Subject: Fwd: ZDMI: Your manuscript entitled Reforming Indonesia Mathematics Classroom through PMRI

From: sutarto_hadi@yahoo.com
To: R.K.SembiringSembiring@
Date: Wednesday, April 9, 2008, 6:32:52 AM GMT+7

Dear Robert and Maarten,
I received review for our article for ZDM. There are mix comments from reviewers. But, for sure a significant revision is needed. Would you give comments that help me to start revision.
Best regards,
Sutarto

Note: forwarded message attached.

Ref.: Ms. No. ZDMI-D-07-00074
Reforming Indonesia Mathematics Classroom through PMRI
ZDM - The International Journal on Mathematics Education

Dear Dr Hadi.

Your manuscript has now been reviewed.

We are not really satisfied with the quality of your paper. In order to be able to include the paper into our planned issue significant changes will be necessary. We hope very much that you will undertake this task. Below you will find the reviewers comments.
May I draw your special attention to review 1, which summarises very clearly, which changes are necessary, i.e. cut down Part A and B, transfer part C into a scientific description. I recommend to extend one example in detail. As it is it remains unclear, why this approach is called realistic maths approach. And please avoid the usage of so many unfamiliar abbreviations.

Your revision is due by 20 May 2008.

To submit a revision, go to http://zdmi.edmgr.com/ and log in as an Author. You will see a menu item call Submission Needing Revision. You will find your submission record there.

If you have any questions, please do not hesitate to contact either the issue editors or me.

Yours sincerely,

Gabriele Kaiser
Editor-in-Chief
ZDM - The International Journal on Mathematics Education

Reviewers' comments:

Reviewer #1: MPRI is a meaningful project for Indonesia. It helps to reform teaching approach in classroom. It has been implemented successfully in some schools in Indonesia. Several PhD theses have also been written on the project. Definitely there are enough materials to produce more than one research paper for publication.

I understand ZDM is a research journal. It publishes research articles. As it is, the submitted article is presented as a report on the movement, its characteristics and dissemination. It should be a report on the research of teaching approach using realistic mathematics to find out the impact, if any, of the project supported by research evidence.

The paper is still publishable if it can be written as a research article. Here are some suggestions.

Acronym PMRI in the title is not helpful. Write, for example, .. through realistic mathematics. The abstract should say the article is a presentation of the research component of the project, and not a policy statement of the project.

Rewrite part A to change the focus from information on PMRI per se to research of teaching approach.

Reduce part B. part B is to serve part C. only information needed for part C needs to be included. It should not be a policy statement of the project. Refer to reports of FI or theses for further details, if necessary. For example, if the focus is primary then say more about primary. For example, information should be connected to the research of PMRI.

There is a lot of what PMRI is and how it is being implemented. There is not enough why PMRI is chosen and not other approaches. Avoid using too many acronyms. Some are unnecessary. They made the article harder to read.

The list of international advisory board is not relevant to the research. The list should be deleted. It applies elsewhere when the information not connected to the focus of the article, which should be research orientated, should be deleted.

Part C is the main section. References should be given. For example, is page 9 the survey conducted by the ministry of education contained in (Somerset 1997)? It is not clear. If it is from the PhD thesis, it should be mentioned.

Page 9 line 4 the research question. The development of PMRI is discussed. If the question is to ask whether PMRI is effective, we are assuming PMRI is the right thing to do. That needs evidence. The subsequent presentation shows various teaching approaches to fractions and fractions only. The question seems to be asking whether such approaches are helpful to learning mathematics effectively. So the question is on teaching approach and not on the development and dissemination of PMRI. Moreover concerning the dissemination we can only speculate. No research was done on the issue.

As I mentioned earlier, the presentation should focus on research findings. Everything else serves the given purpose. For example, the authors may wish to mention the fact that the research can be categorized as a formative research. Mention the model of reconstructive studies if they wish. There is no need to go into the discussion of various models of design research.

One example on teaching of fractions is given. It must explain something. The authors may wish to make explicit (1) what are the research done? (2) what is the analysis? (3) where is the reference? It is all right if PhD thesis. In short, this part should be written as a research report, giving job done, outcome analysed, and conclusion if any. The authors must give evidence and give references of such evidence.

Such research deserves a place for publication. Published in a research journal the article must focus on research, not other aspects of the project. I recommend the authors resubmit the article after making it a research article.

Reviewer #2: Report on the Paper, Entitled "Reforming Mathematics Learning in Indonesian Mathematics Classrooms through PMRI", Submitted for Possible Publication in ZDM

Recommendation

I recommend that the paper be published in ZDM, subject to the English expression being carefully checked and, where necessary, corrected.

Overview

This paper reports on a large-scale and commendable recent attempt to reform school mathematics in Indonesia. The reform has involved the development of materials, the changing of classroom teaching practices, and the working through of underlying mathematics education reform philosophies. Because Indonesia is such a heavily populated nation, because the reported reform has official government backing, and because the reform exercise is supported by

Dutch researchers associated with RME theory, the paper is of special interest. The challenge of transforming the teaching and learning of mathematics, and indeed the soul of school mathematics, in Indonesia is an immense one. It is wonderful to see that sincere efforts to achieve needed changes are being supported by the Indonesian and Dutch governments and by leading mathematics educators in Indonesia and the Netherlands.

The paper under review summarizes the early stages of development research into an important issue in mathematics education-¬the extent to which reform ideas and rhetoric found in Western mathematics education theory (such as RME) can be authentically implemented in non-Western classrooms. The paper is potentially important because the curriculum development, materials development and teaching experiments it describes occurred in Indonesia. There can be little doubt that the Western world is not well acquainted with mathematics education developments in that nation. The paper under review reveals a genuine attempt by Indonesian education authorities, by Indonesian teachers and mathematics educators, and by Dutch researchers - all advised by an international panel of "experts" - to develop policies, theories and practices which will improve the teaching and learning of mathematics in Indonesia's schools.

Some years ago this reviewer assesses a high quality Deakin University doctoral dissertation by Pardjono (1999) titled "The Implementation of Student Active Learning (SAL) in Primary Mathematics in Indonesia". The analyses of data in Dr Pardjono's dissertation suggested that although SAL had been official policy for some years in Indonesia, its philosophies were only partly embodied in the classroom practices of the teachers who were participants in the study. Participating teachers in Pardjono's study were selected because they were regarded as "good teachers" in their schools - teachers who were likely to be good at implementing the Student Active Learning approach. The problem with such an approach is that findings cannot be easily generalized to "ordinary" teachers in, perhaps, remote regions. How can we be sure that the research effort described in the paper under review does not have the same design weakness as Pardjono's (1999) study?

This reviewer is not surprised by the fact that there is no mention of Pardjono's study in the paper under review. The history of school mathematics over the past 200 years indicates that reforms and reformers come and go. Furthermore, it is difficult to keep track of all the mathematics education research being carried out across the world, particularly in nations as vast and inaccessible as Indonesia. One educationally significant lesson from Pardjono's study is that it is relatively easy to have a successful, short-term trial of classroom reform, but it is much more difficult for the reformed approaches to be developed, sustained, and successfully expanded over a significant period of time (for example, for more than 10 years). This reviewer knows of many school mathematics reform efforts - that took place in a range of nations - that initially appeared to be very successful in generating change, but whose effects dissipated after five or ten years had elapsed.

That is not to say that a paper such as the one under review is not interesting, and does not bear important news. It is exciting to learn that RME-inspired reform has been embraced by Indonesian Ministry of Education officials and by teachers and researchers in Indonesia. But, even if RME philosophies have been espoused at the highest levels, the question arises whether there is much chance that, ultimately, they will be faithfully applied in the teaching and learning of mathematics in schools and teacher education institutions across the nation of Indonesia - including schools in the many remote parts of that nation. There are strong forces pushing teachers and schools towards inertia, and the reported study involved the application of RME in just two pilot schools. Furthermore, the Hawthorne effect was not controlled.
Having said that, it should be stated that this is a useful paper. It does make clear that, despite huge difficulties associated with the provision of appropriate materials, teacher education programs, and despite vast student numbers, genuine efforts have been made by Indonesian education authorities and teachers to develop school mathematics curricula and teaching approaches that go beyond mere drill and practice. The brief summary of data in the paper suggest that, on that point, at least, the authorities have achieved something worthwhile.

A Final Comment on Language

I recognize the large amount of effort that has been expended on writing the paper, and everyone closely associated with it deserves much credit for the achievement thus far. However, frankly, the standard of the English expression in the paper, as it was submitted, is not at a sufficiently high level for the paper to be published in a journal like ZDM. That said, this reviewer recognizes that the paper was written by people who did not have English as their first language - and when that is taken into account, the level of English is highly commendable. Nevertheless, improvement is needed.

When I started reading the paper I began to make editorial changes in red, but I quickly realized that that would be too time-consuming for me. Accordingly, I proceeded by simply changing the text (and leaving no record of what I changed, except at the very beginning of the paper). I have attached my revised version, and recommend that the authors copy my version, put it next to their own, and then carefully proceed to make any changes to their version that they think are warranted.

THE ORIGINAL PAPER WITH SUGGESTED EDITORIAL CHANGES (APPENDICES ARE NOT INCLUDED HERE)

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Reforming Mathematics Learning in Indonesian Mathematics Classrooms through PMRI

Robert K. Sembiring1, Sutarto Hadi2 (sutarto_hadi@yahoo.com)
Team Leader of the PMRI Teamepamitb@indosat.net.id2
Dept. of Math Education, Lambung Mangkurat University, Indonesia
and

Maarten Dolk3 (m.dolk@fi.uu.nl)
Freudenthal Institute, University of Utrecht, the Netherlands

Abstract

Pendidikan Matematika Realistik Indonesia (PMRI) is a mathematics education reform movement in Indonesia. The focus of the movement is to implement a new way of teaching and learning mathematics - an Indonesian version of Realistic Mathematics Education (RME) - to improve the results outcomes of mathematics education in primary schools, and to achieve a social transformation in Indonesia. In the middle of the 1990s, PMRI was started by a small group of concerned mathematics educators (PMRI Team). In 2001 the Team - the Director General of High Education (DGHE), the Department of Religious Affairs, four pre-service teacher education institutes (LPTK) and 12 primary schools decided to begin an experiment in first grade classes. Each of the four LPTKs started pilot studies in three schools - two public schools and one Islamic school. The results of these pilot studies are very promising, with improvements being achieved in students' attitude towards mathematics. Following this
success, many schools and teachers have expressed a desire to implement PMRI in their classes. The involvement of the governmental in-service teacher education office (P3G, LPMPs) is imminent and a more cascading dissemination program is expected to surface. The challenge will be to keep the characteristics of the movement, which are the keys for the success, intact during all dissemination activities that will take place.

Keywords: realistic mathematics education, dissemination, sustainability, pedagogy, teacher learning

A. Introduction

Pendidikan Matematika Realistik Indonesia (PMRI) is a new movement which is intended to achieve mathematics education reform in Indonesia. Although PMRI was inspired by the philosophy of the Dutch realistic mathematics education (RME) philosophy, it is based on and has developed through designed studies in Indonesian classrooms. The movement is not merely implementing a new way of teaching and learning mathematics - it is also associated with a drive to achieve a social transformation within Indonesia.

The approach to reform adopted by PMRI involves:
* bottom-up implementation;
* materials and frameworks being based on and developed through classroom research;
* teachers being actively involved in designing investigations and developing associated materials;
* day-by-day implementation strategies that enable students to become more active thinkers;
* the development of contexts and teaching materials that are directly linked to school environments and to the interests of students.

Fundamentally, PMRI uses bottom-up strategies, with its approaches and materials being largely developed in classrooms rather than behind the desks of curriculum officers. Mathematics education reform in Indonesia has been initiated in classrooms and teachers have changed their mathematics teaching approaches as a result of their involvement with new materials, textbooks, investigations, experiments, in-service education, and in-class coaching. Results of classroom experiments have not only provided the bases for the development and refinement of PMRI theory, but have also informed those involved in the development of courses for teachers and the writing of student text books and accompanying teachers' guides.

Within Indonesia, PMRI not only provides a new approach to teaching mathematics, but also a new way of thinking about the purpose and practices of school mathematics. That said, it also needs to be recognized that it has not been easy to implement PMRI theory and approaches into the teaching and learning of mathematics in Indonesian schools. First, the PMRI approach to teaching is at odds with the well-established Indonesian practice of teacher-centred, whole-class teaching and the assumption of transmission of knowledge.

Many commentators on Indonesian schools believe that most innovations introduced into the schools over the past few decades have had no significant impact on the quality of education. It was therefore assumed, by many observers, that the PMRI approach would not capture the minds of teachers, and would not greatly influence their classroom practices. The reality has been quite different, however. Although some teachers have not embraced PMRI's philosophies, and have not adopted the recommended teaching approaches, these are in a minority. Most have developed positive perceptions of PMRI, and have come to view it as an alternative method likely to being about needed reforms in school mathematics. These teachers have grown to accept PMRI's philosophy that teachers should guide students toward reinventing mathematical concepts. Nevertheless, there are some who think the PMRI approach is too radical and is therefore unlikely ever to be accepted by a majority of the nation's teachers.

The PMRI team realized that in order to be successful in implementing PMRI, teachers and students needed curriculum materials that were consistent with Indonesian ideals and contexts. The materials needed to be grounded in and supportive of student thinking, and be able to help teachers guide students toward reinventing mathematical concepts. They should also support teachers to organize rich learning activities in classes in which there is a large diversity of student backgrounds. Clearly, the activities and contexts chosen needed to be easily recognized by students, and the language and diagrams needed to be simple and clear, so that they supported maximally the development of mathematics concepts (Hadi, 2002). One possible approach to fulfil these requirements was for curriculum developers and textbook writers to come from the universities to work with the teachers. However, in Indonesia the difference in status between university lecturers and primary schools teachers was clearly a stumbling block. How could people with such different backgrounds learn to work together profitably on research, so that they communicated and exchanged ideas and experiences fruitfully?

This paper consists of two parts. The first part is largely historical. It is devoted to providing a brief statement on the history of educational policies in Indonesia, especially in relation to school mathematics. It will describe the educational situation in Indonesia, from a historical perspective, and elaborate the need for reform. The second part will describe how the PMRI movement was introduced, focusing on an example of what was done to inform, support, develop, challenge, and refine PMRI.

B. History, Movement and Policy

In this section we provide a brief history of school mathematics in Indonesia and comment on the historical need for reform. We then discuss how the Dutch mathematics education reform initiative, RME, became the inspiration for PMRI, which sought to achieve the needed reform. After elaborating on PMRI's strategy for development and dissemination, we finally take a closer look at some PMRI activities.

1. State of the art of Indonesian mathematics education and the need for reform

The population of Indonesia is currently about 240 million, of whom about 25 million are primary school-age children. The participation rate in schooling is estimated at around 85%. Across the nation there are currently about 145,000 primary schools - not including private and Islamic schools - with 1,235,000 teachers, Primary education in Indonesia operates according to a double management system. The quality of academic qualifications of teachers is managed by the central government's Directorate General for Quality Improvement of Teachers and Educational Personnel (PMPTK), which is within the Department of National Education. The management of teachers is the responsibility of regional governments, which control what is known as 3M ("man, money, and material"). This double management system creates immense problems, because both managements work independently of each other (Joni, 2005).

Primary school teachers are mostly graduates of SPG (Sekolah Pendidikan Guru), a senior high school-level institution that accepts students from lower secondary schools for a three-year course. In 1991 the government decided to increase the education level to a two-year diploma course (D2) following upper secondary education. This D2 education is conducted by the Institute of Teacher Education (LPTK). In 1995 the level of education for intending primary teachers was raised to that of a first strata university graduate. This PGSD (Teacher Education for Primary School) program was established in many LPTKs (Armanto, 2002), and from 2007 a system of certification has been applied to all teachers in the country.

In 1973 the Indonesian government replaced arithmetic with "modern mathematics" as a curriculum subject in primary schools, but this change has proved to be problematic. Many teachers came to believe that modern mathematics was too difficult for their students, and often teachers taught in ways that relied almost totally on mathematics textbooks. In the classroom they followed the textbook page by page, without considering the correctness or otherwise of the mathematics that students wrote in their books (Somerset, 1997). As a result, the teaching and learning of mathematics in Indonesian schools became very mechanistic, with mathematics teachers tending to dictate mathematics formulas and procedures to their students (Armanto, 2002; Fauzan, 2002; Hadi, 2002).

For more than three decades a teacher-centred approach influenced students' attitudes, Most students were expected to learn mathematics in passive ways and, not surprisingly, some hardly learned it at all. Many students became used to being spoon-fed by their teachers, and were rarely asked to think creatively or critically about what they were learning. On this matter, Indonesia was not very different from other Asian countries. Hiebert (2003), for instance, pointed out that eighth-grade mathematics classrooms in Hong Kong were characterized by greater teacher-to-student lecturing than was the case in corresponding classes in the United States and other Western countries.

This top-down, teacher-centred approach to school mathematics not only adversely affected students' perceptions of mathematics but also their achievement in national examinations. It was often claimed that many students had developed "mathematics phobia", and their anxiety toward mathematics was believed, by some, to be responsible for low student achievement. On national examinations from 1990 to 1997, junior secondary school students' average scores for mathematics were always below 5 on a 10-point scale, making it consistently the lowest scoring subject of all the subjects taught in school (Manan, 1998). In international comparative studies like TIMSS and PISA, Indonesian students performed below most other participating countries.

There is a growing awareness among people in Indonesia of the need to improve mathematics teaching in schools. Since 1996, a group of concerned mathematics educators in the country has attempted to improve mathematics education in primary schools. The concerns were frequently expressed publicly, particularly after Indonesia abandoned modern mathematics. The question of what should replace it arose and, after considerable research a group, later called the PMRI Team, chose "Realistic Mathematics Education" (RME) as the development strategy for a new Indonesian paradigm of mathematics education. RME approaches to school mathematics are widely recognized as providing one of the best and most detailed elaborations of the problem-based approach to mathematics education (Hadi, 2002).

A transition from a more traditional, skill-oriented approach towards a problem-based, reform approach to school mathematics in Indonesia would constitute a major and complex transformation. It would require not only the introduction of new instructional sequences and activities, but also new roles for the teacher and new social and socio-mathematical classroom norms. It would the teachers' responsibility to foster a problem-solving classroom culture which challenged students to move on from their current more passive receptive roles toward more active, participatory roles. The students would need to take the initiative, and learn to think and reason for themselves. In addition, teachers would have to learn to guide the new learning process by choosing or designing instructional tasks that generate productive mathematical thinking at any given moment in time. They would need to organize and orchestrate whole-class discussions that helped students to think creatively. The role of the teachers as a consequence would need to change from an authoritarian, instruction-oriented orientation toward a more supportive, student-centred, and constructivist orientation. Obviously, in-service and pre-service teacher education would have to be a key component of the reform process. Co-teaching in classrooms would need to become much more commonplace, as would the production of supportive textbooks and teacher manuals.

The expectation that the intended innovation would fit Indonesian education and social contexts would also be important. In this respect, an important prerequisite for success would be the development of a sense of ownership by the teachers and teacher educators who would be involved. Thus a bottom-up approach was called for, in which Indonesian teachers and teacher educators re-invented a form of realistic mathematics education that fitted Indonesian contexts and priorities.

2. The beginning of Indonesian-Dutch Cooperation on PMRI

One of the first steps taken to implement PMRI in Indonesia was to create a core team of experts on PMRI. The PMRI team then persuaded the Director General of Higher Education (DGHE) to allocate a budget for six doctoral candidates in mathematics education to study RME in the Netherlands in 1998. Four of these students completed their doctoral degrees in 2002. In 2001, the PMRI Team convinced the DGHE, the Department of Religious Affairs, four pre-service teacher education institutions (LPTK) and 12 primary schools to start an experiment. The four LPTKs were UPI in Bandung, USD and UNY in Yogyakarta, and UNESA in Surabaya, and lecturers from these four LPTKs formed the PMRI team. Each LPTK started piloting materials and lessons in three schools - two of which were public and one Islamic. The first partial experiment was in Grades 1 and 3. After an initial evaluation it was decided in 2002 to do a full experiment starting with first grade classes.

The design and format of the experiment were constructed by the team in such a way that it was possible for teachers, text book writers and "interested others" to provide inputs. From the beginning, Dutch experts on RME from the National Center for School Improvement (APS) and the Freudenthal Institute (FI) were consulted on the aims and design of the experiment. A formal first phase cooperation with both APS and FI began with a PBSI grant from the Dutch government (2003-2005). These PBSI funds complemented Indonesian funding. In this first stage the primary goal was to conduct a pilot study involving Grade 1, 2 and 3 classes, in 12 primary schools. The main focus was to investigate the question: "How and under what conditions can a further development and large-scale dissemination and implementation of a new curriculum inspired by realistic mathematics be prepared, planned and executed?" A sub-goal was to establish an expert group of mathematics teachers, mathematics textbook writers and mathematics teacher educators who would be able to apply the principles of RME in Indonesian classrooms, and use it to inspire further development of mathematics education reform. Another sub-goal was that preparations would be made for a large-scale implementation of PMRI. "Large scale" was not to be understood as national, but could involve anything from 100 to 1000 schools in a number of provinces across Indonesia.

At the end of 2005, nine LPTKs were participating in the experiment, in more than 20 primary schools. Some had already reached the fourth grade and some were just beginning in the first grade. An independent evaluation of the first phase cooperation can be found in the Report of the Evaluation of the Bilateral Cooperation Program Indonesia (PBSI) (Dutch Ministry of Foreign Affairs, 2005). Among other things, the report states:

It has become apparent that the project is more than the simple introduction of a new method of teaching mathematics. Although it has been officially stated in the initial project document, discussion with the project holders revealed that for them the introduction of "realistic mathematics" is part of a broader attempt to change the educational culture at the level of basic education. Indeed the introduction of this method will affect the way students and teachers behave in the class and relate to each other. Without exaggeration, it can be stated that the project contributes to democratizing relationships in Indonesia and hence to social transformation.

IP-PMRI and DO-PMRI

In January 2006 the DGHE appointed a new PMRI team, together with a Steering Committee. The new PMRI team consisted of the old team with some new faces. The dissemination of PMRI became a complex endeavour requiring the involvement and coordination of many government offices. Seven of the nine members of the Steering Committee were decision makers representing important government offices, and the chair was the Director General himself. At that time, the PMRI team created a development institution called IP-PMRI, with two main designated tasks:

* to continue the experiment up to grade 6, and
* to disseminate PMRI on a larger scale.

In January 2006, IP-PMRI also managed to win a larger four-year grant from the Dutch government through the NPT/NUFFIC project. With that grant the second-phase of the Indonesian-Dutch cooperation on PMRI started, again with consultants from APS and FI being key players. This second phase project is called Dissemination of PMRI, or DO-PMRI for short. This grant was for strengthening post-secondary education, and not for disseminating PMRI to primary schools. So the dissemination of PMRI to teacher educators in participating LPTKs is conducted through the DO-PMRI project; while the implementation of PMRI in the schools through IP-PMRI is wholly funded by private and governmental Indonesian funds. In practice, both activities are synchronized and run simultaneously. DO-PMRI and IP-PMRI agreed that the main activities of the movement would be:

1. To build knowledge, skills and practices of primary teachers regarding PMRI.
2. To build knowledge, skills and practices of teacher educators regarding PMRI.
3. To institutionalize PMRI in the LPTKs.
4. To institutionalize PMRI at a national level.

The NPT/NUFFIC DO-PMRI project activities focus primarily on the second and third of these objectives. Objectives 1 and 4 are mainly the responsibilities of the IP-PMRI team.

Strategy of Development and Dissemination

A bottom-up dissemination strategy is an essential characteristic of the movement. Elements of this bottom-up strategy are:

* Capacity building of the PMRI Team and strengthening the four bases of LPTK (UPI, USD, UNY, and UNESA) by working closely together with teachers in
* pre-service and in-service teacher training.
* Developing teaching materials based on classroom experience and classroom research.
* Establishing an expanding network of local PMRI resource centres at each participating LPTK (called P4MRI), as starting points for further dissemination.

Currently there are 11 LPTKs and more than 30 schools involved in the dissemination. These LPTKs are expected to be the centres for the development and dissemination of PMRI in their respective regions. Their roles are to be institutionalized by the establishment of P4MRI (centres for PMRI research and development). These centres are places for teacher educators to do design research on PMRI. The wish to create an Indonesian version of RME asks for instructional design, or better, "design research". Design research assumes a scientific basis, and goes beyond the design of PMRI text books. It also takes into account the whole instructional setting, which includes instructional materials, tools, activities, interactions and classroom culture. This reflects the current insight that the design and use of instructional materials alone is too small a basis to ensure curriculum innovation. Teacher educators from respective P4MRI are also expected to work collaboratively with teachers from their partner schools. They are expected to inspire, advise and support teachers who try to change their mathematics instruction.

It is clear then that teacher educators will have to play a central role, if the mathematics education innovations in Indonesia are to take hold and be successful. Therefore, in the years ahead, three of the 11 LPTK's are going to receive support from the DO-PMRI project and, among other things, will focus on ways in which teachers educators can cooperate with teachers, and on the development of these new roles. The experiences of the three LPTKs will provide guidance for the other LPTKs.

Workshops and follow-up activities for teachers are another element of the dissemination strategy. The workshops and follow-up activities basically encompass the following components: investigating and focusing instruction on a certain area of mathematics in primary school, designing instructional activities, and experimenting with those activities in schools. Once mathematics teacher educators from P4MRI local centres have organized a start-up workshop, they continue with activities in which they help teachers to implement PMRI approach in their daily work. The teacher educator will also compose portfolios of their various experiments and activities in their partner schools, and use these to frame interesting findings and questions, which could be a topic for discussion in subsequent workshop sessions. A mathematical-didactical exploration of various primary-school topics is one of the main themes of these workshops. This is valuable for teacher educators and in-service
teacher education, primarily because the participants learn something that is related to their work as teachers. It is also beneficial for the ongoing bottom-up instructional design activities that take place in the context of PMRI.
This general strategy underlies all planned activities, as well as all decisions that have to be made during the execution of the project.

Concrete Strategy in Relation to Activities and Results

The building of knowledge, skills, and practices of teacher educators regarding PMRI (main objective 2) are addressed through a series of workshops. These workshops are held twice a year (around April and around October) and attended by a growing number of teacher educators. The workshops are co-taught by Indonesian and Dutch staff members.

The major priorities in PMRI's strategy are:
1. Educating PMRI team members in the theoretical, practical and research aspects of PMRI (dissemination).
2. Further improving PMRI lesson materials by obtaining recommendations for improvement of the text books and educational methods currently used, as well as piloting these recommendations.
3. Establishing and strengthening 14 Resource Centres at selected LPTKs, as these are the key institutions for disseminating the PMRI methods and teaching approaches. The Resource Centres need to develop skills necessary for disseminating RME methodologies to primary schools in their regions.
4. Educating staff members of the involved institutions in managing the PMRI Resource Centres.
5. Improving the monitoring and evaluation (M&E) and research by setting up an M&E System and the development of an open PMRI database accessible for all who are interested in PMRI dissemination in Indonesia.
6. Establishing an M&E team and other task forces for (a) production and distribution of education materials, (b) public relations, advocacy and PMRI socialization, (c) publication of the quarterly magazine Majalah PMRI, and (d) establishment and maintenance of a website. These task forces will be on a flexible basis engaged in enhancing the promotion and dissemination of the PMRI approaches to the Resource Centres and will ensure continuous access for information and resources seekers. On the International Conference of School Effectiveness and Improvement (ICSEI) in January 2006 in Florida the dissemination strategy was put before an international panel. Recommendations from this panel were studied carefully in the inception phase of the project. From the international panel, an International Advisory Board of nine members was put together. The members of this panel are:

* Dr. Bana Kartasasmita, ITB, Indonesia;
* Professor Lee Peng Yee, from the National University, Singapore;
* Professor Koeno Gravemijer, Freudenthal Institute, the Netherlands;
* Dr. Gerard van de Hoven, as chairman, from APS, the Netherlands;
* Dr. Boudewijn van Velzen, from APS, the Netherlands;
* Professor Mats Ekholm from Sweden;
* Dr. Wilfred Perera from Sri Lanka;
* Professor Karen Seashore, from the University of Minnesota, USA;
* Dr. Cyril Julie from South Africa.

The panel's main functions are to provide advice, support by being available as a reference, and to share their knowledge with the DO-PMRI team. The panel convened in February 2007 in Jakarta and Bandung, and will have a second meeting in February 2009. Its members assess the current progress of the dissemination movement and make recommendations for future activities.
The assumption is that international attention will have a positive effect on the quality of strategic decisions and on the commitment of national stakeholders.

C. Design Studies and Content Development of PMRI

In this second part of this paper we elaborate on the role of "design research" in supporing the implementation of PMRI. As mentioned earlier, the implementation of PMRI cannot be done without the availability of PMRI curriculum materials that arise out of Indonesian contexts. Design research will not only support the development of Indonesian-based PMRI materials, but will also provide a scientific basis for PMRI. Furthermore, it can be instrumental to overcoming the problem of distance between lecturers and teachers.
We will begin with a description of design research. This is followed by an example of what has happened with respect to a mathematics concept that Indonesian students find difficult - fractions. And finally we shall elaborate on a

framework for developing PMRI curriculum materials, and on the result of an experiment study.

1. Design Research

As an important part of the project was to develop exemplary curriculum materials, a key research question became: Can we expect, by developing such materials, the development and dissemination of PMRI will become more effective in supporting Indonesian primary school teachers?

To address this question, a design research approach was chosen. Design 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, 1999). Design research can be classified into two types, depending on its purpose and the time the design 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 which aims at the improvement of the quality of intervention or product.
* Reconstructive studies. With reconstructive studies, activities are sometimes conducted during the development process, but often they are conducted afterl interventions that are intended to articulate and specify the design principles.

At the formative stage, researchers developed curriculum materials based on local instructional theory. Following classroom experiments, these materials and theories were developed to an exemplary level. In teaching experiments, the teachers developed learning trajectories as sequences of activities that were carried out by the students (Gravemeijer, 1994; Armanto, 2002; Fauzan, 2002).

This development was done by designing and testing learning activities in real situations on a daily basis. During the teaching experiments researchers carried out anticipatory thought experiments, in which they foresaw both how the proposed instructional activities might be realized during the interactions in the classrooms and what the students might learn as they engaged in the activities. Both teaching experiments and thought experiments gave useful information for the revision of curriculum material prototypes. By thoughtful reflections, and based on empirical findings, learning trajectories were developed and revised (Figure 1).

<<<insert Figure 1>>>
Figure 1: The construction Local Instructional Theory

2. Problems in Teaching Fractions

The teaching and learning of fractions and decimal numbers have long been problematic in mathematics education in many countries, particularly in primary schools. It is well known that many students struggle to learn to carry out simple calculations involving fractions. Diagnostic surveys conducted by the Indonesian Ministry of Education have revealed that nearly 30% of junior secondary students (aged about 13 years) add the fractions 1/4 and 2/5 simply by adding the numerators and adding the denominators - so that they get the wrong answer, 3/9. Furthermore, most students lack understanding of decimal number values. Apparently, less than one Indonesian primary school student in six can correctly place the three decimals 0.55, 0.8, and 0.14 in order of size from smallest to largest. There are many widespread, systematic errors. For example, more than two-thirds of the students consider 0.8 to be smaller than 0.14, because they evaluate decimal numbers as if they were whole numbers (Somerset, 1997).

Research conducted by the National Assessment of Educational Progress (NAEP) in the United States of America has revealed that many U.S. fourth-grade students also have limited understanding of fractions (Kouba, Zawojewski, & Strutchens, 1997). And, often, a mature understanding requires more than merely getting correct answers to narrow tasks. Thus, for example, students' understanding of the fundamental concept of equivalent fractions should reflect more than mere knowledge of a procedure for generating equal fractions. Students should develop rich connections between symbols, models, pictures, and contexts. However, only 42% of U.S. fourth-graders in the NAEP sample chose a picture that represented a fraction equivalent to a given fraction, and only 18% shaded a rectangular region to produce a representation of a given fraction (Cramer, Post, & delMas, 2002).

Student difficulties with elementary mathematics concepts can often be traced to the use of inappropriate curriculum materials. Many books, especially commercial ones, used by teachers do not succeed in adequately developing students' mathematical thinking because they overemphasize drill responses and fail to emphasize connected comprehension of mathematics concepts and ideas (Cramer, Post, & delMas, 2002). The research reported in this section of the paper was conducted with the purpose of developing exemplary curriculum materials about fractions, based on realistic mathematics education (RME) theory. By developing such exemplary materials it was expected that the teaching and learning of fractions would become more meaningful and would support students' comprehension of mathematics, would enable them to use mathematics to solve daily life problems, and would prepare them to study mathematics at higher levels.

3. The Framework of PMRI Curriculum Materials Development

In developing learning materials about fractions the researchers referred to a didactical framework proposed by Hadi (2005a, 2005b). The framework, which is illustrated in Figure 2, was constructed for the purpose of developing and disseminating PMRI. It could be used as a guideline for developers (script writers) who were designing PMRI exemplary curriculum materials.

The didactical framework consists of several components within education: students, contextual problems, teachers, learning environment, and learning experiences. It is an integrated system in which those components are effectively and efficiently intertwined with each other and with the students as the centre of instruction. The developer would be expected to have in his/her mind that the objective of instruction is to develop students' understanding of mathematical concepts and ideas by using contextual problems and by student exploration based on a reinvention process (Gravemeijer, 1994). Contextual problems are expected to meet relevance and familiarity conditions - specifically, the level of difficulty of problems should be consistent with the level of student thinking, and the contexts chosen should be well recognized by them (Hadi, 2002). The role of the teacher as a facilitator is indicated by his/her ability to build students' thinking processes through an interactive learning environment.

<<<insert Figure 2>>>
Figure 2: Didactical Framework of PMRI

The didactical framework contains three kinds of relationships, visualized by three types of arrows, namely bold arrows, block arrows, and line arrows. The bold arrow in the middle of the figure depicts the main PMRI concept that the learning process should be started by asking students to solve various contextual problems. By doing so, students will immediately and meaningfully become involved in the learning process. The purpose of the contextual problems is to help them to build their own mathematical ideas and concepts (mathematical concept formation). In a meaningful context, students can not only use their common sense to solve problems, but they can also use their personal mathematical theories.

The bold arrow in the middle separates the didactical framework into two parts, namely the top part (reinvention process) and the bottom part (the roles of teachers in PMRI lessons). The top part shows horizontal and vertical "mathematizations". Starting from contextual problems, students begin their mathematical concept formation by describing the problems using their own symbols and notations. In this process it is possible that each student has his/her own way of thinking. The vertical mathematization is also started with contextual problems but, in the long run, the students can construct certain procedures that can be applied to similar problems directly, not necessarily using the context as a bridge. Gravemeijer (1994) calls this mathematization of mathematical matter, as distinguished from horizontal mathematization, which is the mathematization of contextual problems.

The part at the bottom corresponds to the teacher's role as facilitator and motivator in the learning processes. The role of the teacher is to create learning environments that provide students with rich learning experiences. However, this can only be done if the contextual problems satisfy relevance and familiarity conditions. These conditions will have an impact on student activity and interactivity. Teachers' knowledge of contextual problems and their ability to develop interactivity is important for successful learning, which subsequently supports students' mathematical concept formation.

The above framework, which provided the prototype of curriculum material for the teaching and learning of fractions in elementary education, was designed using the following sequence (Hadi, 2005c):

<<<insert Figure 3>>>
Figure 3: Learning Trajectory about Fractions

(1) Fair Sharing

There are many Indonesian contexts that are relevant to the concept of dividing a whole into equal parts, such as sharing bread (a square shape), Bingka cakes (a special hexagon shape), and Bika Ambon cakes (a rectangular shape). In classroom activities, students may be divided into groups of 2, 3, 4, or 6 students. In the experiment, each group received a certain number of breads. In the activities they determine the portion that each student in the group should receive. Students' real life experiences in dividing a whole into equal parts helps them to relate formal fraction notations to their informal understanding on part-whole relations. In the learning process students also become involved in concrete activities, such as making or drawing or cutting out square and rectangular pieces of paper as representations of cakes, and then using these to divide a whole into equal parts. This activity also aids students in understanding part-whole relationships and the relationships between simple fractions.

(2) Repeated Division by Two

For this theme, students firstly measure the lengths of different items in their classroom using paper strips (a measuring strip of any length, made of a piece of paper). Their measurements should be given in terms of "strips." If the length of an item they measured is not exactly the same as the strip or a multiplier of the strip length, students are encouraged to use halves and quarters, rather than whole units, by folding the measuring strips. This activity of measuring things using paper strips prepared students for "Egyptian fractions". Teachers could give problems to help students make connections between the concrete paper strips and the symbols in Egyptian fractions. The oldest system of fractions used by Egyptians was based on halving (dividing by two).

(3) Repeated Division by Ten

The second system of Egyptian fractions involved repeated division by ten. Students examined circular diagrams that show different fractions of a whole revolution. In ancient Egypt symbols were developed and used to describe what fraction of a whole turn was shown on each wheel. The wheel became a model of a fraction clock or fraction circle. In the present experiment, students divided a tenth of a wheel into tenths and thus each tenth of a tenth was one one-hundredth. They then divided a hundredth of a wheel turn into tenths, thereby discovering thousandths. Although this number system was similar to the standard decimal system, it did not pre-suppose the concept of place value.

(4) Decimal and Percent

Prior to the introduction of the concept of percentage, teachers introduced the decimal notation that 1/10 equals 0.1, 2/10 = 0.2, etc. Then, the teachers used students' informal knowledge about percent to introduce the relationship between fractions and percents. For example, 50 percent is the same as one-half, and 25 percent is the same as one-quarter. However, the teachers were not supposed to show students how to convert percents to fractions unless the students themselves specifically asked for this. Students also learned the relative nature of percent. For example, 50 percent of 20, which is 10, is not the same as 50 percent of 50, which is 25.

The experimental study showed the researchers how the exemplary learning material worked in the classroom operating under PMRI principles - such as the use of real contexts, models, students' artefacts, and interactivity. The study was conducted in two primary schools (a private and a public school) in Banjarmasin. In the first school it was conducted in two class sessions on April 5 and 6, 2005. In the second school, the experiment was held on November 30, 2005. The results of the experiment are briefly outlined below.

In the activity of sharing breads and bika-ambon cake, students tried to find out the solution using several strategies of how to slice the bread into several parts equally. Some of them used rulers (or other measuring tools) to make sure that the bread was equally sliced, and several others used approximations. Then, students were invited to use their practical knowledge of slicing bread in a sequence of activities that involved them in cutting and attaching models of bread and bika-ambon cake made of coloured pieces of paper. By making sketch drawings, students planned their solutions by dividing the models using vertical, horizontal and diagonal lines; they then drew their solutions and made marks to find solutions for certain problems - for instance, who would get the most bread? During the activities, students worked on the idea of part and whole relations.

During the learning process, students were actively engaged in discussions with their friends, in groups of four or five (Figure 4), and with their teacher. If and when they encountered difficulties, their teachers tried to help them negotiate their way of thinking by asking guided questions. During a two-hour class session which incorporated a break between lunch and midday prayers, some students enthusiastically worked on work sheets and did not seem to want to stop. They busily continued working on the problems until their teachers reminded them that they should have left. It hardly needs to be added that this would be most uncommon in more traditional Indonesian mathematics classes.

In the first school, after the lesson on the second day, students were asked to write short comments. Students' written comments about the learning can be divided into two groups. Among 39 students who experienced the lesson, 31 regarded the lesson as "very good", and 7 appraised it as "good", while and 1 did not make any comment. Most of them felt the learning was enjoyable and they never got bored even though the lesson extended over a relatively long period. The reason for their positive appraisal would appear to have been the attractive and challenging activities they did during the lesson, and the simple learning tools (such as scissors, pieces of paper, rulers, glue) that helped them easily "grab" the ideas.

<<<insert Figure 4>>>
Figure 4: Students working in a group of four and the sample of their work.

In the second school, the students' reactions to the lesson were collected using a questionnaire. The following are their reactions (n = 30).

Table 1: Students' reaction on the PMRI lesson.

Questions and Student answers
Do you enjoy the lesson? Yes, I enjoy it very much (90%)
Yes, I enjoy it (10%)
Do you find it easier? Yes (93.3%) Not sure (6.7%)
Were you involved in the lesson? Yes (100%) -
Are you enthusiastic about what you learned? Yes (90%) No (10%)
Compared to your daily lesson, do you find this lesson more interesting and easier? Yes (93.3%) No answer (6.7%)

Since the teachers had developed the PMRI material themselves, they felt a sense of ownership with respect to the materials. Furthermore, they recognized that their students' classroom experiences with the materials helped them avoid standard difficulties. That appears to be a special benefit of the bottom-up approach so characteristic of the PMRI movement.

C. Concluding Remark

Demand from schools to implement PMRI is high and beyond the ability of the IP-PMRI to cope. Also, as the movement is spreading it has become necessary to define what PMRI is and what it is not, and how to maintain the integrity of the concept.
There is a great temptation to disseminate PMRI simultaneously nationwide. But, if we learn from the history of the implementation of modern mathematics in Indonesia, this should be resisted.

Both the National Coordination of Professional Development of Mathematics Teachers (P3G) and the Regional Centres for Professional Development of Teachers (LPMP) are under the newly created Directorate General for Quality Improvement of Teachers and Educational Personnel (PMPTK) and are the official bodies which design, prepare, conduct, and evaluate in-service training programs for teachers.

The directorate general of PMPTK has allocated a generous budget for 2007 to train the members of the P3G and LPMP on PMRI, an approach that involves TT (training of trainers), and KKGs (teachers' working groups). A KKG consists of anything between 8 and 20 teachers from a district or town/city. There are about 5500 KKGs in the country. Thus, the challenge for the coming years is to preserve the defining characteristics of the movement, for this is likely to be the key to the success of the dissemination activities that will take place. A model of training that is consistent with the PMRI model and maintains the PMRI model still needs to be developed.

The Office of the Research and Development of the Ministry of National Education will assess the achievement in mathematics of the PMRI experimental classes compared with those of parallel classes from the same schools.

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Reviewer #3: ZDM - The International Journal on Mathematics Education

Manuscript Number: ZDMI-D-07-00074
Manuscript title: "Reforming Indonesia Mathematics Classroom through PMRI"

1. Statement of problem/issue and discussion of its significance:
The paper describes the implementation of a large scale project in Indonesia. It is a significant innovation in the teaching of mathematics in that country

2. Literature review and theoretical framework:
This section treats the literature very quickly as it spends most of the time describing the project and the Indonesian system. It is very complex and contains dense detail, probably more then is needed. The paper would be improved with some reduction in the detail by perhaps providing a diagram to assist the readers understand the educational organization.

3. Methodology and data analysis (where applicable):
This section is very brief and is not really the main aspect of the paper but a shallow addition. By far the significance of the paper is in the insight it gives of the complexity of the Indonesian system and the difficulties with implementing an innovative program. A better methodology would be to adopt Guskey's five levels as an organizer for future papers.

4. Discussion:
The discussion is mainly a narrative of the process so far.

5. Conclusions and implications:
The conclusions and generalizations are modest and relevant to the discussions.

8. Some minor edit items

Page	Side Number	Changes
1	26	delete 'drives'
1	27	delete 'for'
2	27	delete 'Among others because'
2	28	delete 'and also'
2	35	add 's' to 'characteristic"
2	39	add 'be' between 'must well'
2	40	add 'be' between 'must simple'
2	47	delete 'also'
2	47	add after 'instrumental' - 'and will be explained later in section c of this paper'.

3 4 change 'also' to 'will'
3 25 change 'graduated' to 'graduate'
3 40-41-42 delete 'This difficulty implied to the practice om mathematics teaching and learning in which' and add 'Thus'
3 44 add 'of' between 'correctness the'
3 46 change 'Indonesia' to 'Indonesian'
3 51 add 'ing' to 'be'
3 52 add 'a' between 'in critical'
3 53 The use of et al: it is used for a citation that appears for the first time, which should include all authors - Hiebert
3 54 delete 'a'
3 56 add 's' to 'perception'
3 60 add 's' to 'examination'
3 62 change 'is' to 'was'
4 17 change 'are' to 'is'
4 26 change 'bring' to 'assist' and 'changing' to 'change'
4 40 delete one of the two full stops
4 56-57 full stop after 1998 and capital letter for 'Four'
5 10 add 'ed' to 'offer'
5 19-22 Indent - remove???
5 30 add 'to' between '100 1000'
5 34 add 'had' between 'some already'
5 40-51 page number missing
6 56 change 'does not limit' to 'is not limited'
6 57 add 'of' between 'account the'
6 59 delete 'the' after reflects
6 60 change 'is' to 'are'
7 20 add 'the' before P4MRI
7 20 add 's' to centre
7 28 add comma after teachers
8 1 add colon after respectively
8 11 change 'access for' to 'access to'
8 50-51 delete ' we indicated that'
8 53 change 'we' to 'this section'
8 54 change 'Like' to 'As'
8 56 add 'on' after 'elaborate
9 35 add 's' to 'experiment'
9 38 add 's' to 'experiment'
9 46 delete 'construction'
9 53 add 's' to 'survey'
9 58 change 'number' for 'place'
10 1 add 's' to 'problem'
10 7 add 's' to 'fraction'
10 23 new paragraph starting with 'The research'
10 24 change 'to develop' to 'of developing'
10 24 add 's' to 'fraction'
10 27 add 's' to 'fraction'
10 33 add 's' to 'fraction'
10 36 add 's' to 'purpose'
10 42 change 'has in his/her' to 'have in'
11 12 change 'At the top part' to 'The top'
11 19 add 's' to 'procedure'
11 19 delete 'the' after 'to'
11 19 add 's' to 'problem'
11 20 delete 'as'
11 26 change ' give student learning' to 'construct students' learning'
11 26 change 'facilitate them with' to 'provide'
11 28 add 'the'
11 26 add comma after students
12 6 change 'to' to 'for'
12 15 add 's' to 'fraction'
12 17 add 'is' between 'what fraction'
12 30 add 'the' between 'part teacher'
12 37 change 'in' to 'with'
12 58 add 'the' before 'teacher'

12 61 delete 'did'
13 4 add 'to' before 'want'
13 5 change 'fraying' to 'praying'
13 12 change 'of' to 'as'
13 33 change 'do you involve in the lesson?' to 'Were you involved in the lesson?'
13 35 change 'do you enthusiastic' to 'were you enthusiastic'
14 9 remove tot and the parentheses around training of teachers as it is unnecessary.
14 53 reference for Hiebert is incorrect
14 57 change 'Raka' to 'R.,'