

Designing, evaluating and implementing an innovative learning environment for supporting mathematics education reform in Indonesia: The CASCADE-IMEI study

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This paper reports on results of the final phase of a four-year study called CASCADE-IMEI. The project aims at designing, evaluating and implementing a learning environment (LE) which intends to introduce Realistic Mathematics Education (RME) to (prospective) mathematics teachers in Indonesia. This paper, first, describes mathematics education reform in Indonesia since Soeharto's regime was destroyed in 1998. Then, the background of the RME theory and the description of the learning environment are presented. Finally, the tentative changes on student teachers and pupils with regard to the concept of 'democracy classroom' will be presented as the starting point for discussing in the conference.

Background and theoretical framework

There is no doubt that democratic live in Indonesia is freely growing since Soeharto's regime (1966-1998) was destroyed mainly by students from all educational levels in 1998. Contrary to the social-political situation during that time period, society can for instance, freely communicate their opinions with regard to the government regulations in daily newspapers, students from all educational levels as well as their teachers can join a demonstration in the streets asking the government to add educational budget for improving the quality of education, senators can interrupt or even disagree with the Presidential programs. As a result of the latter example of democracy live, Indonesia has changed two Presidents during the last three years. Nevertheless, this way of live only belongs to the society out of schools not (yet) to students in the classrooms. "Education for all" or "Mathematics for all" which is declared by the new Indonesian Ministry of National Education is still merely a slogan. Therefore, it is a big challenge for Indonesian government to engage (mathematics) education with democracy as one of a political action by considering four key notions of socio-cultural democracy, that is: collectivity, transformation, deliberation and coflection, through reform either in the classroom, schools or society (Skovsmose & Valero, 2001).

Up to now, the teaching process in mathematics classrooms is still conducted with a traditional (or mechanistic) approach. Teachers actively explain the material, provide examples and exercises, whereas the students act like machines, they listen, write and perform the tasks initiated by the teacher. Group or whole class discussions are seldom present and interaction as well as communication is often missing. Likewise, mathematical goals and curriculum materials used in the classrooms are still based on ‘mathematician’ mathematics not on student mathematics with a focus on real life application (Lange, 2001). This is in contrary to the needs of the information society in which mathematics literacy is an important goal. In summary, it is clear that goals, content and teaching and learning approaches in the mathematics classroom need to be reformed.

Since the last three years, this study is tied to the current reform of mathematics education in Indonesia. In an attempt to combat the low achievement in mathematics of students on national exams, the Indonesian government has attempted to identify probable reasons for this problem. Research cites various causes, including inaccurate learning materials, inadequate mechanistic teaching methods, poor forms of assessment and the anxiety of students to mathematics. One of the promising approaches toward the teaching and learning of mathematics that is thought to address the problems is realistic mathematics education (RME). RME is a theory of teaching and learning mathematics that has been developed in the Netherlands since the early 70's (cf. de Lange, 1987; Freudenthal, 1991; Gravemeijer, 1994). The philosophy of RME is mostly determined by Freudenthal's view on mathematics. 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, especially in this project, both in developing the course materials and the web site.

Contrary to the current mathematics education in Indonesia, RME uses realistic and interdisciplinary materials as a source as well as a starting point for mathematics teaching. Its accompanying teaching approach represents democratic forms of interaction through discussions, and its assessment accepts all strategies in the form of free contributions or productions of all students. These principles of RME are relevant with respect to the aim of engaging mathematics education to democracy (Skovsmose & Valero, 2000).

Description of the learning environment and research methodology

The CASCADE-IMEI study aims to introduce RME to (prospective) mathematics teachers in teacher education in Bandung, Indonesia by developing a learning environment in the form of a face-to-face RME course and web site support. The RME course is a part of the learning environment that is developed in order to make (prospective) mathematics 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 the RME approach in the classroom; and (4) learning how to assess the pupils in the RME classroom. The web site, <http://www.clix.to/zulkardi> is developed in order to support the course participants in a sustainable way. In order to do so, the following options are available: *online Info-base or task, online Tutor, online Talk, and online Test*.

Research phases

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 phase and assessment phase. In this paper the focus is on the research process in which the prototypes of the learning environment were designed and evaluated in the Netherlands and in Indonesia.

Participants

In Indonesia, the main participants of the formative evaluation cycles of the learning environment were 27 (prospective) mathematics teachers at the Department of Mathematics Education, the Indonesian Educational University in Bandung.

Procedure

The course was implemented in the teacher education institute within a time frame of three to five blocks of four-hours. The course started by giving the participants information about the basic principles of RME and its characteristics. Then some examples of realistic mathematics problems were given and discussed in groups so they got the idea of each characteristic of RME. Next, they were given a number of RME problems in various topics (such as linear equation system, symmetry, side seeing, statistics and matrices). 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. Finally, at the end of the course they were tested to see their performance in solving the problems. In addition, they were followed when they implemented the RME lessons in school classrooms. These activities took the longer time of the research period. They developed the lesson materials in collaboration with the researcher. The researcher observed their lessons. Moreover, during the

whole program, they used the web site as a support system either for information resources, learning facilities and communication tools.

Results and discussions

We present tentative results of the project as follows:

- Changes in (prospective) mathematics teachers as well as pupils in schools in Bandung reflected in their attitude to RME have shown that democracy has been accessed not only in the teacher education organization but also in the school classrooms.
- Changes in (prospective) mathematics teachers in Bandung reflected in their knowledge to RME have shown that the gap between theory and the school practice, in this context, has been reduced.
- The learning environment (the web site) has shown a positive effect to the mathematics society in Indonesia in anticipating the 'fourth world' or globalization era (Skovsmose & Valero, 2000, pp. 23).

However, these tentative changes have only been found mainly in the research locations of the CASCADE-IMEI study in Bandung. As Indonesia is a big country with about 200 million people, of course, the issues of scaling up and dissemination become of paramount importance. In this process we need to learn from experiences of in mathematics education in Indonesia and in other regions all over the world.

During the conference we will discuss as well as argue on our experiences in implementing RME as a "European approach" to the Indonesian context especially on the following points:

- How we read RME approach when seen from an Indonesian perspective?
- What problems that we encountered during the adaptation process of RME in Indonesia?
- Examples of the tentative changes that the project has helped bringing democracy in teacher education organization and also in the school classroom.
- How the process of RME happen in the frame of the CASCADE-IMEI project connected with the initial formulation of a desire of democratization through education?
- What the role of the CASCADE-IMEI project can play in the issues of scaling up and dissemination of RME in Indonesia in next coming years?

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