak pada lantai ubin hitam-putih, siswa menunjukkan peluang bahwa katak akan mendarat pada ubin hitam menggunakan persen, suatu pecahan, dan perbandingan. Terakhir, mereka menyatakan peluang berhenti pada bagian hitam dari spiner dengan menandai tangga peluang.

Tujuan

Siswa dapat:

- Menjelaskan peluang dengan istilah sehari-hari
- Menduga peluang dalam persen dari 0% hingga 100%
- Menentukan peluang, dalam persen, pecahan, atau perbandingan, untuk kejadian-kejadian sederhana.

Waktu

- Diperkirakan tiga atau empat jam pelajaran (3 atau 4 x 45 menit)

Tentang Matematika

Bagian ini memperkenalkan model tangga "peluang" untuk membangun pengertian dasar bahwa peluang terjadinya suatu peristiwa berkisar antara 0% hingga 100%. Untuk menduga peluang, pertama-tama siswa menentukan pada anak tangga mana setiap peristiwa terletak, kemudian menentukan persen yang sesuai dengan anak tangga itu. Ada beberapa cara informal untuk menyatakan peluang, seperti menggunakan persen pada tangga peluang dan menggunakan istilah perbandingan (seperti peluang satu dari enam). Ini mendahului penggunaan persen dan pecahan. Pada bagian akhir, baik cara informal maupun pasti akan diringkaskan.

Alat dan Bahan

- Lembar Kerja Siswa 1-3 (satu untuk setiap siswa)
- Kertas gambar, halaman 6 dan 8 dari Pegangan Guru (empat lembar setiap siswa)
- Crayon hitam, halam 12 dan 16 dari Pegangan Guru (satu setiap siswa)

Rencana Pelajaran

Siswa bekerja sendiri pada soal 1 dan 11 dan berpasangan atau sendiri pada soal 12, 13, 18, dan 19. Untuk soal-soal sisanya mereka boleh berpasangan atau kelompok kecil

Tidak ada soal pengayaan pada bagian ini.

Pekerjaan Rumah

Soal 1 (hal 3 Pegangan Guru), 4 dan 5 (hal 7 Pegangan Guru), 10 (hal 11 Pegangan Guru), 17 (hal 19 Pegangan Guru), dan 18 dan 19 (hal 21 Pegangan Guru) bisa untuk pekerjaan rumah.

Rencana Penilaian

- Soal 4 dapat digunakan secara informal untuk menilai kemampuan siswa menyatakan peluang dalam bahasa sehari-hari.
- Soal 5 dapat digunakan secara informal menilai kemampuan siswa menduga peluang dalam persen dari 0% hingga 100%.
- Soal-soal 11, 13, dan 15 dapat digunakan secara informal untuk menilai kemampuan siswa menentukan peluang dalam persen, pecahan, atau perbandingan, untuk kejadian-kejadian sederhana.

Peristiwa-peristiwa Naik dan Turun

Kadang-kadang sukar untuk mengira apakah suatu peristiwa akan terjadi atau tidak. Tetapi pada lain waktu kamu mengetahui dengan pasti.

1. Gunakan Lembar Kerja Siswa 1. Beri tanda cek pada kolom yang paling baik menyatakan kenyakinan kamu bahwa setiap peristiwa akan terjadi.

	Pernyataan	Yakin Tidak Terjadi	Tidak Yakin	Yakin Terjadi
A.	Akan ada ulangan matematika suatu saat tahun ini			
B.	Di kota kita akan ada hujan suatu saat dalam empat hari mendatang.			
C.	Jumlah siswa di kelas kita yang dapat menggulung lidah sama dengan jumlah siswa yang tidak dapat			
D.	Dapat angka "7" dalam satu lemparan sebuah dadu biasa			
E.	Dalam suatu ruangan yang di dalamnya ada 367 orang, dua orang mempunyai hari ultah yang sama.			
F.	Hari Tahun Baru jatuh pada Senin ketiga bulan Januari			
G.	Mengundi sebuah uang logam satu kali, dapat gambar.			
H.	Jika kamu pencet "2 + 2 = " pada kalkulator, hasilnya akan sama dengan 4.			

Penyelesaian dan Contoh
pekerjaan siswa

1. Untuk beberapa pernyataan jawaban siswa akan beragam. Contoh jawaban siswa:
   a. Yakin terjadi.
   b. Tidak yakin. (Bergantung kepada musim atau di mana siswa tinggal.)
   c. Tidak yakin.
   d. Yakin tidak terjadi.
   e. Yakin terjadi. (Untuk 366 orang, jawaban mungkin "tidak yakin" karena setiap orang mempunyai hari ultah yang berbeda, termasuk 29 Februari. Untuk 367 orang, ada dua orang yang ultahnya jatuh pada hari yang sama.)
   f. Yakin tidak terjadi.
   g. Tidak yakin.
   h. Yakin terjadi.

Petunjuk dan Komentar

Bahan Lembar Kerja Siswa 1 (satu setiap siswa).

Uraian Siswa menduga apakah kedelapan peristiwa terjadi atau tidak.

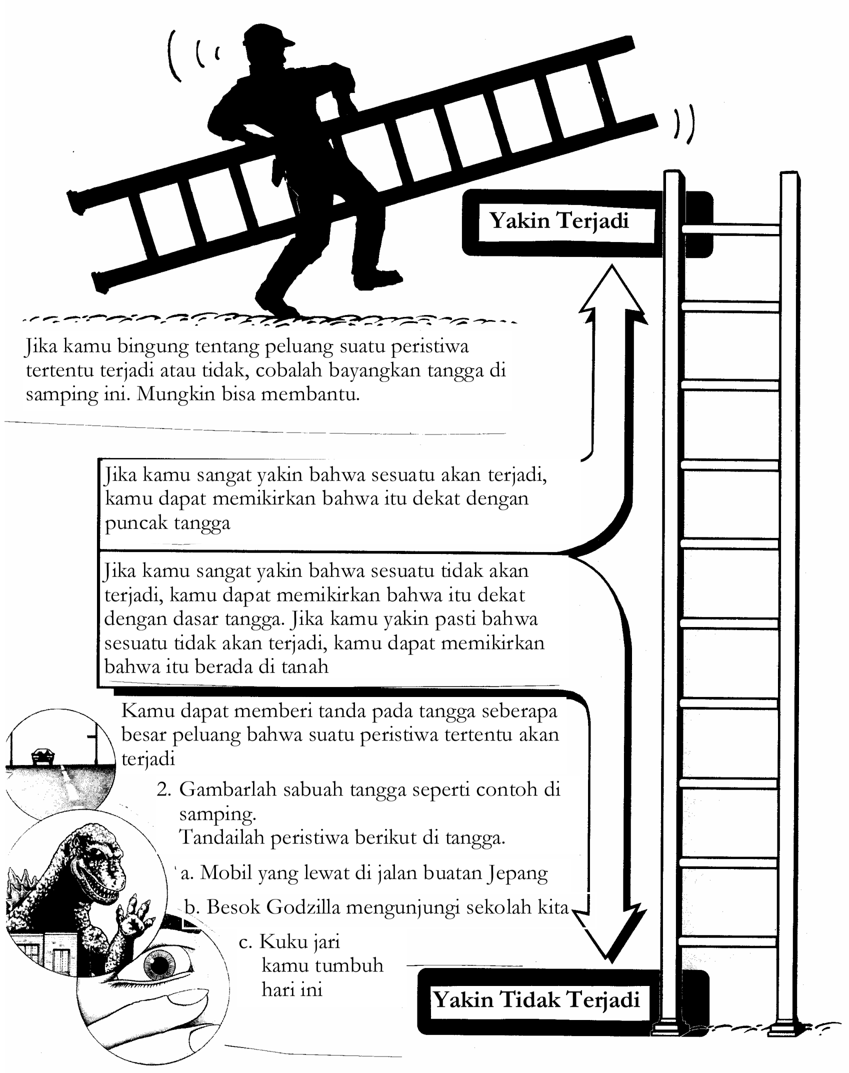
Tentang Matematika Siswa memperoleh pengertian dasar tentang konsep *peluang* dengan menduga peluang-peluang sebelum menyatakan peluang-peluang pasti dengan menggunakan persen, pecahan, atau perbandingan.

Rencana Anda dapat menggunakan soal pertama sebagai PR di depan (sebelum pelajaran), dan memulai pelajaran dengan diskusi terhadap jawaban-jawaban mereka.

Komentar tentang Soal-soal

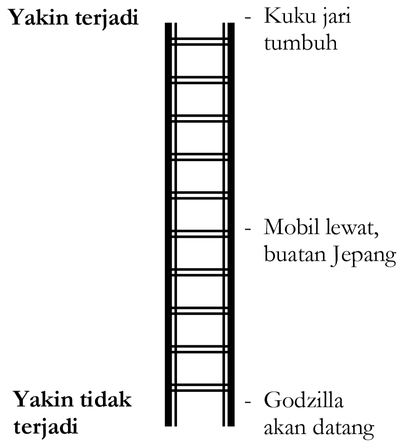
1. Pekerjaan Rumah. Soal ini dapat digunakan sebagai PR. Mintalah siswa untuk menerangkan jawaban mereka. Beberapa jawaban mungkin mencerminkan situasi yang tidak biasa (misalnya, jawaban terhadap soal-soal a, b, dan c). Berikan siswa kesempatan untuk menerangkan.

e. Ingatkan siswa bahwa setahun terdiri dari 365 hari dan tahun kabisat terdiri dari 366 hari. Sehingga terdapat 366 hari berbeda untuk suatu hari ultah.



Penyelesaian dan Contoh
pekerjaan siswa

2. Tangga akan beragam. Contohnya:



Petunjuk dan Komentar

Bahan Kertas gambar (satu lembar per grup)

Uraian Siswa menduga peluang ketiga kejadian dengan cara menempatkan setiap peristiwa pada tempat yang cocok pada tangga peluang.

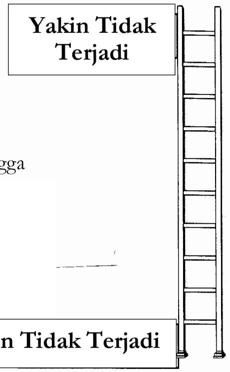
Tentang Matematika Penempatan 10 anak tangga memungkinkan siswa untuk menempatkan kategori "Tidak Terjadi" dari soal 1. Mereka juga dimungkinkan untuk menyatakan peluang dengan istilah "sangat yakin" bahwa sesuatu akan atau tidak akan terjadi, dalam upaya menduga penempatan setiap peristiwa pada tangga peluang.

Rencana Siswa dapat mengerjakan soal 2 berpasangan atau kelompok kecil.

Komentar tentang Soal-soal

2. Sepuluh anak tangga bersesuaian dengan 10% dan kelipatannya, 0% berada di tanah dan 100% pada anak tangga teratas. Jangan ungkapkan hal ini kepada siswa sebab akan diuraikan pada halaman berikutnya.

3. Sekarang kembali ke tabel di halaman 11 dan letakkan pernyataan pada tabel tersebut pada sebuah tangga. Jelaskan jawaban kamu.



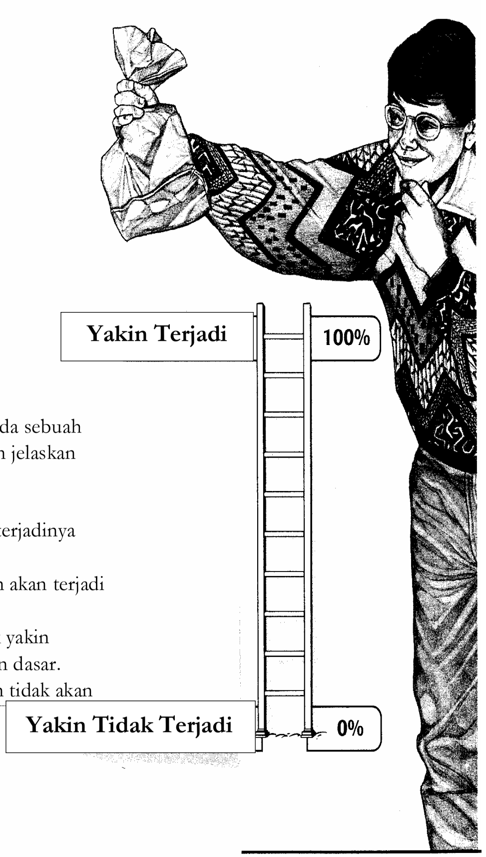
4. Letakkan pernyataan-pernyataan tentang peluang berikut pada tangga

"Saya yakin itu akan terjadi."	"Peluangnya 50-50.?
"Itu tidak mungkin."	"Sangat mungkin terjadi."
"Mungkin akan terjadi."	"Nampaknya sangat tidak mungkin."
"Peluangnya 100%."	"Ya, mungkin terjadi."
"Peluangnya 0%."	

Cocokkan

Seto melakukan suatu percobaan. Ia memegang sebuah bungkusan yang berisi potongan-potongan kertas yang berukuran sama, bernomor 1 sampai 20. Ia akan mengambil sebuah nomor dari bungkusan. Berikut ini beberapa kemungkinan hasil yang ia peroleh:

a. Genap.
b. Habis dibagi lima.
c. Angka 1 atau 2.
d. Jumlah angka (digit) sama dengan 12.
e. Kurang dari 16.



5. Letakkan lima pernyataan di atas pada sebuah tangga seperti contoh di sebelah dan jelaskan jawabanmu.

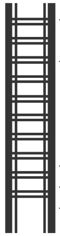
Tangga menunjukkan bahwa peluang terjadinya peristiwa adalah antara 0% dan 100%.

- Peristiwa-peristiwa yang kamu yakin akan terjadi terletak di puncak.
- Peristiwa-peristiwa yang kamu tidak yakin terjadinya terletak antara puncak dan dasar.
- Peristiwa-peristiwa yang kamu yakin tidak akan terjadi terletak di dasar.

Penyelesaian dan Contoh
pekerjaan siswa

3. Tangga akan beragam. Contoh jawaban siswa:

YakinTerjadi

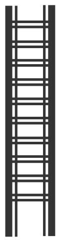


- (A.) Ulangan Matematika, (H.) Kalkulator
- (E.) Dua ultah pada hari yang sama.
(B.) Hujan … tergantung di mana kamu tinggal dan kapan.
- (G.) Undi uang logam.
- (C.) Lidah
- (D.) Dapat 7, (F.) Hari Tahun Baru

Yakin Tidak Terjadi

4. Tangga akan beragam. Contoh jawaban siswa:

YakinTerjadi



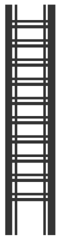
- Yakin terjadi; Peluang 100%
- Sangat mungkin terjadi
- Mungkin terjadi
- Ya, mungkin terjadi
- Peluang 50-50

- Tidak mungkin terjadi
- Sangat tidak mungkin terjadi
- Mustahil terjadi; Peluang 0%

Yakin Tidak Terjadi

5. Tangga akan beragam. Contoh jawaban siswa:

YakinTerjadi



100%

- (e.) Kurang dari 16

- (a.) Genap
- (b.) Habis dibagi lima
- (c.) Angka 1 atau 2

0% (d.) Jumlah angka (digit) 12

Yakin Tidak Terjadi

Petunjuk dan Komentar

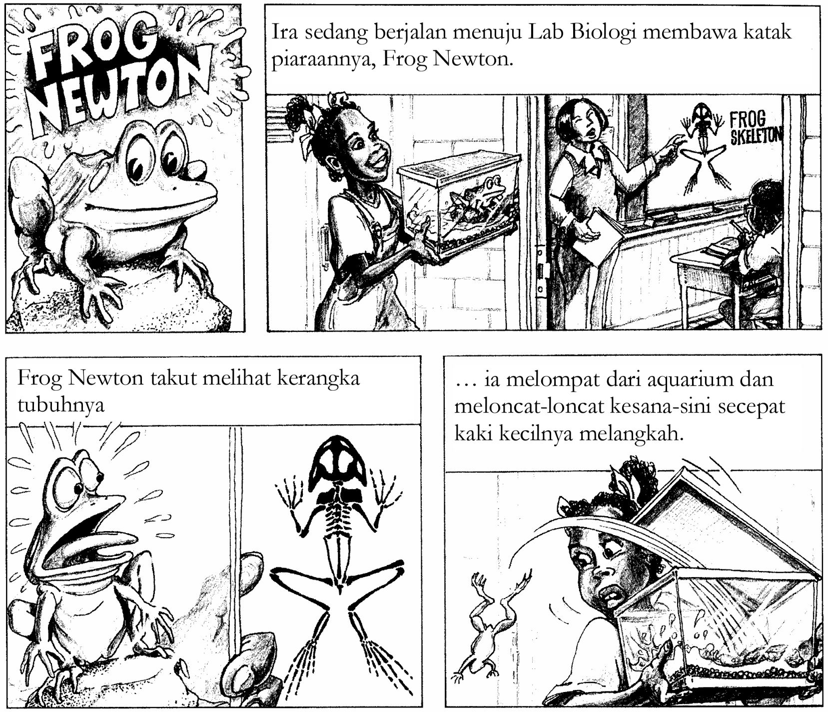
Bahan Kertas gambar (tiga lembar per kelompok)

Uraian Siswa menduga peluang terjadinya peristiwa dengan menempatkan peristiwa tersebut pada tempat yang sesuai pada tangga peluang. Tangga peluang menunjukkan bahwa peluang berkisar antara 0% dan 100%. Pertama-tama siswa akan menyatakan peluang secara informal dengan meletakkan pernyataan pada tangga sesuai tinggi peluang dalam persen. Cara lain adalah dengan perbandingan. Siswa akan menggunakan cara ini kemudian, pada bagian ini.

Rencana Siswa boleh menlanjutkan kegiatan untuk soal 3-5 berpasangan atau kelompok kecil. Anda dapat menggunakan soal 4 dan 5 sebagai penilaian atau untuk PR. Diskusikan penjelasan siswa terhadap jawaban mereka atas soal 3 dan 5.

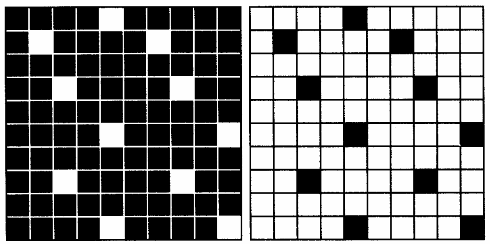
Komentar tentang Soal-soal

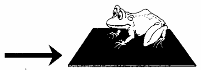
4. **Penilaian informal** Soal ini mengukur kemampuan siswa untuk menyatakan peluang dengan bahasa sehari-hari. Dapat juga sebagai PR. Siswa harus mampu menggunakan tangga peluang dan mengerti bahwa peluang pada rentangan tersebut. Anda dapat mengungkapkan kepada siswa bahwa tangga mempunyai 10 anak tangga, dan tanyakan kepada mereka apakah ini bermanfaat atau tidak. Jika Anda mendapatkan kenyataan bahwa siswa siswa memperoleh kesulitan dengan pernyataan verbal (kalimat), mintalah mereka untuk menggambar sebuah tangga dan gunakan kalimat mereka sendiri untuk menyatakan peluang yang bersesuaian dengan beragam letak.
5. **Penilaian Informal** Soal ini mengukur kemampuan siswa untuk menduga peluang dalam persen dari 0% hingga 100%. Boleh juga sebagai PR. Manfaat dari soal ini hanya untuk mengurutkan peluang. Siswa diperbolehkan menggunakan perbandingan global (secara garis besar). Misalnya, membandingkan b dan c. [Lebih banyak angka-angka yang bersesuaian dengan pernyataan b dibanding pernyataan c, jadi peluang mendapat 1 atau 2 lebih rendah.] Siswa boleh menghitung persentase yang tepat, tapi jangan jadikan ini sebagai sesuatu yang wajib. (Anda boleh berharap mereka akan menyatakan dalam persen nanti. Persen yang benar adalah 50%, 20%, 10%, 0%, dan 75%.)



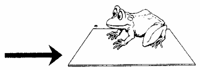
Akhirnya Ira berhasil menemukan kembali Frog Newton. Ia sedang duduk di lantai ubin.

Kafetaria **Aula**





6. Perhatikan dua lantai ubin di sebelah kiri. Menurut kamu Ira menemukan Frog Newton di Kafetaria atau Aula? Jelaskan.
7. Sama dengan soal 6, tetapi Ira menemukannya duduk di lantai di bawah ini



Apakah mungkin si katak berada pada lantai yang sama (seperti jawaban soal 6)?

Penyelesaian dan Contoh
pekerjaan siswa

6. Boleh jadi Ira menemukannya di kafetaria. Karena lebih banyak ubin hitam di kafetaria, sehingga peluang ditemukan dilantai ubin kafetaria lebih besar.

7. Tidak. Ira boleh jadi menemukannya di aula, karena lebih banyak ubin putih di ruangan tersebut.

Petunjuk dan Komentar

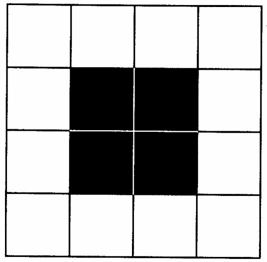
Uraian Dengan menggunakan konteks katak melompat pada lantai ubin, siswa menyatakan peluang bahwa katak akan mendarat pada ubin hitam dengan membandingan jumlah ubin hitam dan putih.

Tentang Matematika Lantai dengan ubin hitam dan putih memberikan siswa dukungan visual (gambar) untuk menduga peluang. Konteks ini mempersiapkan siswa menggunakan istilah perbandingan secara informal, seperti "satu dari empat."

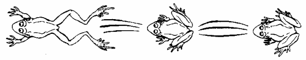
Rencana Siswa dapat melanjutkan kegiatan pada soal 6 dan 7 berpasangan atau kelompok kecil. Diskusikan jawaban mereka atas soal-soal tersebut di kelas (diskusi kelas).

Komentar tentang Soal-soal

6-7 Beberapa siswa mungkin berpendapat bahwa katak mungkin ditemukan baik di kafetaria ata aula (keduanya sama-sama mungkin). Tanyakan kepada mereka: *Pada ruangan mana yang lebih mungkin mendarat di ubin hitam atau ubin putih?* [Frog Newton lebih mungkin mendarat pada ubin hitam di kafetaria, dan akan lebih mungkin mendarat pada ubin putih di aula.]



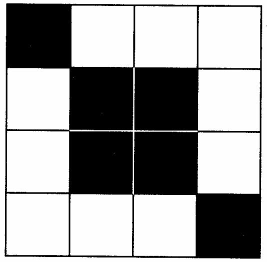
Here is another tiled floor.
Ini lantai ubin yang lain.



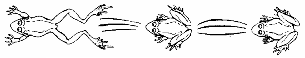
8. Katak Ira, Frog Newton, melompat-lompat supaya tidak tertangkap. Gambarlah skala seperti contoh di kanan. Tandailah peluang bahwa Frog Newton akan berhenti pada bujursangkar hitam. Jelaskan jawabanmu.

Yakin Terjadi — 100%

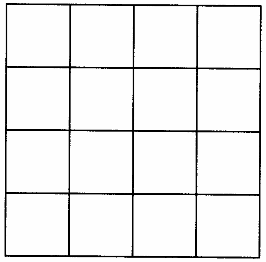
Yakin Tidak Terjadi — 0%

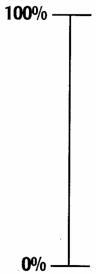


Sekarang perhatikan lantai yang lain

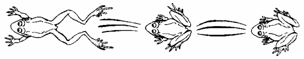


9. a. Tandailah peluang bahwa Frog Newton akan berhenti pada bujursangkar hitam pada lantai tersebut, pada tangga yang sama seperti yang kamu gunakan untuk soal 8.
b. Apakah peluangnya lebih besar atau lebih kecil dibanding soal 8? Jelaskan.

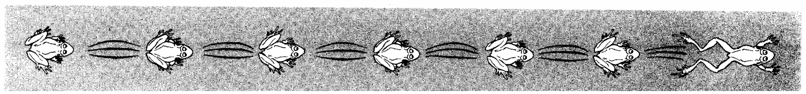




10. a. Pada Lembar Kerja Siswa 2, warnailah lantai pertama sehingga Frog Newton akan mempunyai peluang 50% mendarat pada bujursangkar hitam.
b. Tandailah peluang 50% pada tangga di Lembar Kerja Siswa 2.



c. Adakah cara lain untuk mengatakan "Peluangnya adalah 50%"?



Penyelesaian dan Contoh
jawaban siswa

11. Jawaban mungkin beragam.
Contohnya:

Yakin terjadi — 100%

Peluang katak akan mendarat pada bujursangkar hitam — 25%

Yakin tidak terjadi — 0%

9a. Jawaban bisa beragam.
Misalnya:

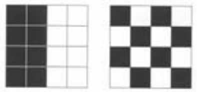
Yakin terjadi — 100%

Peluang katak akan mendarat pada bujursangkar hitam — 37.5%

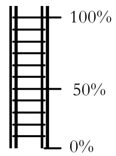
Yakin tidak terjadi — 0%

b. Lebih besar. Pada lantai untuk soal 8, hanya empat dari enambelas bujur sangkar berwarna hitam. Pada soal 9, enam dari enambelas berwarna hitam. Karena terdapat lebih banyak bujursangkar hitam pada soal 9, maka peluang untuk mendarat pada bujursangkar hitam lebih besar.

10a. Lantai akan beragam. Semua jawaban yang menunjukkan separo hitam dan separo putih dapat diterima. Anda bisa membandingkan jawaban-jawaban mereka.
Misalnya:



b.



c. Jawaban bisa beragam. Misalnya:
- peluang satu dari empat, atau
- peluang 50-50.

Petunjuk dan Komentar

Bahan Lembar Kerja Siswa 2 (satu per siswa), krayon hitam (satu per siswa)

Uraian Siswa menggunakan persen untuk menduga peluang bahwa katak akan mendarat pada ubin hitam pada lantai hitam-putih yang berbeda-beda.

Tentang Matematika Tangga peluang sekarang disederhanakan menjadi garis tegak berskala tanpa tanda untuk kelipatan 10%. Titik-titik utama skala adalah 0%, 50%, dan 100%.

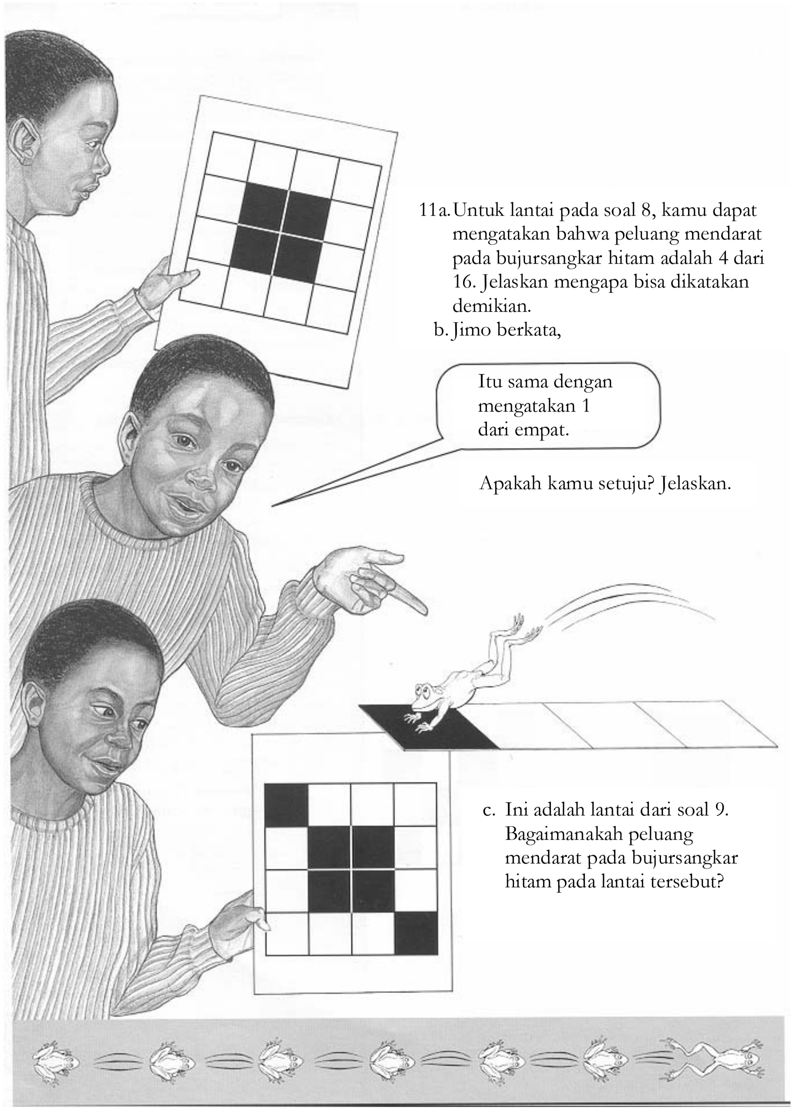
Rencana Siswa menlanjutkan bekerja berpasangan atau kelompok kecil untuk soal 8-10. Anda dapat menggunakan soal 10 sebagai PR. Ingatkan siswa untuk menyimpan salinan Lembar Kerja Siswa 2 untuk digunakan lagi pada soal 12.

Komentar tentang Soal-soal

8. Diskusikan penjelasan siswa atas jawaban mereka. Beberapa siswa boleh jadi mempunyai alasan bahwa katak mempunyai peluang 50% mendarat pada ubin hitam karena lantai hanya terdiri dari ubin hitam dan putih saja. Jika tidak ada siswa yang menawarkan diri untuk menjelaskan , mintalah mereka untuk menanggapi dalam diskusi.

8-9. Siswa tidak harus menghitung nilai persen secara tepat. Malah, mereka seharusnya sanggup menduga peluang dengan menempatkan peristiwa pada posisi yang sesuai pada tangga. Jawaban informal masih diperkenankan di sini. Jika siswa mengatakan bahwa katak tidak akan mendarat pada bujursangkar hitam karena terlalu jauh, ingkatkan mereka bahwa katak mampu melompat pada sembarang bujursangkar di lantai tersebut.

10. **Pekerjaan Rumah** Soal ini dapat digunakan sebagai PR.



11a. Untuk lantai pada soal 8, kamu dapat mengatakan bahwa peluang mendarat pada bujursangkar hitam adalah 4 dari 16. Jelaskan mengapa bisa dikatakan demikian.

b. Jimo berkata,

"Itu sama dengan mengatakan 1 dari empat."

Apakah kamu setuju? Jelaskan.

c. Ini adalah lantai dari soal 9. Bagaimanakah peluang mendarat pada bujursangkar hitam pada lantai tersebut?

Penyelesaian dan Contoh

8. a. Penjelasan bisa beragam. Antara lain:

   Ada 4 bujursangkar hitam dan 16 seluruhnya, jadi peluang mendarat pada bujursangkar hitam adalah 4 dari 16.

   b. Ya. Perbandingan 1 dari 4 sama dengan perbandingan 4 dari 16. Keduanya adalah perbandingan yang ekuivalen.

   c. 6 dari 16, atau 3 dari 8.

Petunjuk dan Komentar

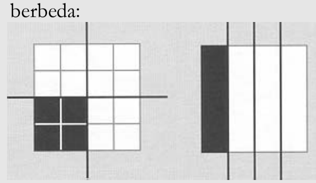
Uraian Siswa menggunakan istilah perbandingan informal untuk menyatakan peluang katak mendarat pada bujursangkar hitam dari bermacam-macam lantai ubin hitam-putih.

Tentang Matematika Pada halaman terdahulu, pendugaan dalam persen dilakukan dengan membandingkan jumlah bujusangkar hitam dan putih. Pada halaman ini, istilah perbandingan, seperti "satu dari enam," mulai diperkenalkan. Untuk menggambarkan peluang menggunakan istilah ini, perlu dibandingkan ubin hitam terhadat seluruh ubin (seluruh kemungkinan). Konteks ini memberikan kesempatan kepada siswa untuk melihat hubungan antara konsep himpunan yang dijelaskan dengan istilah yang sama.

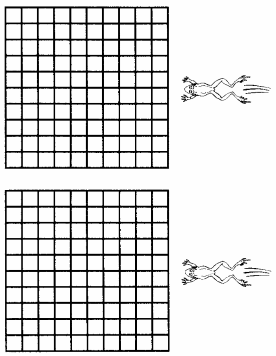
Rencana Anda boleh meminta siswa untuk menyelesaikan soal 11 secara individual. Ini akan memungkinkan Anda untuk melihat sejauh mana masing-masing siswa memahami dan menggunakan istilah perbandingan. Anda boleh dapat menggunakan soal ini atau soal 13 sebagai penilaian.

Komentar tentang Soal-soal

11. **Penilaian informal** Soal ini menilai kemampuan siswa untuk menentukan peluang dalam persen, pecahan, atau perbandingan, untuk situasi-situasi sederhana.
    Untuk bagian b, Anda dapat menunjukkan bagaimana gambar memvalidasi ¼ dengan membagi dan mengiris bujursangkar. Hal ini dapat dilakukan dengan dua cara berbeda:



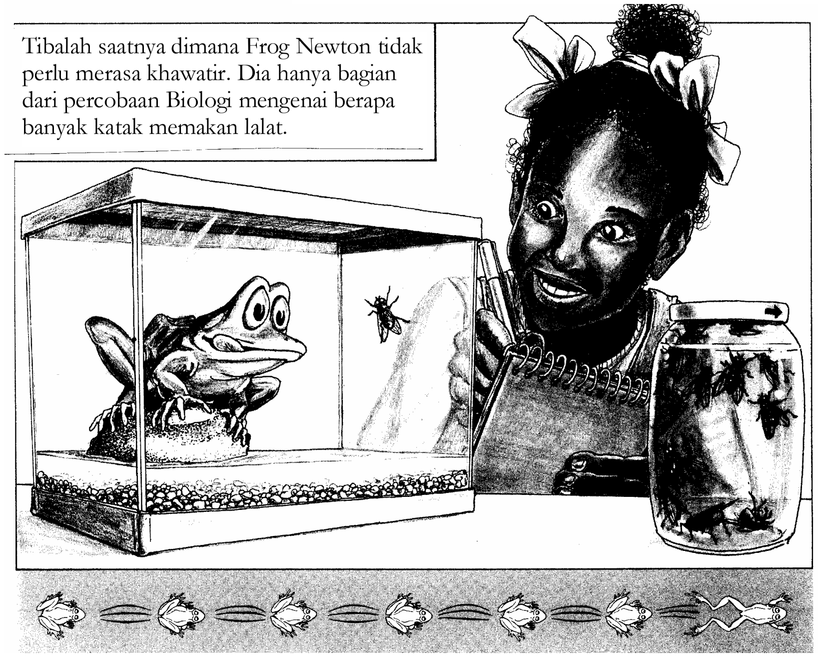
Pada bagian c, siswa diminta untuk menentukan peluang yang pasti mendarat pada ubin tertentu untuk pertama kali. Semua soal-soal terdahulu dapat dijawab secara informal. Beberapa siswa boleh jadi menyederhanakan perbandingan 6 dari 16 menjadi 3 dari 8. Namun demikian, hal ini tidak dipaksakan.



12. a. Warnailah lantai kedua dari Lembar Kerja Siswa 2 sedemikian sehingga peluang katak mendarat pada bujursangkar hitam adalah 1 dari 5.
b. Sekarang warnailah lantai ketiga pada Lembar Kerja Siswa 2 dengan pola sembarang ubin hitam dan putih. Bagaimana peluang katak mendarat pada ubin hitam pada lantai yang kamu buat?

13. Jika kamu mempunyai lantai ubin hitam-putih, jelaskan bagaimana kamu memperoleh peluang bahwa seekor katak mendarat pada bujursangkar hitam.

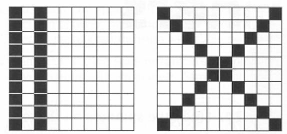
Tibalah saatnya dimana Frog Newton tidak perlu merasa khawatir. Dia hanya bagian dari percobaan Biologi mengenai berapa banyak katak memakan lalat.



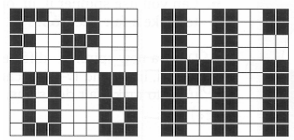
Penyelesaian dan Contoh
pekerjaan siswa

12.

a. Jawaban akan beragam. Setiap jawaban dimana 20% atau 1/5 dari bujursangkar adalah hitam, dapat diterima (benar).



b. Jawaban akan beragam bergantung pada lantai yang dibuat siswa. Peluangnya adalah jumlah bujursangkar hitam berbanding seluruh bujursangkar. Boleh jadi siswa menyatakannya dalam bentuk pecahan.



44 bujursangkar hitam;
Persen: 44%;
Pecahan: 44/100 atau 11/25;
Ratio: 44 dari 100 atau 11 dari 25;

60 bujursangkar hitam;
Persen: 60%;
Pecahan: 60/100, 6/10, 3/5;
Ratio: 60 dari 10, 6 dari 10, atau 3 dari 5.

13. Anda dapat menghitung jumlah bujursangkar hitam dan seluruh bujursangkar pada lantai. Peluang katak mendarat pada bujursangkar hitam adalah ratio bujursangkar hitam terhadap seluruh bujursangkar.

Petunjuk dan Komentar

Bahan Lembar Kerja Siswa 2 (satu per siswa), krayon hitam (satu per siswa)

Uraian Pada soal terdahulu, siswa menyatakan peluang berdasarkan jumlah ubin hitam dan putih pada latai. Sekarang mereka bekerja sebaliknya, peluangnya diberikan kemudian mereka diminta membuat pola ubin pada lantai. Siswa juga menggeneralisasi bagaimana mencari peluang mendarat pada bujursangkar hitam.

Tentang Matematika Siswa boleh menggunakan pengetahuannya tentang ratio dan proporsi untuk menyelesaikan soal-soal ini. Beberapa cara dapat digunakan untuk menyelesaikan soal 12:

- Secara berurutan warnai satu dari setiap lima ubin,
- Warnai satu baris dari setiap lima baris (atau dua dari setiap sepuluh baris),
- Hitung berapa banyak ubin yang perlu diwarnai sebelum mewarnai.

Ratio ekivalen digeneralisasi berdasarkan cara di atas. Beberapa ratio ekivalen ditunjukkan oleh tabel berikut.

Jumlah Ubin Hitam (atau Baris)	1	2	20
Jumlah Seluruh Ubin (atau Baris)	5	10	100

Soal ini dapat mendorong pemahaman siswa tentang hubungan antara ratio, pecahan, dan persen. Misalnya, ratio satu dari lima adalah ekivalen dengan pecahan 1/5 dan ekivelen dengan 20%.

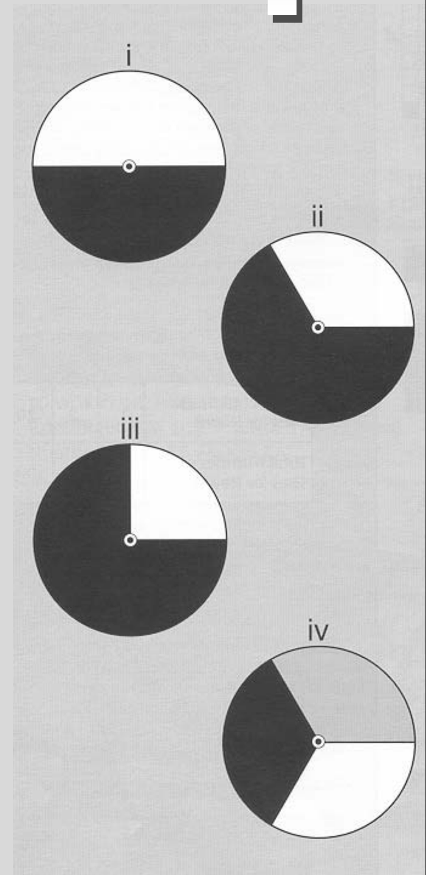
Rencana Pastikan bahwa siswa masih mempunyai fotocopy Lembar Kerja Siswa 2. Mereka boleh menyelesaikan soal 12 dan 13 sendiri-sendiri. Anda dapat menggunakan soal 13 sebagai penilaian. Diskusikan cara-cara siswa dan penyelesaian soal 12 dengan seluruh siswa (kelas).

Komentar tentang Soal-soal

12. a. Mintalah siswa untuk menerangkan cara yang ia gunakan sebelum mulai mewarnai.
b. Mintalah siswa menunjukkan bagaimana ia mendapatkan peluang mendarat pada ubin hitam.

13. **Penilaian Informal** Soal ini mengukur kemampuan siswa menentukan peluang dalam persen, pecahan, atau ratio, untuk situasi sederhana

Spiner



14. Perhatikan spiner di samping kiri.

a. Dapatkah kamu menggunakan spiner i untuk membuat keputusan yang adil? Jelaskan.

b. Dapatkah kamu menggunakan spiner ii, iii, atau iv untuk membuat keputusan yang adil?

c. Gambarlah sebuah spiner (berbeda dari i, ii, iii, dan iv) yang dapat digunakan untuk membuat keputusan secara adil.

15. a. Gambarlah sebuah tangga peluang pada buku catatan kamu. Untuk masing-masing spiner di samping, tandailah tangga tersebut yang menunjukkan peluang berhenti pada bagian hitam.

b. Gunakan cara yang berbeda selain tangga untuk menyatakan peluang berhenti pada bagian hitam oleh masing-masing spiner.

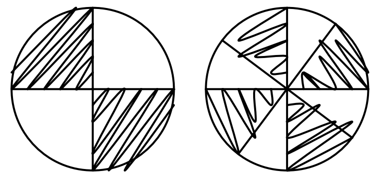
Penyelesaian dan Contoh

pekerjaan siswa

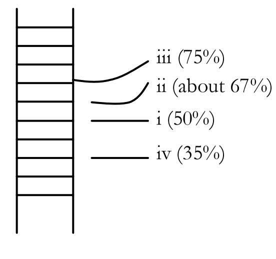
14. a. Ya, jika ada dua orang ikut serta atau ada dua pilihan yang harus ditentukan. Karena peluang untuk berhenti pada bagian hitam atau putih seimbang, spiner tersebut adil.

b. Anda tidak dapat menggunakan spiner ii dan iii untuk membuat keputusan yang adil antara dua orang. Spiner iv mungkin adil digunakan untuk membuat keputusan diantara tiga orang.

c. Spiner akan beragam. Spiner yang dibuat siswa mungkin memuat bagian yang mempunyai daerah yang sama. Misalnya:



15. a. 100% →



b. Jawaban akan beragam. Siswa dapat menyatakan peluang dengan menggunakan persen, ratio, atau pecahan. Misalnya:

i. 50%, satu dari dua, atau ½
ii. kira-kira 67%, dua dari tiga, atau 2/3
iii. 75%, tiga dari empat, atau ¾
iv. kira-kira 33%, satu dari tiga, atau 1/3

Petunjuk dan Komentar

Uraian Siswa memutuskan apakah spiner yang berbeda dapat digunakan untuk membuat keputusan yang adil. Mereka menyatakan peluang berhenti pada bagian hitam masing-masing spiner dengan menggunakan tangga peluang dan menyatakannya dalam persen, pecahan atau ratio.

Tentang Matematika Secara teknik, apakah spiner dapat digunakan untuk membuat keputusan yang adil bergantung pada apa yang akan diputuskan. Misalnya, jika Anda ingin memberikan hasil peluang yang berbeda, spiner dengan sudut pusat yang tidak seimbang dapat dipandang adil. Hal ini tidak penting dibicarakn dengan siswa pada saat ini.

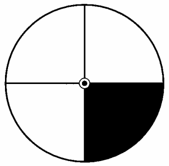
Rencana Siswa dapat mengerjakan soal 14 dan 15 berpasangan atau dalam kelompok kecil. Anda dapat menggunakan soal 15 untuk penilaian.

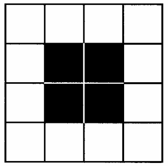
Komentar tentang Soal-soal

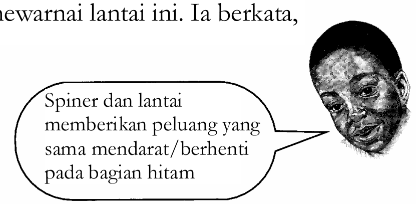
14. Pada soal ini, siswa menggunakan spiner untuk membuat keputusan yang adil. Apabila siswa mengalami kesulitan berikan contoh sederhana dari permainan anak-anak.
15. **Penilaian Informal** Soal ini menilai kemampuan siswa untuk menentukan peluang, dalam persen, pecahan, atau ratio, untuk situasi sederhana.

Siswa harus mampu menerangkan jawaban mereka dengan menggunakan pecahan atau persen. Doronglah mereka untuk menyatakan jawaban gambar mereka pada bagian a dalam bentuk ratio, pecahan, atau persen apabila mereka belum menggunakannya.

Jimo membuat spiner sendiri dan mewarnai lantai ini. Ia berkata,







16. Apakah kamu setuju dengan Jimo? Jelaskan

Kegiatan

17. Lihatlah pada berita di surat kabar yang memuat pernyataan tentang peluang. Tempatkan pernyataan tersebut pada suatu tangga peluang. Bawalah tangga tersebut ke sekolah dan jelaskan mengapa kamu menempatkan pernyataan tersebut di sana. Berikut ini adalah potongan berita koran untuk menolong kamu.

Peluang untuk merebut gelar divisi tipis

By Mel Bergman
of The Reporter staff

It was no surprise that the Cal-away CooCoos' manager Regg Loopendorf refused to give a statement regarding his team's even though the seri led to a new definitic Future chances for a can only hope that it

Genjatan Senjata Mungkin Berakhir Segera

Home Buyer's Guide

Kesempatan terakhir untuk membeli rumah baru di Telaga Perak

Site rating guide ★★★★

LATEST LUXURIOUS LISTINGS

The last twenty homes will go on sale this weekend.

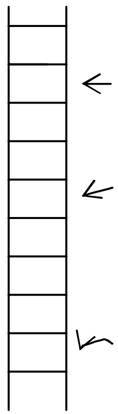
The increase in the number of families wanting to settle in this spectacular area has increased dramatically over the last few weeks. The few the range of views and the availability of easy access to many of the recreational out-lets bring a new meaning to the term "Land of Dreams"

Penyelesaian dan Contoh
pekerjaan siswa

16. Jimo benar. Peluang untuk mendarat/berhenti pada ubin/bagian hitam adalah satu dari empat, baik menggunakan spiner atau lantai ubin.

17. Tangga akan beragam. Siswa mungkin menemukan pernyataan peluang dari iklan, berita olahraga, hasil jajak pendapat, dan lain-lain

Misalnya:



Petunjuk dan Komentar

Uraian Siswa membandingkan peluang berhenti pada bagian hitam dari spiner terhadap peluang mendarat pada ubin hitam dari lantai. Kemudian siswa membagikan dengan temannya tangga peluang yang mereka buat yang menyatakan peluang berita utama suratkabar.

Rencana Siswa dapat mengerjakan soal 16 dan 17 berpasangan atau kelompok kecil. Anda dapat memberikan soal 17 sebagai PR atau sebagai tugas proyek. Jika siswa tidak memiliki suratkabar di rumah, Anda dapat menyediakannya di kelas

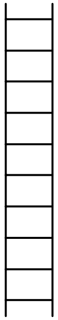
Komentar tentang Soal-soal

16. Soal ini menyatakan secara jelas hubungan antara peluang pada spiner dengan peluang pada lantai. Anda dapat meminta siswa untuk membuat spiner dan lantai yang lain yang menyatakan peluang yang sama.

17. **Pekerjaan Rumah** Soal ini dapat ditugaskan sebagai PR. Kunci utama dari kegiatan ini adalah untuk mendapat kesan tentang bahasa peluang dalam kehidupan sehari-hari.

Ringkasan

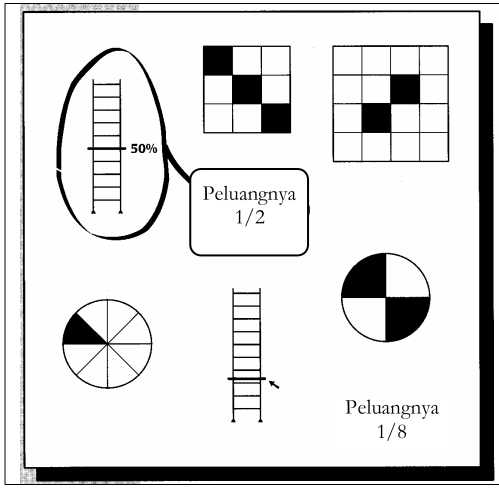
Pada bagian ini, kamu menyaksikan cara-cara berbeda dalam menyatakan peluang. Kamu melihat bahwa peluang pada tangga dapat dinyatakan dengan persen. Jika kamu yakin bahwa sesuatu akan terjadi, kamu dapat menyatakan bahwa peluangnya adalah 100%. Jika kamu yakin bahwa itu tidak akan terjadi, peluangnya adalah 0%. Peluang juga dapat dinyatakan dengan pecahan. Anda juga dapat menyatakan suatu tangga peluang dengan menggunakan pecahan.



Pertanyaan Ringkasan

18. a. Pecahan apa yang dapat kamu gunakan untuk menyatakan peluang 50-50?
    b. Letakkan beberapa pecahan lain yang termasuk anggota suatu tangga peluang.

Di bawah ini beberapa pernyataan tentang peluang. Beberapa di antaranya adalah anggota bersama; hanya berbeda dalam menyatakannya.



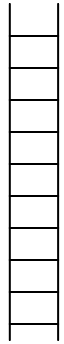
19. Pada Lembar Kerja Siswa 3, hubungkanlah seluruh pernyataan yang menjelaskan hal yang sama. Satu contoh sudah diberikan.

Penyelesaian dan Contoh

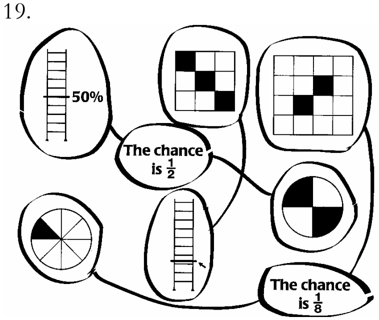
pekerjaan siswa

18. a. Jawaban akan beragam. Semua pecahan yang ekivalen dengan ½ benar. Misalnya: ½, 5/10, atau 50/100.

    b. Jawaban akan beragam. Misalnya:



19.



Petunjuk dan Komentar

Bahan Lembar Kerja Siswa 3 (satu per siswa)

Uraian Halaman ini meringkaskan konsep utama pada pelajaran ini. Cara-cara yang berbeda dalam menyatakan peluang dikaitkan satu sama lain: tangga peluang, persen, dan pecahan.

Rencana Setelah siswa membaca Ringkasan, Anda dapat meminta mereka untuk mengerjakan soal 18 dan 19 secara individual. Anda boleh pula menggunakannya sebagai PR. Diskusikan jawaban-jawaban mereka pada seluruh siswa di kelas. Setelah siswa menyelesaikan seluruh pelajaran, saatnya Anda memberikan siswa tugas-tugas yang sesuai untuk pengayaan.

Komentar tentang Soal-soal

18. a. **Pekerjaan Rumah** Beberapa siswa diperkenankan menggunakan ungkapan *satu dari dua*. Tapi usahakan agar mereka menyatakannya dengan pecahan. Tanyakan kepada mereka apakah ratio tersebut sama dengan ½.

    b. Anda dapat menanyakan kepada siswa pecahan yang mana termasuk *Yakin Terjadi* dan *Yakin Tidak Terjadi.*

19. **Pekerjaan Rumah** Soal ini dapat digunakan sebagai PR. Beberapa siswa mungkin memerlukan petunjuk dimana lebih dari dua pernyataan telah terhubung.

APPENDIX N
ANALYSIS OF JUNIOR HIGH SCHOOL (GRADE 8) STUDENTS' WORK

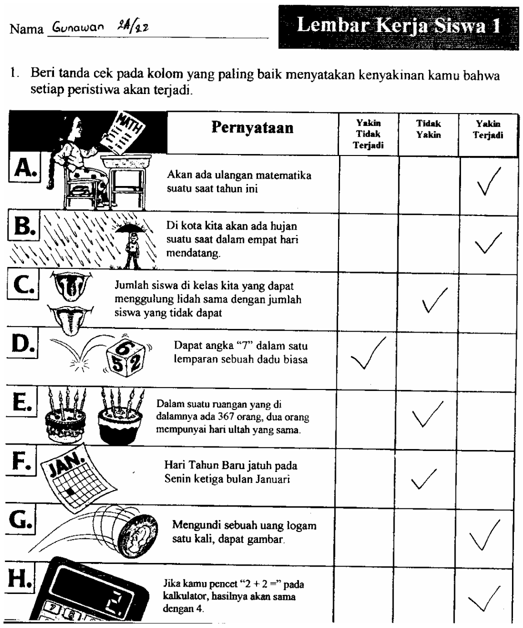
Students' works analysed in this paper are taken from the classroom practice of a participant of tryout of IndoMath program. In this tryout ten mathematics teachers participated in a workshop, conducted classroom practice as part of in-service program, and reflected on it in a meeting to discuss the issues that emerged in the workshop as well as in the classroom practices. The classroom practice took place two times within two days with duration 2 x 45 minutes each. The teachers used MiC-based RME exemplary material of *Apakah Peluang Itu?* (What is the chance?) in their lesson.

The students works analysed in here are taken from the result of classroom practice in Junior High School of SLTPN 5 Yogyakarta of Grade 2 (14 years old). The SLTPN 5 is located in the urban area. There are 40 students in the class. They worked individually and in small groups (4 students). The teaching-learning process proceeded in a way that the students work independently using their own material – each student got a copy of RME exemplary module. The teacher let the students to interpret and find the solution of the problems in the module by themselves with the teacher's guidance if needed.

The module of *Apakah Peluang Itu?* starts with Problem 1 from which students have to decide among three possibilities of events to happen, namely "sure to happen", and "sure not to happen", and all others possibilities between those two extremes.

To give the idea of how this starting problem is designed we may have a look again at 'Up and Down Events' on Figure 5.2. There are eight statements on the problem using the contexts those students familiar with. By using this problem, the lesson is designed to engage students in meaningful mathematical activities. This Problem 1 is intended to give students basic understanding of the meaning of chance.

In the following of figures 5.6, 5.7 and 5.8, students' works on Problem 1 are given: Gunawan, Kus and Putri (see Figure 5.2 for original version in English). From their work we know how – in some statements – the different answer come up that reflect the various perceptions about the possibility of an event to happen or not to happen, whereas for some other statements they come up to the same idea.



Nama Gunawan 2A/22

Lembar Kerja Siswa 1

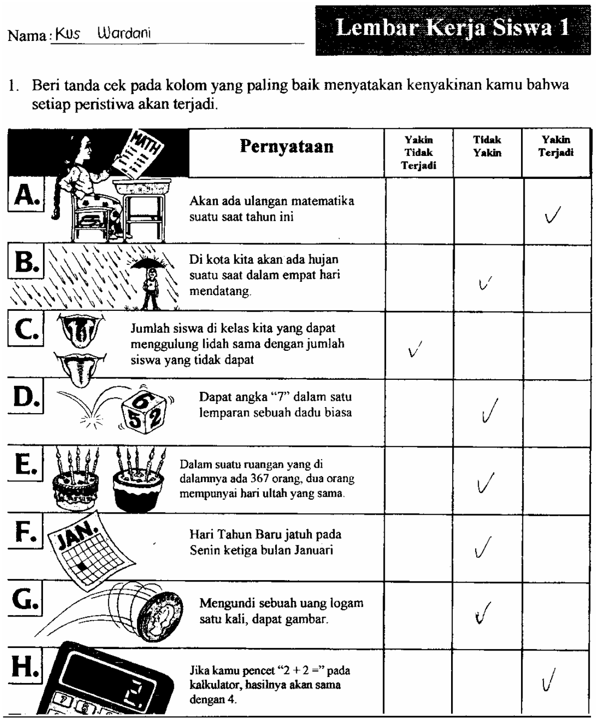
1. Beri tanda cek pada kolom yang paling baik menyatakan kenyakinan kamu bahwa setiap peristiwa akan terjadi.

	Pernyataan	Yakin Tidak Terjadi	Tidak Yakin	Yakin Terjadi
A.	Akan ada ulangan matematika suatu saat tahun ini			✓
B.	Di kota kita akan ada hujan suatu saat dalam empat hari mendatang.			✓
C.	Jumlah siswa di kelas kita yang dapat menggulung lidah sama dengan jumlah siswa yang tidak dapat		✓	
D.	Dapat angka "7" dalam satu lemparan sebuah dadu biasa	✓		
E.	Dalam suatu ruangan yang di dalamnya ada 367 orang, dua orang mempunyai hari ultah yang sama.		✓	
F.	Hari Tahun Baru jatuh pada Senin ketiga bulan Januari		✓	
G.	Mengundi sebuah uang logam satu kali, dapat gambar.			✓
H.	Jika kamu pencet "2 + 2 =" pada kalkulator, hasilnya akan sama dengan 4.			✓

Figure 5.6
Gunawan's answer for Problem 1

It is interesting to note here that the statements are not as simple as we think. For example in statement E (in a room of 367 people, two people will have the same birthday) Gunawan's answer was "not sure." Whereas the correct answer is "sure it will happen," because each person could have his or her birthday on a different day, including February 29 during leap years. In this case, teacher can remind Gunawan (and other students) that a year has 365 days and a leap year has 366 days. So, there are 366 possible days for a birthday.

The same matter was also happen for statement F (New Year's Day will come on the third Monday in January). Gunawan answered incorrectly by put a check on "not sure" column. Both statement E and F is related to almanac (such as the number of days in a year and new-year's day) – apparently some Indonesian students were not familiar with the context of calendar. If we look at Kus's answer (Figure 5.7) we find the same case. These two statements appear to be useful to facilitate discussion between teacher and whole class.



Nama : Kus Wardani

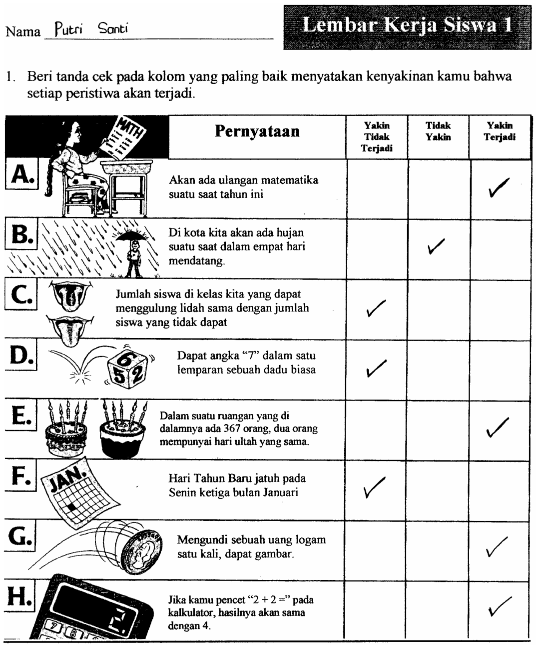
Lembar Kerja Siswa 1

1. Beri tanda cek pada kolom yang paling baik menyatakan kenyakinan kamu bahwa setiap peristiwa akan terjadi.

	Pernyataan	Yakin Tidak Terjadi	Tidak Yakin	Yakin Terjadi
A.	Akan ada ulangan matematika suatu saat tahun ini			√
B.	Di kota kita akan ada hujan suatu saat dalam empat hari mendatang.		√	
C.	Jumlah siswa di kelas kita yang dapat menggulung lidah sama dengan jumlah siswa yang tidak dapat	√		
D.	Dapat angka "7" dalam satu lemparan sebuah dadu biasa		√	
E.	Dalam suatu ruangan yang di dalamnya ada 367 orang, dua orang mempunyai hari ultah yang sama.		√	
F.	Hari Tahun Baru jatuh pada Senin ketiga bulan Januari		√	
G.	Mengundi sebuah uang logam satu kali, dapat gambar.		√	
H.	Jika kamu pencet "2 + 2 =" pada kalkulator, hasilnya akan sama dengan 4.			√

Figure 5.7
Kus's answer for Problem 1

Sometimes an ambiguity occurs due to the translating inappropriateness. For instance, in Indonesian version "birthday" is translated as "hari ultah." Some students referred "hari ultah" as days in a week (Monday, Tuesday, … Sunday). Therefore, it is logical if the answer is "sure it will" because among 367 people there are many – more than 2 – who born on "the same day" (Monday, Tuesday, … Sunday). An ambiguity also appears for statement G. We usually translate "head" as "gambar" and "tail" as "angka. Indonesian coins, at present, have "gambar" (head) on both sides, therefore the answer should be "sure it will" like Gunawan's answer.



Nama Putri Santi

Lembar Kerja Siswa 1

1. Beri tanda cek pada kolom yang paling baik menyatakan kenyakinan kamu bahwa setiap peristiwa akan terjadi.

	Pernyataan	Yakin Tidak Terjadi	Tidak Yakin	Yakin Terjadi
A.	Akan ada ulangan matematika suatu saat tahun ini			✓
B.	Di kota kita akan ada hujan suatu saat dalam empat hari mendatang.		✓	
C.	Jumlah siswa di kelas kita yang dapat menggulung lidah sama dengan jumlah siswa yang tidak dapat	✓		
D.	Dapat angka "7" dalam satu lemparan sebuah dadu biasa	✓		
E.	Dalam suatu ruangan yang di dalamnya ada 367 orang, dua orang mempunyai hari ultah yang sama.			✓
F.	Hari Tahun Baru jatuh pada Senin ketiga bulan Januari	✓		
G.	Mengundi sebuah uang logam satu kali, dapat gambar.			✓
H.	Jika kamu pencet "2 + 2 =" pada kalkulator, hasilnya akan sama dengan 4.			✓

Figure 5.8
Putri's answer for Problem 1

However, from the above illustrations we know that Indonesian students gained basic understanding of the meaning of chance as intended to, particularly in relation to everyday life statements. For statement H, for instance, some students answered orally "sure it will happen …, except the calculator is broken." This reaction was not only a reflection of their involvement in the lesson but also made the atmosphere of the class was cheerful that was conducive for the next sequence of learning process. From this point of view, the first tenet of RME: "start the lesson by giving contextual problem that engage students immediately in meaningful mathematical activity" is met by the problem. In general, Indonesian students did not have any obstacle in interpreting the statements in Problem 1 as described on Table 5.5.

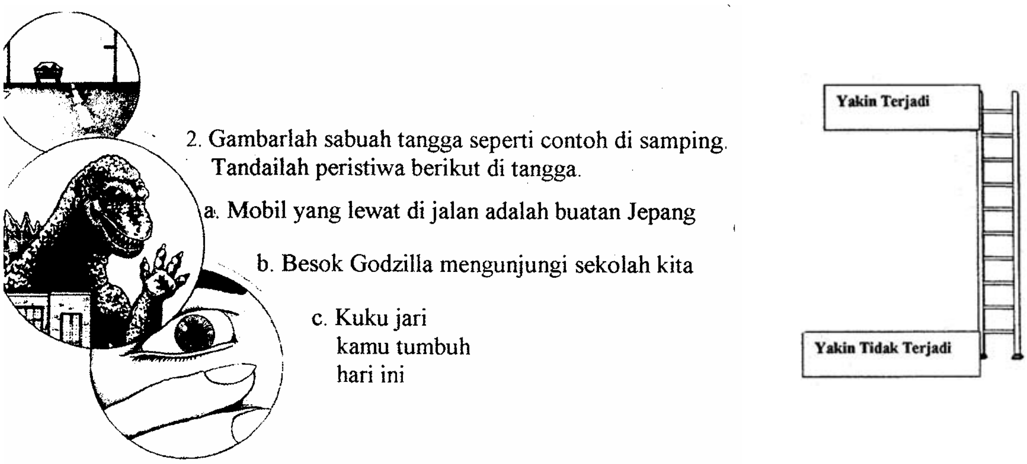
Table 5.5
Indonesian students answer for Problem 1 (in percent, N = 40)

Statement	**Sure It Won't**	**Not Sure**	**Sure It Will**
a. You will have a test in math sometime this year.	0	0	100
b. It will rain in your town sometime in the next four days.	0	65	35
c. The number of students in your class who can roll their tongues will equal the number of students who cannot.	20	80	0
d. You will roll a "7" with a normal number cube.	95	2.5	2.5
e. In a room of 367 people, two people will have the same Birthday.	0	35	65
f. New Year's Day will come on the third Monday in January.	85	12.5	2.5
g. When you toss a coin once, heads will come up.	0	70	30
h. If you enter "2 + 2 =" on your calculator, the result will be 4.	0	2.5	97.5

The differences in the students' reaction on that problem can facilitate the discussion among them – except for statement A (you will have a test in math sometime this year) where all students (100%) had the same answer, that is 'sure it will.' For the rest, the responses varied among three possibilities. From the above description we understand that teacher can use this situation as starting point to motivate the students to engage in the learning process. In this regard, the contextual problem will lose its meaning if teacher let the atmosphere that created by that problem go without any effort to build students' interest. It is particularly important in Indonesia where teaching and learning process is usually dominated by passive nature of students.

Indonesian teachers who participate in the tryout of IndoMath program and use the exemplary materials in their classroom practice seemed to be aware of the nature of this realistic approach. For this matter, they did not have any obstacle in bringing their lesson to the expected situation that was immediately engaging their students in meaningful mathematical activities. This seems simple, but how strong this starting point influences the next step of learning process: students start to stay awake if at any moment teacher ask their comment and reaction. This appears to be promising to shift the learning process from teacher centred to students centred. Also, students becoming aware of their role, that they were not only 'object' that should be filled with information or knowledge, but they had the right to deliver their thoughts.

In the following, students' answers for Problem 2 are analysed.



2. Draw a ladder like the one on the right. Put these three statements on your ladder.
   a. The next car you see on the road will have been built in Japan.
   b. Godzilla will visit your school tomorrow.
   c. Your fingernails will grow today.

Figure 5.9
Problem 2 from Module of Apakah Peluang Itu?

In analysing students' work for Problem 2 we are interested in students' interpretation of the statements in the problem and put them on the ladder to represent their chance. The ladder has ten rungs which correspond to the 10% benchmark and its multiples, with 0% at ground level and 100% at the highest rung. The addition of 10 rungs on the ladder makes it necessary for students to refine the category "Not Sure" of Problem 1.

The statement *'Mobil yang lewat di jalan adalah buatan Jepang'* (The next car you see on the road will have been built in Japan) was interpreted differently by the students. Nineteen out of 40 or 47.5% students put the statement on the eighth rung on a ladder or indicated 80% the possibility that this will happen. Six of them (15%) were even very confident by putting on the top ladder which mean that they were sure it will happen or 100%. Other answers were varied, namely 4 students put on the fifth rung or indicated 50%, 4 students indicated 75%, 3 students indicated 90%, 1 student put on the sixth rung, 3 student indicated 70%, 50% and 40% respectively.

So, we know that students' answer were varied among 100%, 90%, 80%, 75%, 70%, 60%, 50%, and 40%. We also know that most of them were very confident of the chance of this event to happen. It is understandable as the fact that almost all cars in Indonesia have Japan brand like Toyota, Honda, Suzuki, Nissan, Mazda, and Mitsubishi. Note that in the original version the statement is ' the next car you see on the road will have been built in the United States.' In the Indonesian version *the United States* is replaced with *Japan*.

In this regard we notice the influence of students' preconception or knowledge about car brand to their interpretation in approaching the problem.

For statement b, namely '*Besok Godzilla mengunjungi sekolah kita*' (Godzilla will visit our school tomorrow) students answers were almost uniform, namely by putting on the ground of the ladder (6 students) or indicated 0% (22 students). If we add 8 students who put on the first rung that apparently wanted to say that this event will not happen or 0%, then altogether we have 36 students (90%) who answered 0% for the chance of 'Godzilla will visit our school tomorrow.'

Examining eight students who put at the first rung instead of on the ground of the ladder to indicate 0% chance, we understand that the ladder with ten rungs did not go without saying, that is meant it still needed to be explained orally. During the tryout of this material in the lesson we know that some students still confuse to indicate 0% whether on the ground or at the first rung.

For Problem 2b we also found 2 students indicated 5%, 1 student indicated 10% and 1 student had no answer.

For statement c, namely '*Kuku jari kamu tumbuh hari ini*' (Your fingernails will grow today) students' answers were varied. Fifteen students indicated 100% and 10 students put on the tenth rung. So, 25 out of 40 students (62.5%) gave 100% chance for this statement.

Three students indicated 95% and three other indicated 90%. Four students indicated 50% or put on the fifth rung. Five students indicated 80%, 70%, 65%, 60%, and 40% respectively. So, 15 students (37.5%) were not sure that their fingernails would grow at that day. It is understandable because the growing of fingernail is not visible in daily observation. Again, here we understand students' factual knowledge, namely what they see and feel, influence their approach to the problem.

Problem 3 corresponds to Problem 1 in which students are asked to put the statements on a ladder. In this problem students estimated the chances of events by placing each event in an appropriate position on a chance ladder. The ladder shows that the chance that an event will occur is between 0% and 100%.

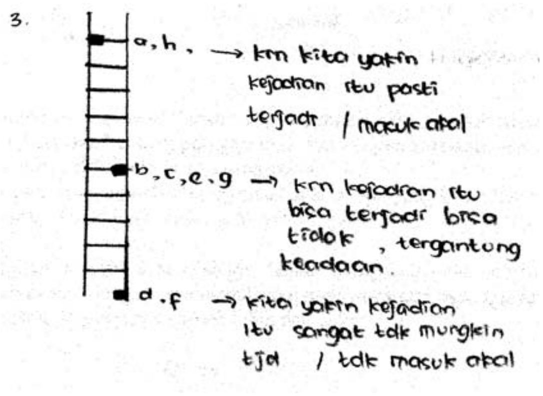
Sekarang kembali ke tabel di halaman 2 dan letakkan pernyataan pada tabel tersebut pada sebuah tangga. Jelaskan jawaban kamu.	Now go back to the table on page 2 and put the statements from the table on one ladder. Explain why you put the statements where you did.

Figure 5.10
Indonesian version of Problem 3

In the following we find how Indonesian grade 8 students deal with the problem 3. There were three model answers appear for that problem, namely
(1) Students put the statements on three places on the ladder: on the top (100% = sure to happen), on the middle (50% = not sure) and on the ground (0% = sure not to happen);
(2) Students put the statements on different places on the ladder without indication of exact percentage;
(3) Students put the statements on different places on the ladder with indication of certain percentage.

As representative of those models we give here some of their answers. It is interesting to notice here how Erika gave reason for her answer: for statements A and H where she put on the top, she indicated that those events were sure to happen and logic as she wrote '*karena kita yakin kejadin itu pasti terjadi / masuk akal*' (because we are sure that those events will happen / logic). For statements B, C, E and G she put on the middle with the reason '*karena kejadian itu bisa terjadi bisa tidak, tergantung keadaan*' (because those events may or may not to happen, depend on the situation). For statements D and F she put on the ground with reason '*kita yakin kejadian tersebut sangat tidak mungkin terjadi/ tidak masuk akal*' (we are sure that those events very unlikely to happen / not logic).

Put statements on the Top, Middle and Ground (35%)



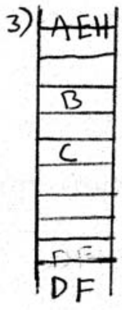
a, h, -> Because we are confident that those events sure to happen / logic.

b, c, e, g -> Because those events may or may not to happen, depend on the situation.

d, f -> We are confident that those event very unlikely to happen / not logic

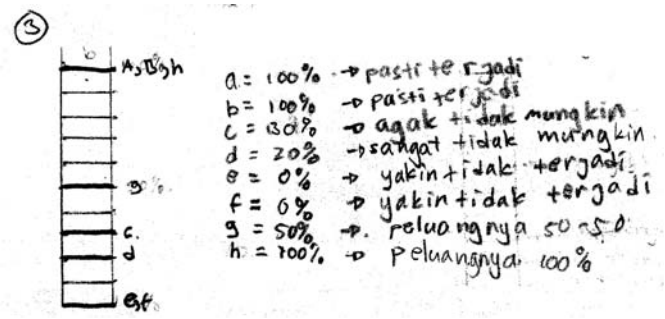
Erika

Put statements on different places without certain percentage (20%).



Tezar

Put statements on different places with certain percentage (37.5%).



A=100% -> sure to happen
b=100% -> sure to happen
c=30% -> seems unlikely
d=20% -> very unlikely
e=0% -> sure not to happen
f=0% -> sure not to happen
g=50% -> the chance is 50-50
h=100% -> the chance is 100%

Atria

Figure 5.11
Answer models for Problem 3

Fourteen out of 40 students (35%) had the same answer as Erika. Some of them put the percentages (100%, 50% and 0%) on the ladder like Dhomas's answer as shown on Figure 5.12.

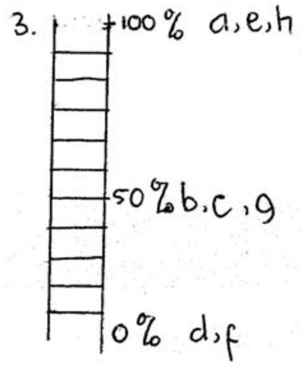
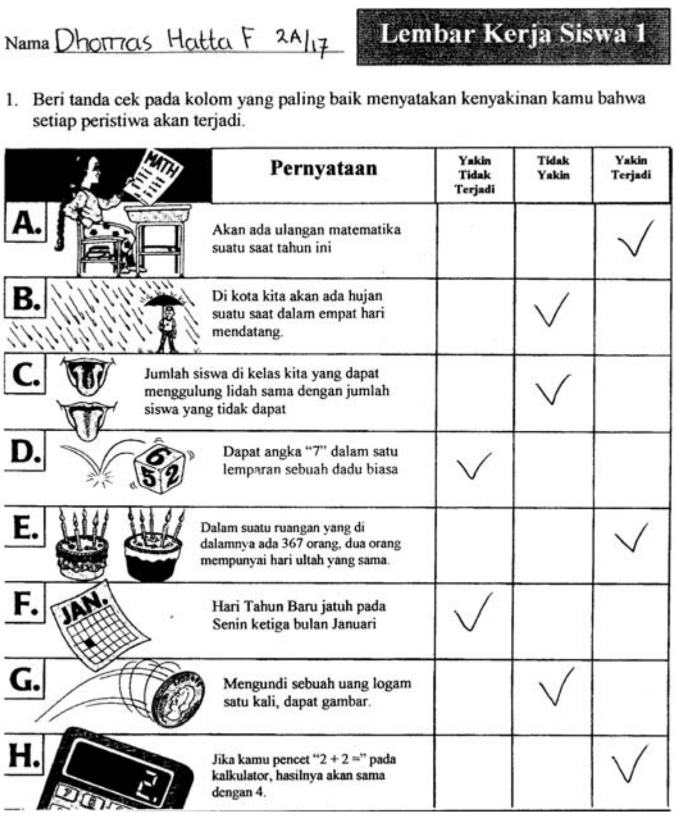


Figure 5.12
Dhomas's answer to Problem 3

If we compare Dhomas's answers to Problem 1 and Problem 3 we find a consistency, that is the decision he took for each statement among three possibilities: 'sure to happen', 'not sure' and 'sure not to happen' (Figure 5.13) were consistent with the place he chose on the ladder for each statement (see Figure 5.12).



Nama Dhomas Hatta F 2A/17

Lembar Kerja Siswa 1

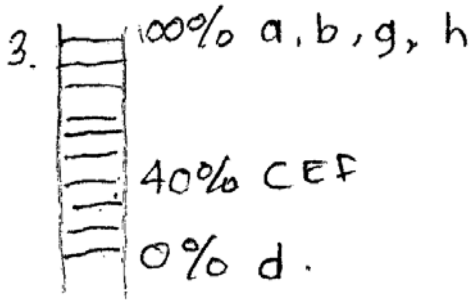
1. Beri tanda cek pada kolom yang paling baik menyatakan kenyakinan kamu bahwa setiap peristiwa akan terjadi.

	Pernyataan	Yakin Tidak Terjadi	Tidak Yakin	Yakin Terjadi
A.	Akan ada ulangan matematika suatu saat tahun ini			✓
B.	Di kota kita akan ada hujan suatu saat dalam empat hari mendatang.		✓	
C.	Jumlah siswa di kelas kita yang dapat menggulung lidah sama dengan jumlah siswa yang tidak dapat		✓	
D.	Dapat angka "7" dalam satu lemparan sebuah dadu biasa	✓		
E.	Dalam suatu ruangan yang di dalamnya ada 367 orang, dua orang mempunyai hari ultah yang sama.			✓
F.	Hari Tahun Baru jatuh pada Senin ketiga bulan Januari	✓		
G.	Mengundi sebuah uang logam satu kali, dapat gambar.		✓	
H.	Jika kamu pencet "2 + 2 =" pada kalkulator, hasilnya akan sama dengan 4.			✓

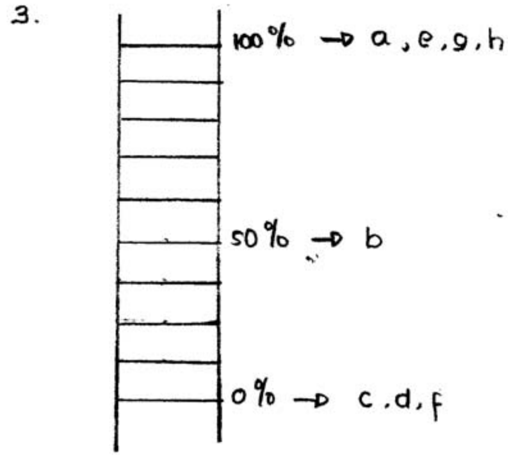
Figure 5.13
Dhomas's answer to Problem 1

Apparently, it was save for Dhomas to put the statements that he was not sure to happen on the middle of the ladder.

Also compare Gunawan and Putri's answers for problems 1 (Figure 5.6 and 5.8) and problem 3 (Figure 5.14). Their answers for Problems 1 and 3 are very consistent each other.



Gunawan's answer for Problem 3

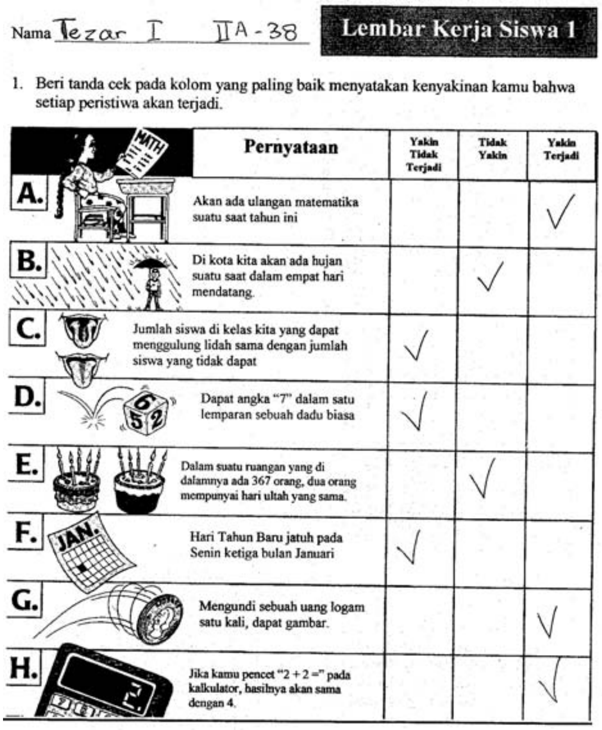


Putri's answer for Problem 3

Figure 5.14
Gunawan and Putri's answers to Problem 3

The second model of students' answer on Problem 3 was put the statements on different places on the ladder as represented by Tezar's answer.

Notice that to some extent Tezar's answer for Problem 3 was consistent with his answer on Problem 1 as shown on Figure 5.15. In Problem 1 he put statements B as Tidak Yakin (Not Sure) and put on the middle of the ladder as in Problem 3. He put statements A and H as Yakin Terjadi (Sure To Happen) and put on the top of the ladder, and D and F as Yakin Tidak Terjadi (Sure Not To Happen) and put on the ground of the ladder.


Nama Tezar I IIA - 38

Lembar Kerja Siswa 1

1. Beri tanda cek pada kolom yang paling baik menyatakan kenyakinan kamu bahwa setiap peristiwa akan terjadi.

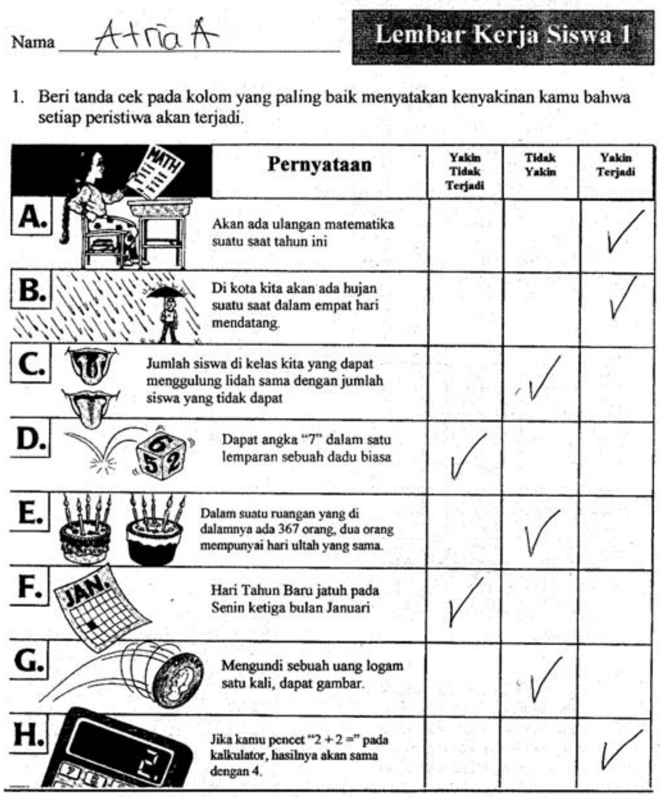
	Pernyataan	Yakin Tidak Terjadi	Tidak Yakin	Yakin Terjadi
A.	Akan ada ulangan matematika suatu saat tahun ini			√
B.	Di kota kita akan ada hujan suatu saat dalam empat hari mendatang.		√	
C.	Jumlah siswa di kelas kita yang dapat menggulung lidah sama dengan jumlah siswa yang tidak dapat	√		
D.	Dapat angka "7" dalam satu lemparan sebuah dadu biasa	√		
E.	Dalam suatu ruangan yang di dalamnya ada 367 orang, dua orang mempunyai hari ultah yang sama.		√	
F.	Hari Tahun Baru jatuh pada Senin ketiga bulan Januari	√		
G.	Mengundi sebuah uang logam satu kali, dapat gambar.			√
H.	Jika kamu pencet "2 + 2 =" pada kalkulator, hasilnya akan sama dengan 4.			√

Figure 5.15
Tezar's answer to Problem 1

Eight out of 40 students (20%) had the same model as Tezar's. Although it was not exactly the same, but the places they chose to put the statements on the ladder were different according to their possibility to or not to happen.

The third model of students' answer on Problem 3 was to put the statements on different places along with their percentages. As representative of this model we look at Atria's.

To some extent Atria's answer to Problem 3 was consistent with her answer to Problem 1 as shown in figure 5.16. For instance, for statements A, B and H she checked 'sure to happen' column, and put on the top ladder and indicates 100% chance.


Nama Atria A

Lembar Kerja Siswa 1

1. Beri tanda cek pada kolom yang paling baik menyatakan kenyakinan kamu bahwa setiap peristiwa akan terjadi.

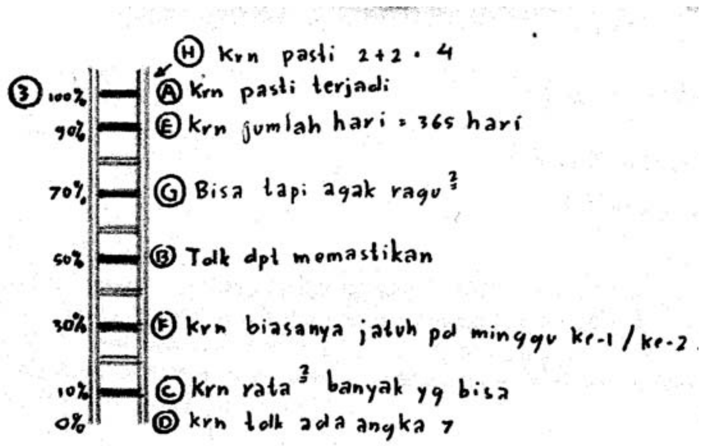
	Pernyataan	Yakin Tidak Terjadi	Tidak Yakin	Yakin Terjadi
A.	Akan ada ulangan matematika suatu saat tahun ini			✓
B.	Di kota kita akan ada hujan suatu saat dalam empat hari mendatang.			✓
C.	Jumlah siswa di kelas kita yang dapat menggulung lidah sama dengan jumlah siswa yang tidak dapat		✓	
D.	Dapat angka "7" dalam satu lemparan sebuah dadu biasa	✓		
E.	Dalam suatu ruangan yang di dalamnya ada 367 orang, dua orang mempunyai hari ultah yang sama.		✓	
F.	Hari Tahun Baru jatuh pada Senin ketiga bulan Januari	✓		
G.	Mengundi sebuah uang logam satu kali, dapat gambar.		✓	
H.	Jika kamu pencet "2 + 2 =" pada kalkulator, hasilnya akan sama dengan 4.			✓

Figure 5.16
Atria's answer to Problem 1

Only for statements D and E it seems not consistent. Atria checked on the 'sure not to happen' column for event D, but in the ladder for Problem 3 she indicated it as 20% chance. On the other hand, for statement E she checked 'not sure' column in Problem 1, but indicated it as 0% chance.

Beyond those three groups of model answer to Problem 3, two students did not answer the question properly. It seems that they did not understand the question. And one student put statements in two places on the ladder that is on the top (100%) and on the ground (0%). Interesting to notice that it was consistent with his answer to Problem 1 where for all statements he chose two possibilities only: sure to happen and sure not to happen.

Another example of students' answer to Problem 3 can be seen on Figure 5.17.



H because it is sure 2 + 2 = 4
A because sure to happen
E because the number of days = 365 days

G Possible but doubt
B cannot ascertain

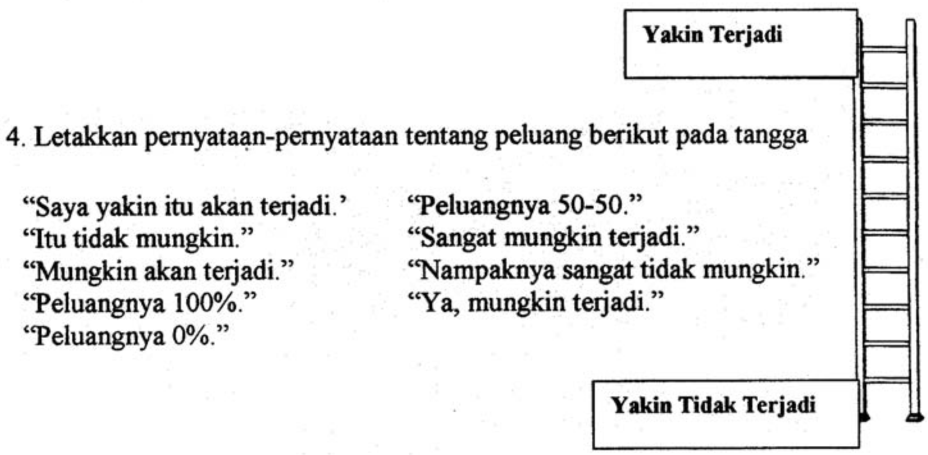
F because usually fall on the 1st week/ 2nd week

C because many can do it
D because there is no number 7

Figure 5.17
Isaac's answer to Problem 3

On Figure 5.17 we see different place for each event with certain exact percentage and the reason for that percentage. Events A and H are on the top (100%). The reason for that is '*karena pasti terjadi*' (because it is a definite will happen). Event E is close to the top (90%). The reason for that is '*karena jumlah hari = 365 hari*' (because the number of days = 365 days). Event G is 70% because '*bisa tapi agak ragu-ragu*' (may to happen but doubt). Event B is 50% because '*tidak dapat memastikan*' (cannot ascertain). Event E is 30% with the reason '*karena biasanya jatuh pada minggu ke-1/ke-2*' (because usually fall on the first week/second week). Event C is 10% with reason '*karena rata-rata banyak yang bisa*' (because on average many [students] can do it). And event D is 0% with the reason '*karena tidak ada angka 7*' (because there is no number 7). Isaac's answer tells us how a ladder facilitates his thinking about the up and down of chance of certain events.

Problem 4 in the following can be used to understand how Indonesian students describe everyday language in percent that is facilitated by the chance ladder.



4. Put the following statements about chance on a ladder:

"I'm sure it will happen."	"There's a 50-50 chance."
"That's unlikely."	"It's very likely to happen."
"It probably will."	"It seems very unlikely."
"There's a 100% chance."	"It could happen."
"There's a 0% chance."	

Figure 5.18
Indonesian version to Problem 4

On Figure 5.18 we can see the translation of the statements in Indonesian from which Indonesian students have to put those statements on a chance ladder.

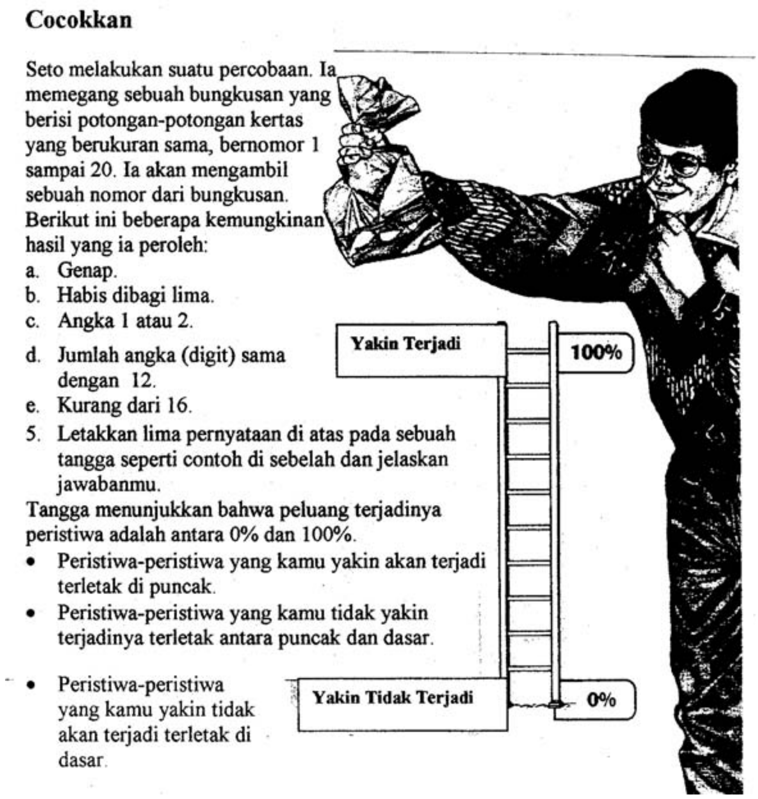
The first model that came up from students' answer to problem 4 was put each statement on the ladder differently with 'there's a 0% chance' on the ground and 'there's a 100% chance' on the top of the ladder. Others statements were put in between. Majority of the students had this model answer. Twenty six students out of 40 had this model answer.

However, from students' answer we understand that for some of them it was quite difficult to see the different between those statements in term of the chance in percent. As can be seen from Gunawan's answer. In his answer we realise that 'that's unlikely' and 'it seems very unlikely' were the same with a 0% chance. Also, 'I'm sure it will happen' and 'It's very likely to happen' were the same with a 100% chance. Five others students had the same answer as Gunawan.

Four students to some extent had similar answer as Gunawan, but they just divided the statements into three, namely on the top, on the middle and on the ground. The statements 'there is a 100% chance,' 'I'm sure it will happen,' and 'it's very likely to happen' are put on the top of the ladder. The statements 'it probably will,' 'there's a 50-50 chance,' and 'it could happen' are put on the middle. The statements 'that's unlikely,' 'there's a 0% chance,' and 'it seems very unlikely' are on the ground.

Four students had no answer for this problem or gave the incomplete and incorrect answer.

The context "Match 'Em Up" from MiC exemplary material is adapted to the Indonesian context with the same picture and chance ladder to become "Cocokkan" (Figure 5.19).



Cocokkan

Seto melakukan suatu percobaan. Ia memegang sebuah bungkusan yang berisi potongan-potongan kertas yang berukuran sama, bernomor 1 sampai 20. Ia akan mengambil sebuah nomor dari bungkusan. Berikut ini beberapa kemungkinan hasil yang ia peroleh:

a. Genap.
b. Habis dibagi lima.
c. Angka 1 atau 2.
d. Jumlah angka (digit) sama dengan 12.
e. Kurang dari 16.

5. Letakkan lima pernyataan di atas pada sebuah tangga seperti contoh di sebelah dan jelaskan jawabanmu.

Tangga menunjukkan bahwa peluang terjadinya peristiwa adalah antara 0% dan 100%.

- Peristiwa-peristiwa yang kamu yakin akan terjadi terletak di puncak.
- Peristiwa-peristiwa yang kamu tidak yakin terjadinya terletak antara puncak dan dasar.
- Peristiwa-peristiwa yang kamu yakin tidak akan terjadi terletak di dasar.

Figure 5.19
Cocokkan, Indonesian version for Match 'Em Up and Problem 5

In the following we find how Indonesian students deal with Problem 5.

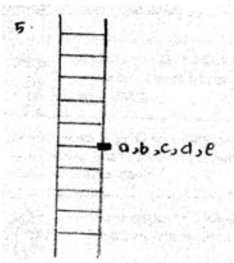
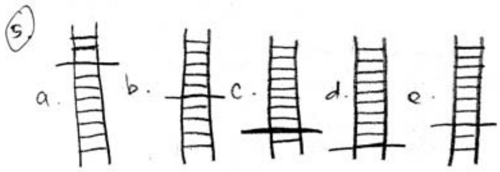
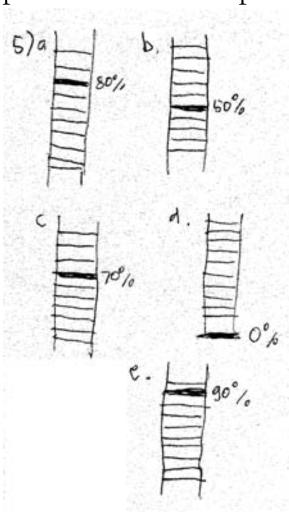
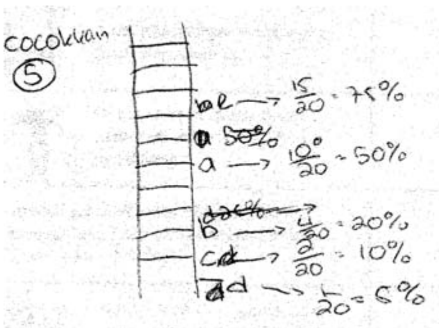
All in the middle  Lidya	Four out of 40 students (10%) had this model answer.
Different places without certain percentage  Wina	Six out of 40 students (15%) had similar model as Wina's.
Different places with certain percentage  Lersta	Twenty-two out of 40 students (55%) had the model answer like Lersta's.
Correct answer  Rano	Three out 40 students (7.5%) had correct answer as Rano's.

Figure 5.20
Answer models to Problem 5

Four out of 40 students (10%) had the same answer as Lidya's. Apparently, they thought that all events were possible to happen. The reason for that was they may or may not occur depend on the circumstance as she wrote '*karena bisa terjadi bisa tidak, tergantung keadaan*' (because it occur or not depend on the situation). However, the way they put all events on the same place (on the middle of the ladder) reflected that the experiment (story problem) on *Cocokkan* (Problem 5) was not fully understood by some of students.

Six out of 40 students (15%) put the events on different places on the ladder without indication of certain percentage as represented by Wina's answer.

From Wina's answer we understand that no position on the ladder was correct. It reflected that she did not fully understand the story. However, her answer reflected that she has in her mind that the events had different possibility to happen.

Twenty-two out of 40 students (55%) put the events on different places. But, in addition of put them on different places, they also indicated the percentage of each event. Some of the positions were correct. It reflected that they understood the story. Only because of wrong interpretation of the question brought them to the incorrect percentage of chance that the event to happen. Lersta's answer is given here as a sample of this group of students who had this sort of answer.

Three out of 40 students (7.5%) had correct answer for Problem 5 as represented by Rano's answer.

From Rano's answer we understand how he comes to the exact percentage for each event, that is counting the number of possible outcomes then divided by the number of all possible outcomes, such as $\frac{15}{20} = 75\%$. From his answer we learn that he understood correctly the experiment as explained on the story problem.

Beyond those groups, there were five students (12.5%) who did not answer the question. It seems that they did not have any idea of what is the 'experiment' that they have to interpret.
The following figure is the figure for Problems 6 and 7 in the module of *Apakah Peluang Itu?*

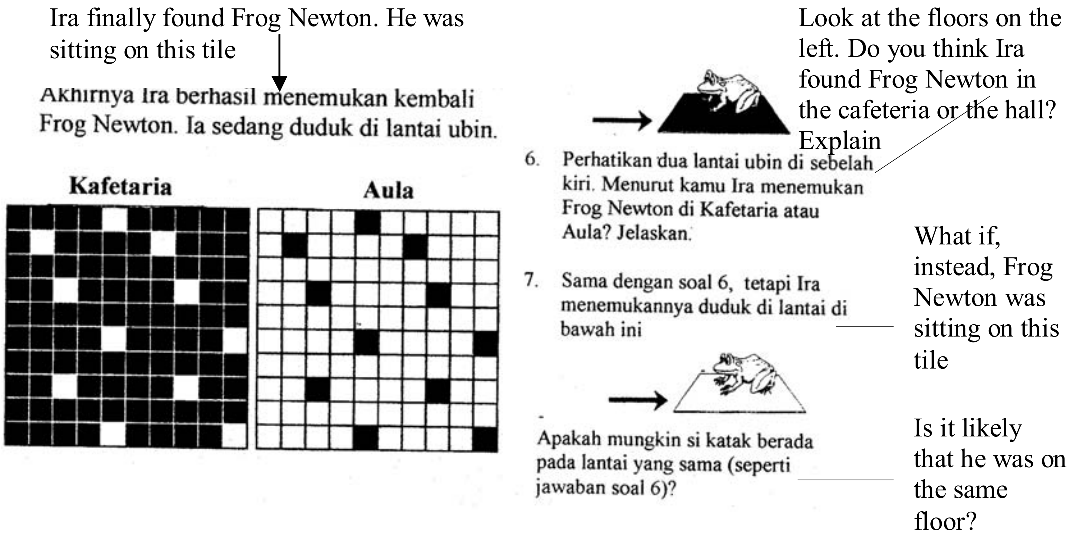


Figure 5.21
Indonesian version for Problems 6 and 7

There were three answers appear for Problem 6*) (see Figure 5.21), namely
(1) In the hall: Ira found Frog Newton in the hall (27.5%);
(2) Both in the hall and cafeteria is possible: It is possible for Ira to find Frog Newton in the cafeteria as well as in the hall (10%); and
(3) In the cafeteria: Ira found Frog Newton in the cafeteria (60%).

For Problem 6, Isaac answered 'Di Aula' (in the hall). The explanation of his answer was '*karena katak berada di ubin hitam jadi tidak mungkin ia lompat bolak-balik*' (because the frog is on a black tile, so it is unlikely he jumps back and forth).

For Problem 6 Lidya wrote '*bisa di Kafetaria dan Aula, karena dua-duanya mempunyai warna lantai yang sama*' (it is possible [to find the frog] either in the cafeteria as well as in the hall, because both [floors] have the same colour).

*) A pupil (2.5%) had no answer for this problem.

In the hall (27.5%)

6 Di Aula
→ krn katak beradi di Ubin hitam jadi tdk mungkin ia lompat bolak - balik

In the hall
➔ Because the frog is in a black tile, so it is unlikely he jumps back and forth

Isaac

In the hall and cafeteria is possible (10%)

6. bisa di kafetaria dan Aula.
karena dua-duanya mempunyai
warna lantai yang sama

it could be in the cafeteria as well as in the hall, because both have the same colour

Lidya

In the cafeteria (60%)

6. Kafetaria, karena peluang frog newton mendarat di ubin hitam lebih banyak

Cafeteria, because the chance of Frog Newton to land on the black tile is bigger.

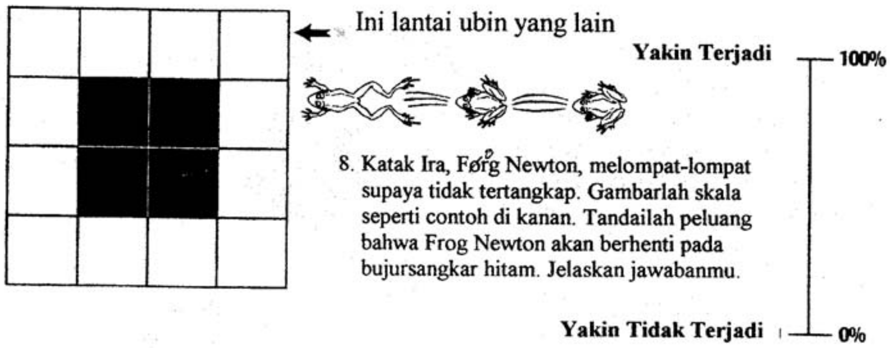
Dhomas

Figure 5.22
Students's answer for Problem 6

From both Isaac and Lidya's answers we understand that in giving the answer and the reason for its they did not yet touch the logic of the problems to compare the number of black and white tiles on each floor. The idea of giving the context of floor with black and white tiles is to give students visual support for estimating chances. This context prepares students to use informal ratio terminology, such as eleven out of one hundred. However, their answers were not wrong. It is logic to say that the frog may land on cafeteria as well as hall because both have white and black tile as well. Some students gave this sort of argument in their answer.

For Problem 6 Dhomas wrote '*Kafetaria, karena peluang frog newton mendarat di ubin hitam lebih banyak*' (Cafeteria, because the chance of frog newton to land on black tile is bigger [than white tile]). The sample of Dhomas's answer tell us that he knows how to compare the number of black and white tiles. It is interesting to notice that 60% students have the same answer as Dhomas's.

In the following students' answers for problem 8 are analysed.



Here is another tiled floor.

8. Ira's frog, Frog Newton, made a dash for freedom on this floor. Draw a scale like the one shown on the right. Mark the chance that Frog Newton would end up on a black square. Explain why you marked the scale where you did.

Figure 5.23
Problem 8 from Module of *Apakah Peluang Itu?*

From the analysis of the students' answer to Problem 8 we know that they did not have problem in converting from a ladder to a vertical scale line. In this problem the chance ladder is reduced to a vertical scale line without markings for multiples of 10 percent. The main reference points on the scale are 0%, 50%, and 100%.

Fourteen out of 40 students answered correctly, that is put 25% chance on the line and explaining how to get that percent. Ten students also indicated 25% chance on their scale line, but without explanation. Five students gave the answer 25% with explanation that there were 4 tiles out of 16 from which they came up to the answer, but they did not drew the scale line in their answer.

It is interesting to consider Rafika's answer that she drew a scale line and indicated 50% chance for the frog to land on black tile on the floor. Her explanation was 'because it is likely that the frog jump closer or further depend on its ability to jump.' Three others students had the same answer as Rafika.

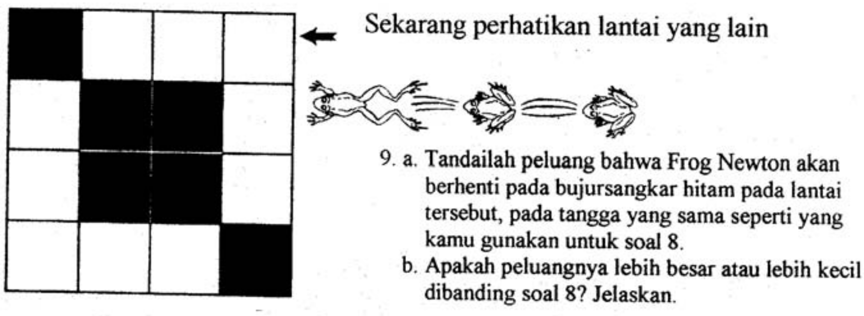
Yonatan indicated in his line 70% chance and explained that frog jump over a tile.

We also find this kind of approach in Kus's answer that she indicated 60% chance in the scale line, Adhya who indicated 45% in his scale line, and Anang who indicated 80% chance in his scale line.

Rafika, Yonatan, Kus, Adhya and Anang's answers tell us that in giving the explanation some students using the facts within the boundary of their experiences and knowledge over the context. Students' preconception about frog influences their approach to the problem.

In this regard students do not have to compute the exact percents. Informal answers are still acceptable here. Furthermore these informal answers can facilitate discussion.

In the following students' answers for problem 9 are analysed.



Now look at another floor.

9. a. Mark the chance that Frog Newton would end up on a black square on this floor on the same ladder that you used for problem 8.
   b. Is it bigger or smaller than the chance in problem 8? Explain.

Figure 5.24
Problem 9 from Module of *Apakah Peluang Itu?*

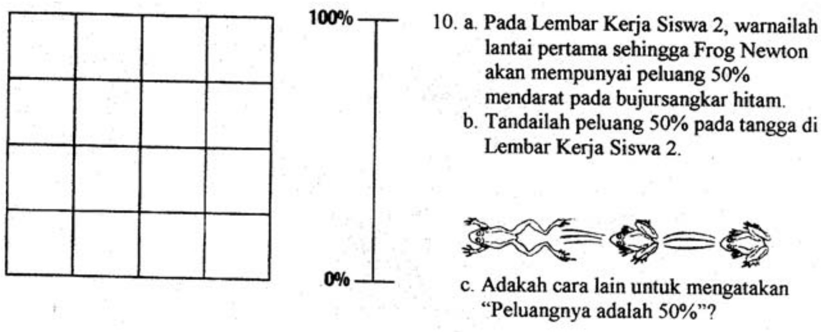
The patterns of students' answer for problem 9a are almost the same with the patterns for problem 8.

Eighteen out of 40 students drew a scale line and indicated 37.5% chance along with the explanation how they come up to the percentage. Eight students just drew the scale line and indicated 37.5% chance on its without explanation. Three students answer 37.5% with explanation but without drew a scale line.

For question 9b most of them answered that the chance was greater because 37.5% is greater than 25%.

However, it is interesting to note that Rafika persisted with her argument that it was likely that frog land on black or white tile whatever you change the pattern black and white on the floor, such as colour more black tiles on the floor. So, her answer was 50% chance the same with her answer for problem 8. Other three students had the same argument as Rafika.

In the following students' answers to Problem 10 are analysed.



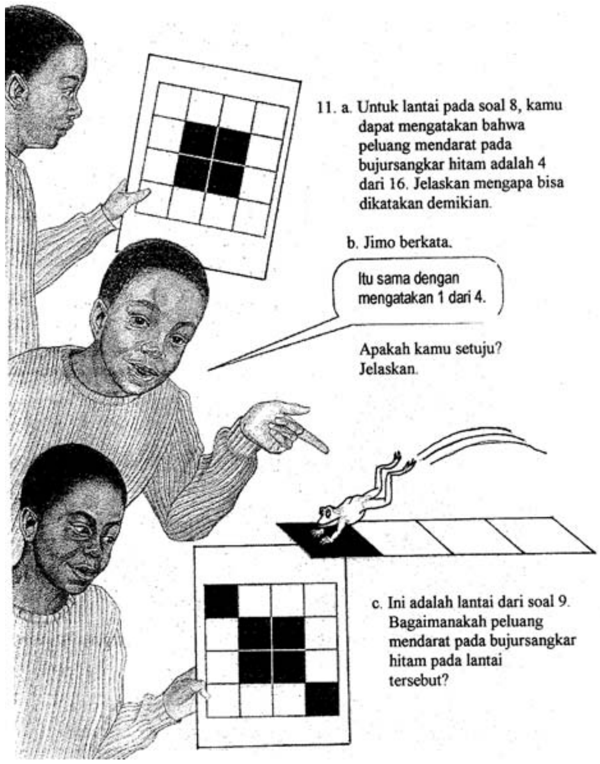
10. a. On Student Activity Sheet 2, color the first floor so that Newton will have a 50% chance of landing on a black square.
    b. Mark the 50% chance on the ladder on Student Activity Sheet 2.
    c. What is another way of saying: "The chance is 50%"?

Figure 5.25
Problem 10 from Module of *Apakah Peluang Itu?*

In order to get 50% chance for the frog to land on the black tile 35 out of 40 students blacked 8 tiles. Four students blacked 4 tiles and a pupil blacked 1 tile.

Up to this problem it seems that the majority of the students in the class understood how to count the chance using the black and white floor. Most of them (30 students) could also indicate (drew a mark but without certain percentage) correctly on the ladder that is at the fifth rung. Six students indicated between fourth and fifth rungs. Three students had no answer.
For problem 10c, 24 out of 40 students gave others way to say 50% chance such as ½, 1 : 2, 50 – 50, 50 : 50, 1 out of 2, and 8 : 16.
However, it is interesting to note that for Problem 10c 23 students had no answer. It was quite a lot. Apparently the translation of '*Adakah cara lain untuk mengatakan "Peluangnya adalah 50%"?*' for '*What is another way of saying: "The chance is 50%"?*' is confusing for some of the students. Because for that question the answer can be as simple as 'yes' or 'not' which is not intended by the original one. The best translation for this is '*Sebutkan cara lain untuk mengatakan: "Peluangnya adalah 50%"?* The message addressed in this question is clear and direct.

In the following students' answers to Problem 11 are analysed.



11. a. For the floor in problem 8, you can say that the chance of landing on a black square is 4 out of 16. Explain this.

  b. Jimo says, That's the same as 1 out of 4.

  Do you agree? Explain.

  c. Here is the floor from problem 9. What is the chance of landing on a black square on this floor?

Figure 5.26
Problem 11 from Module of *Apakah Peluang Itu?*

On the previous problem (Problem 10), percent estimates were made by comparing the numbers of black and white squares. On problem 11, ratio terminology, such as "one out of six," is introduced. To describe chance using this terminology, it is necessary that the black tiles be compared with the total number of squares (the total possibilities).

For this problem most of the students (28 students) explained that the number of black tile is 4 and the number of all tile (black and white) is 16 from which bring to the chance of landing on black tile of 4 : 16 or 4/16.

Some students expressed differently like Farista who explained that the number of black tile is ¼ of the whole tile.

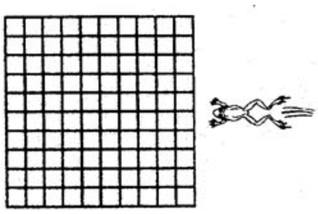
Three others students argued that the four black tiles are in the middle of the floor and all tiles are 16 that bring to the chance 4 out of 16. One other pupil answered that the number of black tile is 4 out of 16 while tiles. One other said that the number of black tiles is 4. Four students had no answer.

For question 11b almost all students (37 students out of 40) agreed with Jimo's statement that 4 out of 16 is the same as 1 out of 4. Thirty three of them, namely the students who agree with Jimo, had similar explanation that 1 out of 4 is the simplification of 4 out of 16, and four of them just agree without any explanation. Three students had no answer.

For question 11c almost all students (35 out of 40) came up with the answer of 6 : 16 or 37.5% chance for frog landing on black tile. This answer seems in line with their argument for previous questions 11a and 11b that is comparing the number of black tiles with the number of all tile.

Four students had no answer and a pupil gave an answer in words: the chance is quite good because the number of black and white tiles is the same.

In the following we will find how Indonesian students deal with Problems 12a and 12b.



12. a. **Warnailah lantai kedua dari Lembar Kerja Siswa 2 sedemikian sehingga peluang katak mendarat pada bujursangkar hitam adalah 1 dari 5.**
    b. **Sekarang warnailah lantai ketiga pada Lembar Kerja Siswa 2 dengan pola sembarang ubin hitam dan putih. Bagaimana peluang katak mendarat pada ubin hitam pada lantai yang kamu buat?**

12. a. Color the second floor on Student Activity Sheet 2 so that Newton's chance of landing on a black square is 1 out of 5.
    b. Now color the third floor on Student Activity Sheet 2 with any pattern of black and white tiles. What is the chance that Newton will land on a black tile on the floor you made?

Figure 5.27
Indonesian version for Problem 12a and 12b

The pattern of "1 out of 5" was used by Rachmat to answer Problem 12a (Figure 5.27): starting from the up-right tile and counting tile from one until five to black the fifth one. He continued using the same way for this first row until the up-left tile as he blacked it. He continued to the second row but starting from left, and so on until the last tile (bottom-right).

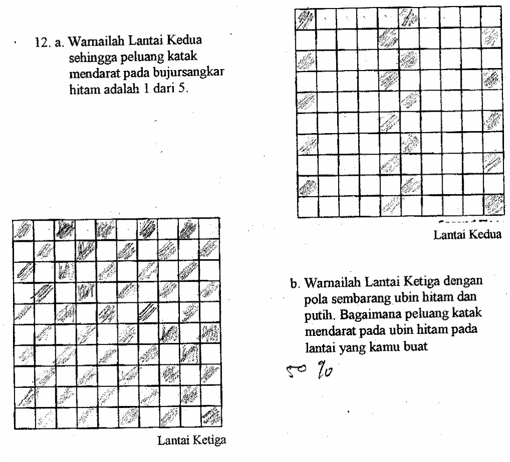


Figure 5.28
Rachmat's answer to Problems 12a and 12b

The same pattern was used for Problem 12b to get 50% chance for frog to land at black tile. Realising that Rachmat wrote 50% for his answer instead of 1 out of 2 as question 12a of that 1 out of 5 from which he got 20 tiles to be blacked, he apparently gained an understanding that 50% chance is the same with 1 out of 2 chance. The same pattern was used by Atria as described by Figure 5.29.

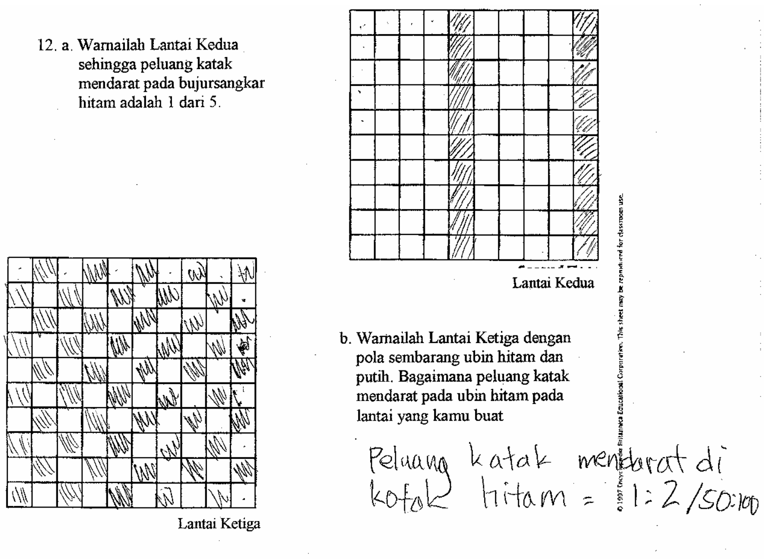


Figure 5.29
Atria's answer for Problem 12a and 12b

It is interesting to look at how the pattern of 1 out of 2 (Figure 5.30) was used by Atria to get 1 : 2 or 50 : 100 chance as she writes on her sheet.

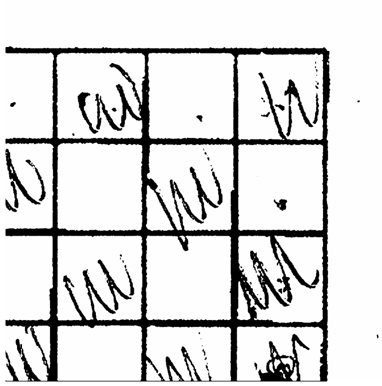


Figure 5.30
Pattern 1 out of 2 to get 50% chance

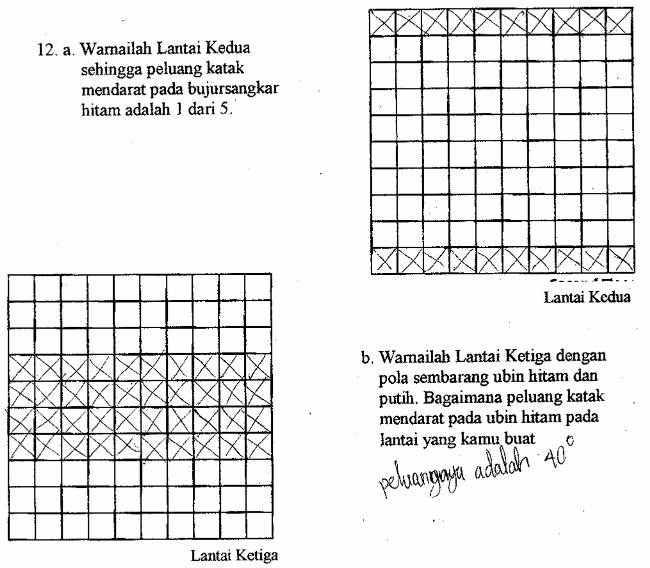


Figure 5.31
Carter's answer to Problems 12a and 12b

The understanding that 1 out of 5 chance is the same with 20% guides Carter to black 20 tiles in the floor. But, before he decided to black the first and the last rows, he realised that the floor has 10 times 10 tiles equal to 100 tiles.

Using this understanding quickly he blacked 4 rows in the third floor to get 40% chance. The same way was used by Rano as described in Figure 4.32: he realised that 1 out of 5 was the same with 20% then he blacked 20 tiles without any certain pattern, that is just counting from 1 until 20. For problem 12b he blacked three columns quickly to get 30% chance.

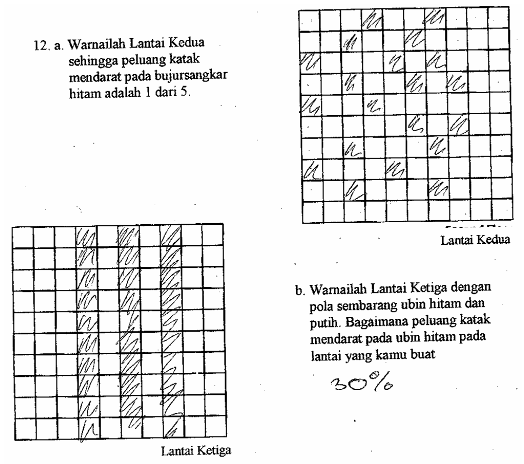


Figure 5.32
Rano's answer to Problem 12a and 12b

Thirty-six out of 40 students (90%) had correct answer for Problem 12a, but only twenty-one students (52.5%) had correct answer for Problem 12b. The students who had incorrect answer for Problem 12b can be divided into two groups. First, students who were incorrectly decide the chance of Frog Newton to land on black tile in the floor their make, and second students who did not give answer of the chance of Frog Newton to land on the floor they made. The second group, apparently did not understand the message in the problem.

In the following students's answers for problem 13 are analysed.

13. Jika kamu mempunyai lantai ubin hitam-putih, jelaskan bagaimana kamu memperoleh peluang bahwa seekor katak mendarat pada bujursangkar hitam.

13. If you had a black-and-white tile floor, explain how you would find the chance that a frog would land on a black square.

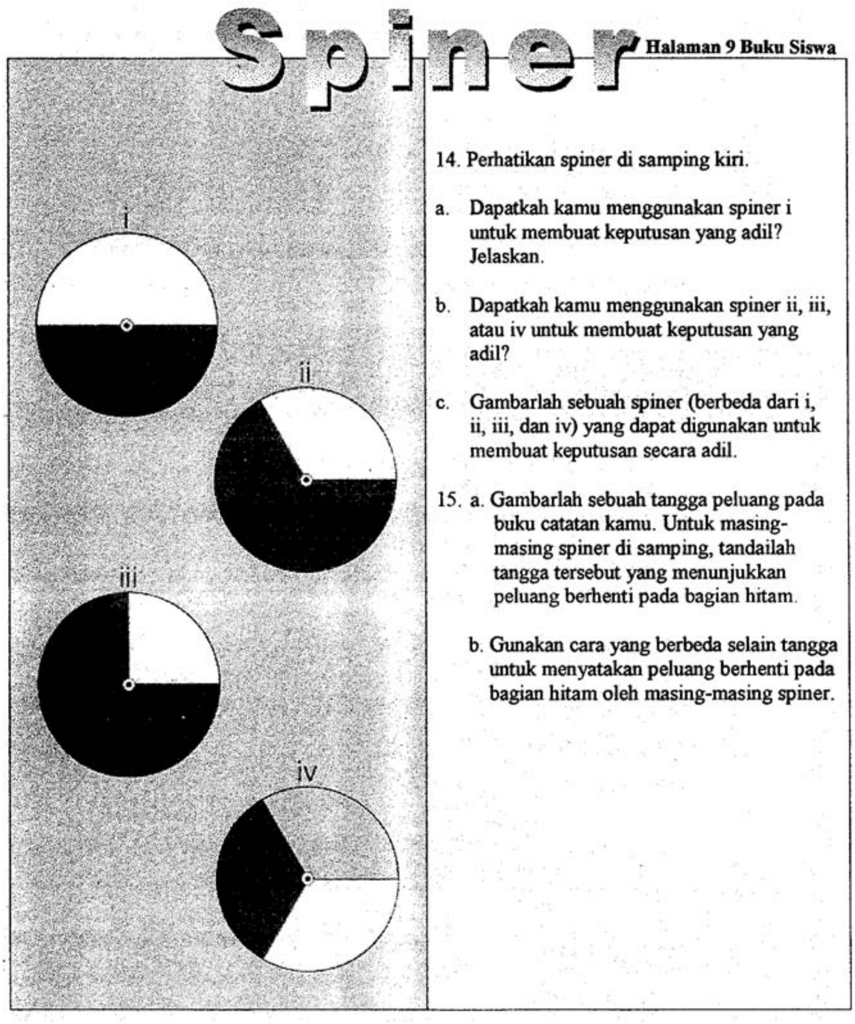
Figure 5.33
Problem 13 from Module of *Apakah Peluang Itu?*

This problem assess students' ability to find chances, in percents, fractions, or ratio for simple situations. Nine students out of 40 gave an answer: *comparing the number of black tiles with all tiles.* This at least reflects their ability to find chances in ratio for simple situation.

Nine students incorrectly answered: *comparing the number of black tiles with white tiles.* Yonatan, Farista and Kus answered: *we cannot determine the chance of a frog to land on black tile because we do not know frog's feeling.* Kus said that *the chance must be small.* Anang said that *we could not predict what is in frog's mind, everything could happen, so the chance is between 25% and 75%.* Erika and three other students answered: *to find the chance of a frog to land on a black square we can make the black and white tiles like in a chess board.* Gunawan and eight other students answered: *to find the chance of a frog to land on a black square we can make the black square more.*

Examining students answers for this problem we notice that among them there are different interpretation of the meaning of the question that is not intended by the question.

The following is Indonesian version of Problems 14 and 15.


Spiner

Halaman 9 Buku Siswa

i

ii

iii

iv

14. Perhatikan spiner di samping kiri.

a. Dapatkah kamu menggunakan spiner i untuk membuat keputusan yang adil? Jelaskan.

b. Dapatkah kamu menggunakan spiner ii, iii, atau iv untuk membuat keputusan yang adil?

c. Gambarlah sebuah spiner (berbeda dari i, ii, iii, dan iv) yang dapat digunakan untuk membuat keputusan secara adil.

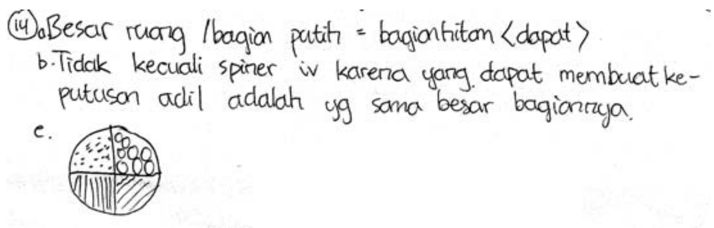
15. a. Gambarlah sebuah tangga peluang pada buku catatan kamu. Untuk masing-masing spiner di samping, tandailah tangga tersebut yang menunjukkan peluang berhenti pada bagian hitam.

b. Gunakan cara yang berbeda selain tangga untuk menyatakan peluang berhenti pada bagian hitam oleh masing-masing spiner.

Figure 5.34
Indonesian version of Problem 14 and 15 (Spinner)

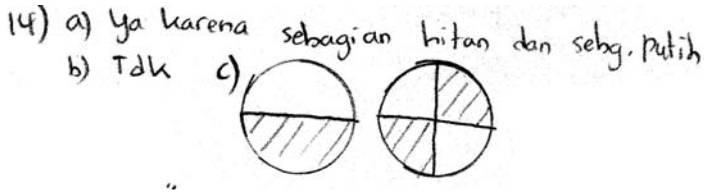
The following are samples of Indonesian grade 8 students' answers for Problem 14 and 15.

<table>
<tr><td>
Perfect



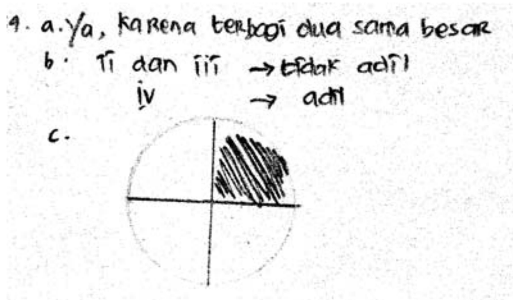
a. Space area of white part = black part (it is can)
b. No, except spinner iv because the spinner that can make fair decision is one which is divided by the same part

Dhomas
</td><td>Eight out of 40 students (20%) had this perfect answer as represented by Dhomas's answer on the left.</td></tr>
<tr><td>
Correct



a. Yes because part of it is black and part of it white
b. No

Tezar
</td><td>Nineteen out of 40 students (47.5%) had correct answer. The only thing that make their answer is not perfect is b, they did not realise that spinner iv can be used to make fair decision among three people.</td></tr>
<tr><td>
Partly Correct

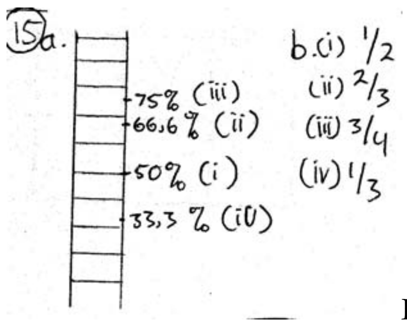


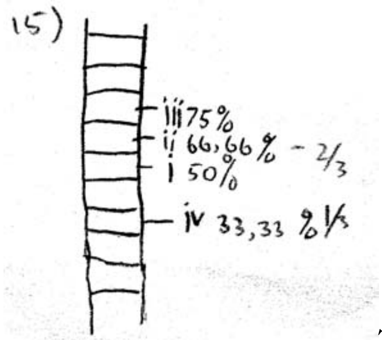
a. Yes, because it is divided by two equally
b. ii and iii -> not fair
iv -> fair

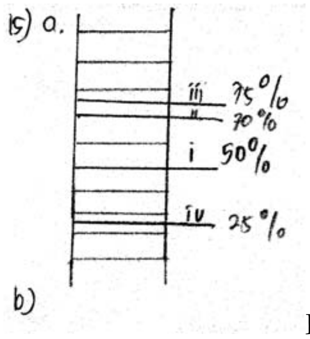
Lidya
</td><td>Thirteen out of 40 students (32.5%) had the answer of partly correct. Among this group 2 students had no answer for question c; 4 students had wrong answer for c like Lidya's answer on the left; 3 students had wrong answer for a and b; and 4 students have wrong answer for b and c.</td></tr>
</table>

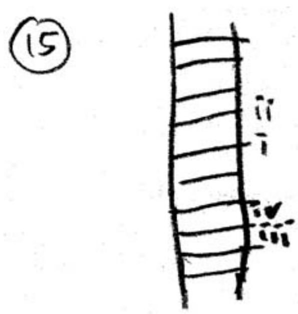
Figure 5.35
Model answer for Problem 14

In the following students' answers for problem 15 are given.

<table>
<tr><td>Perfect


Dhomas</td><td>Seven out of 40 students (17.5%) had perfect answer. Some of them without exact percentage, but put correctly in the ladder.</td></tr>
<tr><td>Correct


Tezar</td><td>Eighteen out of 40 students (45%) had correct answer. But, they do not answer question b.</td></tr>
<tr><td>Partly Correct


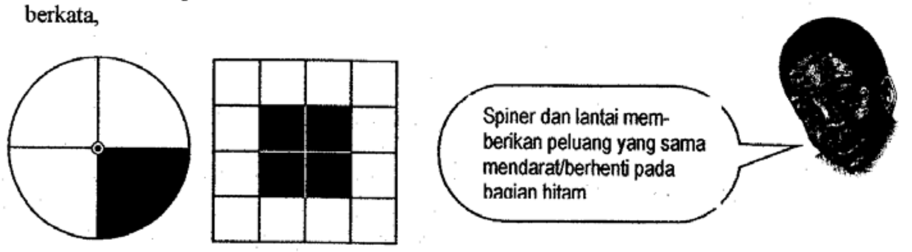
Kus</td><td>Seven out of 40 students (17.5%) had partly correct answer.</td></tr>
<tr><td>Incorrect


Atria</td><td>Three out of 40 students (7.5%) had incorrect answer.</td></tr>
<tr><td>No answer</td><td>Five out of 40 students (12.5%) had no answer.</td></tr>
</table>

Figure 5.36
Answer models to Problem 15

In the following, students' answers for problem 16 are analysed.

Jimo membuat spiner sendiri dan mewarnai lantai ini. Ia berkata,



16. Apakah kamu setuju dengan Jimo? Jelaskan

Jimo made this spinner and colored in this floor. He says,

> The spinner and the floor give the same chance for landing in the black part.

16. Do you agree with Jimo? Explain

Figure 5.37
Problem 16 from Module of *Apakah Peluang Itu?*

In this problem students compared the chance of landing on the black part of spinner to the chance of landing on the black tiles on a floor. This problem makes explicit connections between chances on a spinner and chances on a tile floor.

Almost all the students (37 out of 40) agreed with Jimo and explained that spinner and floor give the same chance for landing in the black part, namely ¼ or 25%. Two students had no answer and a pupil did not agree with Jimo with an argument that the number of black and white floor is not the same.

The following figure is Indonesian version for problem 17.

Kegiatan

17. Lihatlah pada berita di surat kabar yang memuat pernyataan tentang peluang. Tempatkan pernyataan tersebut pada suatu tangga peluang. Bawalah tangga tersebut ke sekolah dan jelaskan mengapa kamu menempatkan pernyataan tersebut di sana. Berikut ini adalah potongan berita koran untuk menolong kamu.

Peluang untuk merebut gelar divisi tipis

By Mel Bergman
of The Reporter staff
It was no surprise that the Calaway CooCoos' manager Regg Loopendorf refused to give a statement regarding his team's even though the ser led to a new definiti Future chances for a can only hope that

Genjatan Senjata Mungkin Berakhir Segera

Home Buyer's Guide

Kesempatan terakhir untuk membeli rumah baru di Telaga Perak

The last twenty homes will go on sale this weekend.
The increase in the number of families wanting to settle in this spectacular area has increased dramatically over the last few weeks. The few the range of views and the availability of easy access to many of the recreational outlets bring a new meaning to the term "Land of Dreams".

Site rating guide
★ ★ ★ ★

Activity

17. Look in the newspaper for statements about chance. Put these statements on a chance ladder. Bring the ladder to school and explain why you decided to place the statements where you did. Here are some examples to help you.

    'Chances for a Run at Division Title Slim'
    'Cease-Fire May End Soon'
    'This may be your last chance to buy a new home on silver lake'

Figure 5.38
Problem 17 from Module of *Apakah Peluang Itu?*

In this problem students share with the class chance ladder they constructed to represent newspaper headlines about chance. The point of the activity is to get a sense of the language of chance in everyday occurrences.

However in the tryout in SLTPN 5 Yogyakarta students did not bring their own newspaper that consist of chance statements. They put the existing news headlines as in the module on the ladder they made in the classroom.

For each headline their answers were vary among rungs in the ladder or indicated the exact percentages, such 20% for the headline '*chances for a run at division title slim*,' 70% for the headlines '*cease-fire may end soon*,' and 35% for the headline '*this may be your last chance to buy a new* *home on silver lake.*' Notice the way students used in converting the everyday statement to the percentages, such as 'slim' = 20%, 'soon' = 70%, and 'last chance' = 35%.

In the following, students' answer for problem 18 are analysed.

18. a. Pecahan apa yang dapat kamu gunakan untuk menyatakan peluang 50-50?
    b. Letakkan beberapa pecahan lain yang termasuk anggota suatu tangga peluang.

18. a. What fraction would you use to represent a 50-50 chance?
    b. Put some other fractions where they belong on a chance ladder.

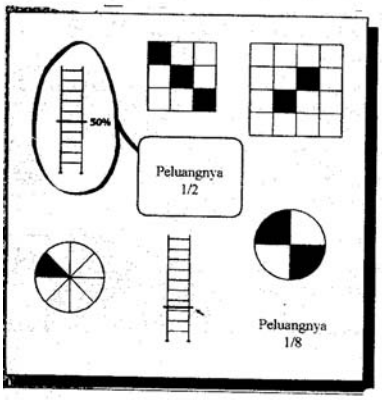
For problem 18a most of the students (30 out of 40) gave a fraction of ½ to represent 50-50 chance. Some others students in this group put others fractions such as 2/4, 3/6, 4/8, 5/10, in percent of 50% and in decimal number of 0.5. Seven students answered: *decimal*. These students apparently wanted to say that the chance can be represented in a decimal number like 0.5 for 50-50 chance. Three students gave no answer.

For problem 18b almost all of the students (26 out of 40) answered by giving some fractions that belong to chance ladder correctly, that is the fractions that are between 0 and 1 like ¼, ¾, 1/3 1/8, 2/5. Three students were influenced so much by their understanding about chance ladder that bring them to give answer like 100%, 90%, 80%, 70%, 60%, 50%, 40%, 30%, 20%, 10%, 0%. Three students had an answer of 1/10, 2/10, 3/10, 4/10, 5/10, 6/10, 7/10, 8/10, 9/10, 10/10=1 that also represent the influence of the chance ladder. Remember that the chance ladder has 10 rungs which each of them represent 10% and its multiples, with 0% at ground level and 100% at the highest rung.

Five students answered: *biasa* (common) that apparently wanted to say that the chance can be represented by common fraction numbers like ½, 1/3, ¾, etc. Three students had no answer.

The following figure is Indonesian version for problem 19.

Di bawah ini beberapa pernyataan tentang peluang. Beberapa di antaranya adalah anggota bersama; hanya berbeda dalam menyatakannya.



19. Pada Lembar Kerja Siswa 3, hubungkanlah seluruh pernyataan yang menjelaskan hal yang sama. Satu contoh sudah diberikan.

Below are some statements about chances. Some of them belong together; they are just different ways of saying the same thing.

19. On Student Activity Sheet 3, connect all statements that say the same thing. One example has already been done.

Figure 5.40
Problem 19 from Module of *Apakah Peluang Itu?*

Almost all the students can connect the figures in problem 19 correctly according to their chance. From students' answers for Problem 18 and 19 (summary problems) we understand that students learned step by step guided by various problems using the tools of ladder, floor and spinner in various contextual problems about the concept of chance or probability.

Problems 18 and 19 are summary questions. These problems summarise the main concepts of the module (section). Different ways of describing chance are tied together: chance ladder, percents, and fractions.