

CASCADE-IMEI: Web site support for student teachers learning Realistic Mathematics Education (RME) in Indonesia

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Abstract

CASCADE-IMEI is a learning environment in the form of a face-to-face course and a web site (www.cascadeimei.com) which aims to support student teachers in Indonesia to learn Realistic Mathematics Education (RME). RME is an instructional theory in mathematics education that was originally developed in the Netherlands. So far, two prototypes of the learning environment have been developed and evaluated both by student teachers in Indonesia and several experts in the Netherlands. This paper presents the origins of the learning environment (with an emphasis on its web site) as well as the results of the first two cycles of its prototyping process.

INTRODUCTION

CASCADE-IMEI (Computer Assisted Curriculum Analysis, Design and Evaluation for an Innovation in Mathematics Education in Indonesia) is a learning environment that aims to support mathematics student teachers in Indonesia who are planning to implement lessons that are based on the realistic mathematics education (RME) approach. RME is a well-known teaching-learning theory in mathematics education that has been proved to be successful in reforming the mathematics curriculum especially in the Netherlands (Lange, 1993; Gravemeijer, 1994). Contrary to the teaching approach that is common in Indonesia, RME uses contextual problems or applications as a source as well as a starting point for mathematics teaching. In this study RME is assumed to be a promising approach to improve mathematics education in Indonesia. The learning environment consists of two main parts that is a face-to-face course and a web site. The course stresses on the activities such as learning about the main ideas behind RME, its curriculum materials and how to use the materials in the classroom. On the other hand, the web site focuses on supporting course participants with RME materials, training opportunities focuses on how to teach RME materials using RME approach in the school and communication tools that can be used by participants when implementing RME lessons (Nieveen, 1997; Khan, 1997).

This paper first presents theoretical framework of the study that is theory of Realistic Mathematics Education that is used as a guidelines in designing the learning environment and the strategies how to introduce RME as well as web site technology as innovation to the prospective teacher of school mathematics in Indonesia. The description of the learning environment is briefly presented. Then, the research methodology and the results of the study are discussed. A discussion and a conclusion complete the article.

THEORETICAL FRAMEWORK

RME: philosophy, principles and characteristics

The learning environment, including both the course and the web site, is designed based on the RME philosophy and principles. The philosophy of RME is mostly determined by

Freudenthal's view on mathematics (Freudenthal, 1991). Two of his important points of view are: (1) mathematics must be connected to reality; and (2) mathematics should be seen as a human activity. First, in order to start from reality that deals with phenomena that are familiar to the students, *Freudenthal's didactical phenomenology* that learning should start from a contextual problem is used. Second, by the *guided reinvention* principle through *progressive mathematizations*, students are guided didactically and efficiently from one level to another level of thinking through mathematization. These two principles and the concept of *self developed models* (Gravemeijer, 1994) can be used as design principles both in developing the course materials and the web site. Furthermore, these principles are operationalized into five basic characteristics of realistic mathematics education or five tenets of RME (de Lange, 1987; Gravemeijer, 1994). In short those are:

- (1) *Use of contextual problems* (contextual problems figure as applications and as starting points from which the intended mathematics can come out).
- (2) *Use of models or bridging by vertical instruments* (broad attention is paid to development models, schemas and symbolization rather than just offering the rule or formal mathematics right away).
- (3) *Use of students' contribution* (large contributions to the course are coming from student's own constructions, which lead them from their own informal to the more standard formal methods).
- (4) *Interactivity* (explicit negotiation, intervention, discussion, cooperation and evaluation among pupils and teachers are essential elements in a constructive learning process in which the student's informal strategies are used as a lever to attain the formal ones).
- (5) *Intertwining of learning strands* (the holistic approach implies that learning strands can not be dealt with as separate entities; instead, an intertwining of learning strands is exploited in problem solving).

Strategies for introducing RME in teacher education in Indonesia

De Lange (1993) pointed out several problems that were faced when Dutch experts introduced the RME approach in Dutch secondary education. The general problem was: How to educate teachers to learn using new materials and to teach with materials using the new approach? This appeared to be a complex endeavor due to several changes: (1) the mathematics materials differ from former ones; (2) the role of teachers change from teaching to 'unteaching' ; and (3) the level of thinking needed changes from low level thinking towards middle-level and high-level order thinking. These changes need to be taken into account when considering implementation strategies for RME in Indonesia.

As a consequence of reform, alternative curricula, alternative teaching materials, and alternative forms of assessment are essential (Van den Heuvel-Panhuizen, 1996; Fullan, 1991). Selter (1997) pointed out that these are all mediated through the teacher, specifically through teacher's beliefs about how to organize and facilitate pupil's learning of mathematics. From this perspective, teacher education (pre-service as well as in-service) plays a vital role. One key strategy in this situation is to engage teachers or student teachers in their professional development using the following strategies (Loucks-Horsley, Hewson, Love & Stiles, 1998): (1) a short course (for *building knowledge* by teachers or student teachers); (2) curriculum

development (by *adapting the innovative materials into the school practice*); and (3) using technology (in order to *provide teachers or student teachers with a sustainable tool which provides rich information about the new approach*).

In this study, RME will be introduced to Indonesian student teachers by developing a learning environment in which a face-to-face RME course and a web site both contain background information and RME curriculum materials.

DESCRIPTION OF THE LEARNING ENVIRONMENT

This section provides a brief description on both components of the learning environment: the course and the web site (see Figure 1).

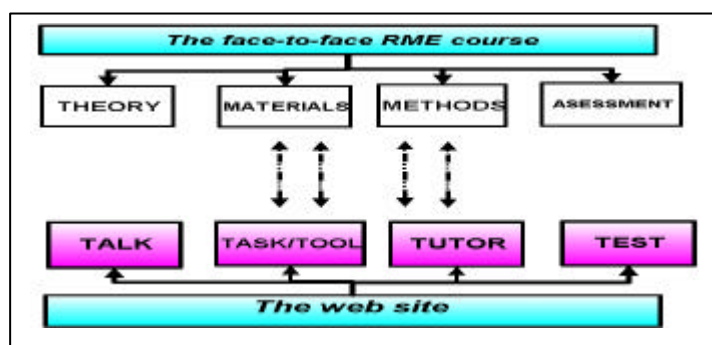


Figure 1. *The components of the learning environment*

The course and its materials

The RME course is a part of learning environment that is developed in order to make student teachers understand what RME is and how to implement RME in the classroom. The main contents of this course include: (1) overview of the RME theory; (2) learning what are RME materials and how to redesign them; (3) learning how to teach using RME approach in the classroom; and (4) learning how to assess the students in the RME classroom.

The course materials are adapted from RME books that were developed by Freudenthal Institute experts as well as materials from the "Mathematics in Context" books (mathematics books for student grade 5-8 in USA) that were developed during the collaboration project between Freudenthal Institute and University of Wisconsin-Madison (Romberg, & de Lange, 1998). Especially the examples, curriculum level, context of mathematics topics and number of mathematics problems on each topic needed to be adapted to the Indonesian context. At this moment, five topics were adapted and used in the course that is *side-seeing*, *symmetry*, *linear equation system*, *four cubes* and *matrices*.

The web site

The web site, <http://www.cascadeimei.com>, is developed in order to support the course participants in a sustainable way. In order to do so, the following options are available:

- 1) *Online Info-base or task*. The online info-base is the main component of the web site and consists of exemplary RME materials such as student materials and teacher guides (figure 2); student productions from RME classes; applet programs and mathematical games; links to web sites that have relationship with mathematics education in general and RME.

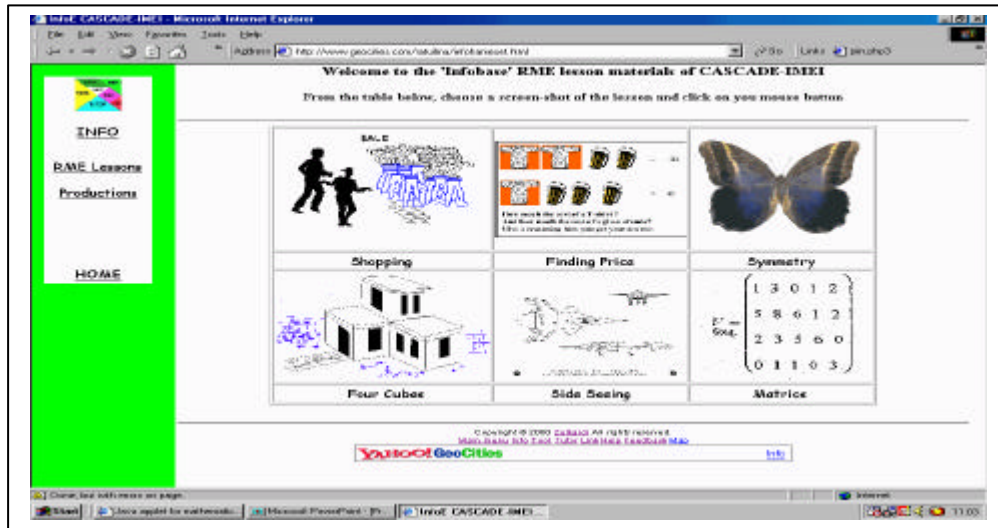


Figure 2. Online RME lesson materials

- 2) *Online Tutor*. In order to inspire student teachers before they conduct teaching practice in the school, an online tutor was designed. This moment, the online tutor consists of theory on how to use RME materials in the classroom. In the next coming months, a number of video clips that illustrate critical moments of teaching using RME materials in the classroom will be made available. For example, how to start the lesson, how to organize and to manage groups or class discussions and how to close the lesson.
- 3) *Online Talk*. In order to provide student teachers a support in which they can discuss their problems and their experiences, the online talk elements of the web site was provided. Two kinds of communication tools can be used are e-mail and a mailing list.
- 4) *Online Test*. In order to facilitate the users or student teachers with a number of RME problems, an online test called *problem of the month* (see figure 3) was developed. It contains not only example of RME problems but also a guide how and when to use them in the classroom practice.

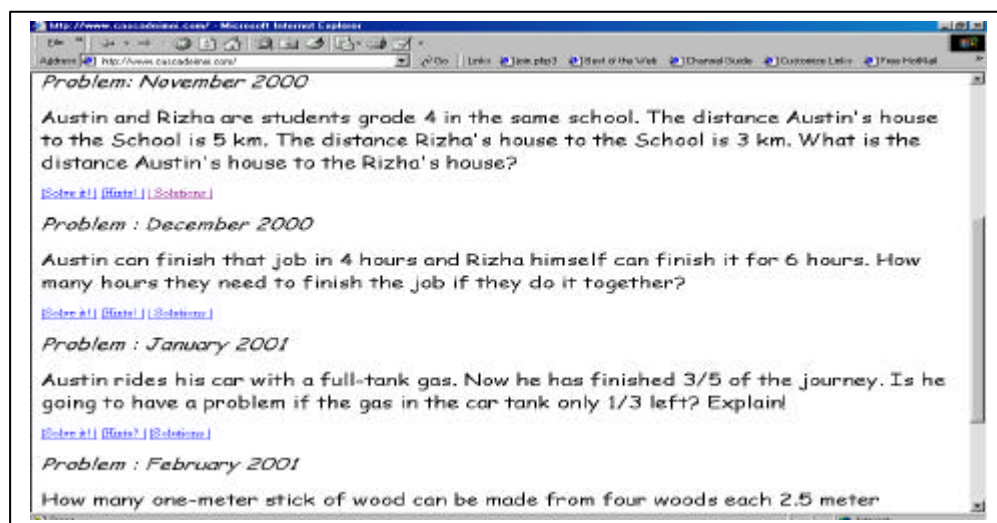


Figure 3. RME problem of the month

METHODOLOGY

Research phase

This study uses a development research approach (van den Akker, 1999). With this method, the learning environment is developed and evaluated in three main phases: preliminary study, prototyping stage and assessment stage. This paper only discusses the first two phases.

The preliminary study phase

In the first phase, a review of the relevant literature on RME and curriculum development has been conducted and resulted in preliminary prototype of RME curriculum materials. Also a preliminary prototype of the learning environment has been designed and evaluated with several experts in the Netherlands. After revising this preliminary prototype and adapting it to the Indonesian context it was implemented to the target group in teacher education in Bandung, Indonesia.

The prototyping phase

In this phase, two prototypes of the learning environment have been developed and evaluated both in the Netherlands and in Indonesia. Based on results and suggestions, the third prototype was developed and evaluated from February 2001 to May 2001.

The results of the formative evaluation of third prototype are discussed in the remainder of this paper. The formative evaluation was geared towards the following questions:

- *What is the perception of participants with respect to the learning environment?*
- *What is the practicality of the third prototype of the learning environment?*
- *What knowledge and skills did participants learn after using the learning environment?*

Participants

The participants of the formative evaluation of the learning environment were 8 pre-service student teachers (1 man and 7 women) at the Department of Mathematics Education, Indonesian Educational University in Bandung, Indonesia. All of them were fourth-year students and have no teaching experience before. They can use window-based computer but without access to the internet. The average of their age is 22 years old.

Instruments and activities

The instruments that were used in order to evaluate both the course and the web site are summarized in table 1.

Table 1. *Activities, research questions and data collection on effects*

Activities Research question	Whole program	Cooperative evaluation of the web site	Document analysis	Teaching practice in the schools	Seminar
Participants' perceptions	Questionnaire				
Practicality of the learning environment		Interview schema	Analysis of e- mails and reflective journals		
Participants' learning gains	Questionnaire and test		Analysis of teaching preparation	Lesson observation	Group discussion /seminar check list

Procedure

RME Course

The course was implemented in the teacher education college in the period Feb 2001 - May 2001. The activities were conducted within a frame time of eight blocks of two-hours for training and two blocks of two hours for seminar a reflection. After the participants filled out the entry questionnaire the course started by giving the participants information about the basic principles and characteristics of RME. Then some examples of realistic mathematics problems were given and discussed in groups in order to get an idea of each characteristic. Next, the student teachers were given a number of RME problems in five topics (*side-seeing, symmetry, linear equation system, four cubes and matrices*). In this case they were treated as learners while the researcher acted as a teacher. After they solved the problems, they were guided in discussing the various strategies and in several cases they were invited to present their answers in front of the class. At the end of the course they were tested to see their performance in solving the problems and redesigning a number of contextual problems into a short lesson. In addition, they filled out the final questionnaire.

All participants demonstrated their RME teaching skills in front of their peers. Here, they gained input and feedback from their peers as well as the researcher. Then, they used the materials in the school classroom. Due to time limitation only three participants were followed when they implemented the RME lessons in their classroom. The researcher observed their lessons.

The web site

The following activities were held regarding the web site. First, participants got some technical training. They were trained how to access the internet and were guided in making a personal e-mail. In order to get e-mail experience they were invited to send some personal background to the researcher as well as to other participants. Here, they learned how to compose a new e-mail, to send it and to receive e-mail. In addition they were taught how to use the attachment facility. Then, they were asked to access the web site of CASCADE-IMEI (www.cascadeimei.com), to give comments and to send those to the developer by e-mail. Further, they were asked to communicate their experiences and problems in the course with the developer and other participants using e-mail. Finally, the web site was evaluated using a cooperative evaluation, during which four student teachers were invited to work aloud while using the web site. All comments were recorded on tape for analysis.

RESULTS AND DISCUSSION

Due to limited space, only the main results are presented in this section.

Result 1:

What is the perception of participants with respect to the learning environment?

The data resulting from the questionnaire are summarized in the table 2. In general, their overall perception is that the learning environment is an helpful and interesting innovation for them. Both the RME course and the web site materials that perceived to be relevant to their needs as a student teacher.

Table 2. *Participant's perceptions to the learning environment*

Overall perception to the learning environment	N	Mean	S.d.	Max.	Min.
Helpful for me as a math student teacher	8	4.9	0.35	5	4
Rich with new math information	8	4.6	0.52	5	4
Interesting	8	4.6	0.52	5	4
Educative	8	4.1	0.35	5	4
Consistent with the needs	8	4.0	0.53	5	3

Note: 5 = highly positive, 1 = highly negative

Result 2:

What is the practicality of the third prototype of the learning environment?

Based on the data from the questionnaire, interviews and reflective journals, the third prototype of learning environment seems to be practical for student teachers (easy to use, helpful, easy to understand and the content is consistent with the school curriculum).

However, there are several comments from users which suggest some parts of the web site need to be improved such to add more topics on RME materials and more example of RME problems.

Result 3:

What knowledge and skills did participants learn after using the learning environment?

In order to answer this question four kind of results are used. First of all, the assessment of the understanding of student teachers of the RME theory. All participants were able to describe the philosophy of RME, its principles and its characteristics. It was important for them to gain this understanding before they dealt with the materials and how to use them in the classroom. Second, based on the analysis of the preparation plans it may be concluded that the student teachers were able to design the materials based on the RME tenets, of course, with support from the developer (such as a number of ready made lessons and guidelines how to make them). Then, the teaching skills of student teachers were observed by the researcher both in the simulated situation and in the real classroom. An overall impression was that they were able to teach using realistic materials. They used their knowledge from the course such as how to starting the lesson, making groups of student, guiding group and class discussions and closing the lesson. However, they also met several problems such as how to motivate the students to get involved in the discussion and how to conclude the lesson.

Finally, the reflections of the student teachers during the seminar were observed and discussed. Here they invited to present their experiences in front of the teacher educators and the researcher. In this activity the researcher was able to observe and discuss the performance of the student teachers with regard to their knowledge of RME theory, their attitudes and their skills related to RME.

CONCLUSION

Based on the results of the formative evaluation of the RME learning environment section it can be concluded that:

- the learning environment was perceived to be an interesting program by student teachers in teacher education in Bandung.

- the web site as a part of learning environment was judged to be practical by student teachers
- student teachers gained the following knowledge and skills:
 - how to use e-mail facilities for communicating with peers or other users
 - how to access or retrieve data from web site or internet
 - background theory of RME and its materials
 - how to redesign RME materials
 - how to use RME materials in the real classroom and
 - how to assess pupils during and after each lesson.

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