CASCADE-IMEI: An ongoing study in the field of reform in Mathematics Education using Web technology in Indonesia

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Abstract

CASCADE-IMEI stands for Computer Assisted Curriculum Analysis, Design and Evaluation for Innovation in Mathematics Education in Indonesia. The main purpose of this four-year study (a dissertation project at the University of Twente) is to develop a rich learning environment in the form of a Web site and a face-to-face for mathematics student teachers in Indonesia learning Realistic Mathematics Education (RME) as an innovation. In order to reach that aims, development research method is used. While the development part which focus on the design and development of RME materials, the course and the Web site, the research part focus on the formative evaluation activities which are conducted in the UPI Bandung. Up to the end of second cyclic of the research, the CASCADE-IMEI has been proved effectively at least in the first three out of five of effectiveness scales (reaction, knowledge, performance, impact and achievement).

Keywords: Mathematics education, Learning environment, Web, Realistic Mathematics Education (RME)

Introduction

Based on the literature review in the preliminary study of CASCADE-IMEI, mathematics education in Indonesia especially in the secondary level need to be improved or reformed. Why? One of the reason is told by the expert that mathematics education is changing continuously. It can be seen by a movement from traditional curricula to problem oriented curricula or application based curricula (de Lange et al. 1993). Such change or reform in mathematics education can also be seen as a shift away from the transmission of knowledge by teachers towards investigation, construction and discourse (Gravemeijer, 1997). This reform is mostly influenced by changes in ideas on goals, content and the theory for learning and teaching of mathematics.

Concerning the *goals*, there is a growing emphasis on the usefulness of mathematics in daily practice. This trend is fostered by societal changes. The coming information society poses new demands to the citizens as 'mathematical literacy'. Nowadays, goals of mathematics education in Indonesia only focus on the low-level (procedural and algorithm) instead of higher level (problem solving, communication, development of critical attitude and mathematizing). These societal changes also have their influence on

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the *content* of mathematics education in terms of reconsideration of what it means to know and do mathematics. The contents of mathematics education in Indonesia merely focus on product-oriented (on the solution) less on the process how to get the product (process-oriented). The notion of mastery rules and procedures of mathematics is being exchanged for the idea that students should have a deep understanding of their mathematics and should be able to explain and justify it. Furthermore, mathematics teaching learning approach in Indonesia is categorized into the mechanistic-structuralist approach. While many countries already change their approach from mechanistic-structuralistic to the new approach, realistic approach (RME), it is clear that in Indonesia mathematics education need to be changed as well.

The CASCADE-IMEI study

The CASCADE-IMEI study will result in a product in the form of a web-based system as well as a face-to-face RME course and directions for design and development of such products. It combines a preliminary study and formative research study stage of development research. In doing these types of development research, several activities are to be carried out.

In the preliminary study two main activities are conducted in order to get insight in the foundation as well as the basic concepts of the actual CASCADE-IMEI study. First, a literature review is performed on the concepts of curriculum development, computer supported curriculum development, EPSSs and realistic mathematics education. Second, a preliminary prototype of CASCADE-MEI system is designed and evaluated.

In the formative study there will be two phases: a prototyping phase and an assessment phase. In the prototyping phase two prototypes of the RME course and three prototypes of the Web site will be developed. While course will be resulted in the paper-based, the web site will resulted in the form of paper- based, first web-based and second web-based prototypes. Each prototype will be developed and subsequently evaluated by target users and experts. Finally, in the assessment stage, the final version of CASCADE-IMEI system, RME course and the Web site will be evaluated.

The quality criteria the system

In order to develop an effective system, the emphasis for quality during development process is usually shifting from validity, to practicality, to effectiveness. The system and the course should meet these quality criteria in order to be categorized as being a high-quality system. These criteria are (Nieveen, 1997; 1999):

- validity: system should be designed based on the state-of-the-art knowledge and should be internally consistent between its components;
- practicality: system should meet the needs and contextual constraints of the users (and other experts). In this case student teachers able to use the system in a practical way. In addition to the course, student teachers should easily to follow and to understand the course ; and
- effectiveness: the system and the course should be consistent to the intended aims, helping student teachers in Indonesia learning RME as an innovation in mathematics education in Indonesia.

Components of the CASCADE-IMEI system

During design and development, the following three key components of the system should be focused on: content, support and user interface.

1. Content

The content of the CASCADE-IMEI system is the conceptualization of realistic mathematics education. The philosophy of RME is based on the ideas of Freudenthal (1991) that mathematics should be seen 'as human activity' and it should be 'connected to real situations of the students. The characteristics of this theory are summarized in five tenets of RME (Treffers, 1987; Streefland, 1991; de Lange 1987):

- The use of contextual problems: contextual problems did not figure just as applications, but also as starting points for mathematical (didactical) activity and reflection.
- The use of models: paradigmatic models, schemes, diagrams, ….., were the vehicles of progressive mathematization (didactization).

- The use of student contribution: teacher students were encouraged to decisively influence the teaching learning process via their own constructions and own productions.
- Interactivity: Explicit negotiation, intervention, discussion, cooperation and evaluation were key elements that carried the potential to influence each student's teacher learning path as well as the whole teaching learning process.
- Intertwining among strands: Learning strands were intertwined and the long-term learning process was taken in to account.

2. Support

In order to inspire student teachers to learn about RME and on how to implement the RME materials in the classroom, support elements are designed and integrated in the rich environment for active learning system. These elements are categorized as follows (see figure #):

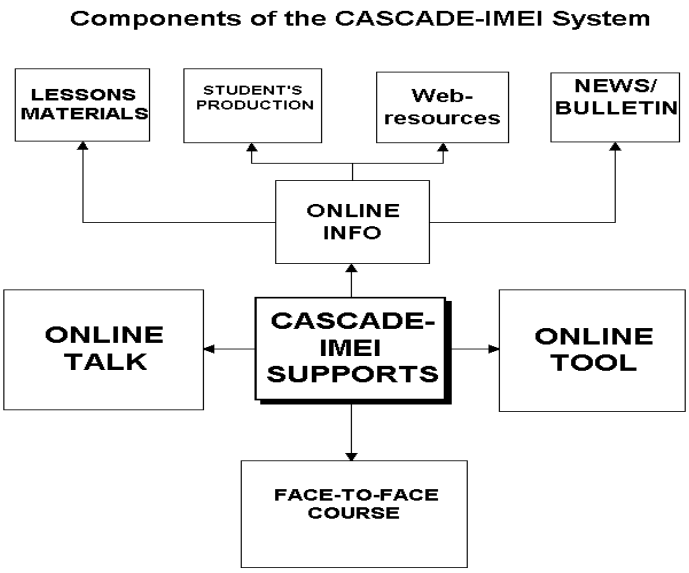


Figure # The components of CASCADE-IME learning environment

- *Online Info*. The online info contains:

a) a number of topics of exemplary RME materials in the form of student materials;
b) teacher guide; and assessment materials;
c) students production from the RME classroom as a result of the cyclic prototyping stages;
d) web resources that relate to RME such as Java applet, small computer programs for simulation and links to the mathematics teaching strategies; and
e) news or bulletin board.

- *Online Tool*. A number of tools for users that can be facilitated by the Web such as links to the site that contains as free e-mails facilities and free mathematics software, search engines, templates for writing feedback, calculators, graphics and so forth.
- *Online talk*. One-way communication or asynchronously discussion area using e-mail and newsgroups as well as the capability to meet synchronously using eGroups Chat.
- *Face-to-face course***.** A face-to-face course which is developed in order to make student teacher understand what RME. The content of this course including overview of the RME characteristics, RME materials, RME didactics and RME assessment and how to utilizes the Web site of CASCADE-IMEI. This course can be a preparation course before student teachers teach in the school practice. In the future, it can be used as an elective course in the department mathematics education in Teacher Training in Indonesia both in the undergraduate and graduate level.

3. User interface

This component bridges the user and the content as well as the support of the system. The 'accessory' of the Web as a learning environment should be user friendly. A number of system are used for designing and developing the CASCADE-IMEI system such as programming language (HTML, Java script and Java applet), graphics program, and word processor.

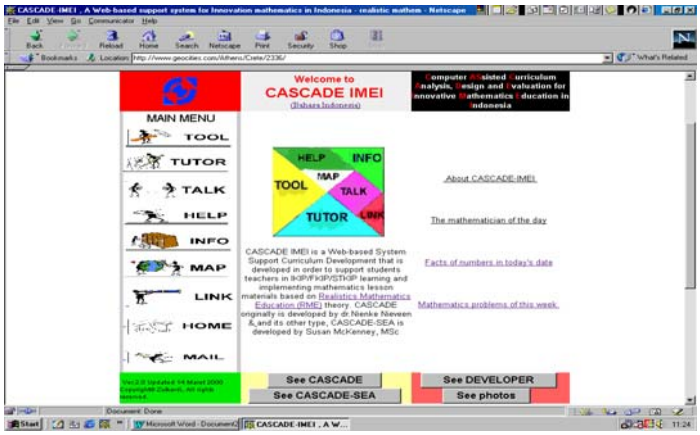
Methodology

This study is guided by the Development Research method. In this case, the learning environment system is developed in the Netherlands and it is researched or implemented to the mathematics student teacher in Teacher Education in Indonesia.

Subjects of the CASCADE-IMEI study are mathematics student teachers at the University of Educational Indonesia in Bandung (UPI Bandung). Two groups of student teachers are involved: about 40 third-year pre service students, students who are not have teaching experience and about 30 in-service students, teachers who are working on their bachelor degree. To the both groups, the RME course are given. Finally, ten students are chosen from the former group and four students from the latter. With this working groups, the course and the web site are formatively evaluated in the number of cycles.

Tentative Result

A number of mathematics lessons have been developed and researched as well as the Web site and the course. These tentative result can be seen in the CASCADE-IMEI web site (see figure below) that is placed in DIKTI homepage (http://www.dikti.org) in the 'inisiatif civitas academica' part of the Higher Education page.



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