CHAPTER 2
CONCEPTUAL FRAMEWORK AND PROBLEM ANALYSIS

The previous chapter introduced the background of the CASCADE-IMEI study, that aimed to develop and evaluate a learning environment in order to assist student teachers in UPI Bandung learning RME as a new approach for mathematics education. This chapter presents the conceptual framework and problem analysis of the study. It reviews relevant literature and the connections to the Indonesian context. First, section 2.1 explains the concept of curriculum and its connection to the context of junior secondary mathematics in Indonesia. Section 2.2 discusses the concept of RME including its theoretical background, its materials, its teaching approach and its assessment. Section 2.3 presents the concept of curriculum implementation and its strategies. Section 2.4 describes the process of student teacher learning in pre-service mathematics teacher education in Indonesia, as well as the more general process of teacher learning. Next, the principle of web-based performance support systems is discussed in section 2.5. The chapter concludes by offering tentative implications for the learning environment to be developed.

2.1 THE CURRENT MATHEMATICS CURRICULUM IN INDONESIA

The purpose of this study was to assist student teachers in learning RME, which includes how to develop RME lesson plans and materials and how to implement these in the classroom practice. Hence, the concept of curriculum is important. The next sections elaborate on the concept of curriculum as relates it to the junior secondary school mathematics curriculum in Indonesia.

2.1.1 Concept of curriculum

The basic working definition of curriculum used here is that of curriculum as 'a plan for learning' (cf. Taba, 1968; van den Akker, 1998). The plan can be found at different levels of various educational settings. At the micro level (classroom), the
curriculum refers to a plan for concrete instructional activities. At the meso level (school or institutional) it refers to a course or an educational program and at the macro level it is used to indicate a more general curricular framework for a district, province or nation.

For the discussion on curriculum development and implementation, it is helpful to use the representations of the curriculum according to the typology as proposed by Goodlad, et al. (1979) and adapted by van den Akker (1998). These include: ideal curriculum, the original assumptions and intentions of the designer; formal curriculum, the concrete curriculum documents, such as student materials and teacher guides; perceived curriculum, the curriculum as interpreted by teachers; operational curriculum, the actual instructional process as realized in the classroom (also referred to as curriculum-in-action or the enacted curriculum); experiential curriculum, the curriculum as it is experienced by the pupils; and attained curriculum, the learning outcomes of the pupils. In some studies the term intended curriculum is used, which refers to a combination of the ideal and formal curriculum while implemented curriculum refers to a combination of the perceived and the operational curriculum. This typology (cf. van den Akker, 1998; Ottevanger, 2001) has proven to be helpful in understanding the relationships and discrepancies between different representations of the curriculum in practice. This typology will be elaborated in the next section by taking mathematics curriculum at the junior secondary school level as an example.

Also, a curriculum can be characterized as being ‘site specific’ or ‘generic’ (cf. Marsh & Willis, 1995). In cases where the target group of a curriculum is small and homogenous and all persons involved (such as pupils, trainees or developers) are in relatively close proximity to each other and know each other quite well, one can speak of a site-specific curriculum. On the contrary, a generic curriculum is developed for a large and diverse target group and the physical distance between the participants is usually great. Finally, Marsh and Willis define curriculum development as a collective and intentional process or activity considered to be beneficial for curriculum change.

2.1.2 Analysis of the current mathematics curriculum in Indonesia

This study assists student teachers in learning to teach mathematics on the level of
junior secondary school. Consequently, it is important to first discuss the current junior secondary mathematics curriculum in Indonesia's schools. The Goodlad's typology that was introduced in the former section was used as an analysis framework. The curriculum was taken from the Curriculum Implementation Guide (MONE, 1993) as a part of the national curriculum.

**Ideal curriculum**

The ideal curriculum contains the original assumptions and intentions of the designer, or goals for all topics to be learned by pupils in the school. According to MONE (1993), the goals of mathematics education curriculum in the junior secondary mathematics are that pupils:

- can use the concepts, identify symbols and facts and recognize the elements in the topics;
- can solve problems in the topics, and are able to apply the learned approaches in other subjects and everyday live;
- have the knowledge concerning geometry in one, two and three dimension; can use mathematical concepts to communicate ideas and data, and are able to interpret the meaning of statistics;
- have a critical attitude, are open, are consistent and appreciate mathematics; and
- start understanding mathematics deductively, which can give rise to a systematic way of thinking.

**Formal curriculum**

This type of curriculum represents the concrete curriculum materials, such as student materials and teacher guides, that are developed based on the ideal curriculum. The strands in junior secondary school include: arithmetic, algebra, geometry, trigonometry, probability and statistics. For each topic, information is provided on the depth and breadth of treatment, as well as its goals. Regions, schools or teachers who need materials other than the minimal materials are required to develop them themselves. In this guide, the term materials means the main content of curriculum or student materials (for all pupils) and enrichment materials (for high achieving pupils only). Use of the minimal materials is also suggested for the remedial teaching of the weaker pupils. However, as Somerset (1997) and Suryanto (1996) reported, the current materials lack quality and have
been designed with a mechanistic approach in mind, i.e. one that stresses drill and practice. The books are more product-oriented then process-oriented. In addition, the lesson materials contain only learner materials; teacher guides are lacking. Therefore, the goals of the ideal curriculum (such as: pupils can use mathematical concepts to communicate ideas, pupils have a critical attitude, are open to and appreciative of mathematics) are far from achieved. The gap between the ideal curriculum and the formal curriculum of mathematics in junior secondary schools is broad, indeed.

**Perceived curriculum**

This type of curriculum relates to the curriculum as it interpreted by the teachers in the schools. In the national curriculum (*MONE*, 1993), it is presumed that teachers should design and develop lesson preparations in the form of a year-plan, quarterly plan and daily lesson plans. These plans are critical since not all learners have their own textbooks. However, due to a lack of quality materials and the lack accompanying instructor’s guides, it becomes the teacher's responsibility to arrange all requirements in the lesson plan (*Somerset*, 1997; *Suryanto*, 1996). Hence, most teachers do not clearly understand what the intended means. Some teachers perceived that the goal of mathematics education is simply to prepare their pupils to answer the questions or mathematics tasks found in the textbooks or in the national exams.

**Operational curriculum**

This type of curriculum refers to the approach chosen by the teacher to make pupils active in the learning process. It relates to the use of teaching methods and assessment strategies. The curriculum guide (*MONE*, 1993) suggested that the role of teachers is to teach the pupils and to help them understand the mathematics tasks. Teachers are supposed to use teaching strategies that will inspire active involvement of their pupils. Yet, according to Marsigit (2000), teachers mostly use the common, traditional, expository teaching method (that they learned in teacher education). This method usually consists of the following steps:

- teacher starts the class by explaining a mathematics rule of a mathematics topic;
- teacher then presents an example on how to use the rule in solving a mathematical task from the textbook;
• teacher calls some pupils forward to solve some mathematical tasks from the
textbook in the front of the class;
• the remaining tasks are assigned as homework; and
• teacher closes the lesson by giving summary.

In conducting the assessment, moreover, the curriculum explicitly suggests that
teachers use mathematics tasks that invite divergent answers, such as open-ended
problems that can be solved by more than one strategy. But in most cases,
teachers were unable to follow this suggestion since the textbooks do not provide
these kinds of examples. Hence, there is a discrepancy between the formal
curriculum and the operational curriculum. Teachers need to be supplied with
exemplary materials with open-ended problems, or need to learn to construct
these materials themselves. Furthermore, the curriculum guide (MONE, 1993)
suggested that the methods used for teaching mathematics should be adapted to
the characteristics of the concepts, strands, topics and the cognitive development
of the pupils. Nevertheless, as has been extensively discussed in the Indonesia’s
newspaper, most teachers focus almost exclusively on teaching how to solve the
specific mathematics tasks most likely to be found in the national examination.
Therefore, their approach doesn’t even attempt to foster true understanding of the
mathematics concepts.

**Experiential curriculum**

This type of curriculum refers to the way that curriculum materials and
instructional processes influence pupils' learning of mathematics in the classroom.
Suryanto (1996) reported that the mathematics curriculum materials in the junior
secondary level are lacking practical applications. This problem is also found in
the primary schools. Hence, because the concepts are not experientially real to
them, pupils perceive mathematics as a very abstract and thus a difficult subject
compared to others. Besides, since the instructional process most often in use
does not move the pupils to activity, they remain passive (Marpaung, 1995).

**Attained curriculum**

The attained curriculum (or learning outcomes of the pupils in mathematics)
mainly refers to students' achievements and attitudes. It is mentioned in the
curriculum guide (MONE, 1993) that in order to determine the achievement of the
pupils, teachers should evaluate the pupil both during and at the end of the instructional process. However, based on the reports of Somerset (1997) and Suryanto (1996), most teachers do not focus on the formative evaluation (during the instructional process), but focus only on the summative evaluation (at the end). Therefore, measurements of the learning outcomes of pupils place emphasis on the cognitive part of the learning outcome. Changes in attitudes are not taken into consideration as learning outcomes. Furthermore, the MONE curriculum (1993) suggests that teachers should provide enrichment materials for pupils who want to deepen their knowledge of mathematics and remedial teaching for those who have difficulty in learning mathematics. However, very few teachers have sufficient time to conduct these kinds of activities in addition to their normal teaching responsibilities. The number of hours spent by teachers on instructional time in Indonesian junior secondary schools (including mathematics) is categorized at the highest level in the world (Mullis et al., 2000) – that is ranked 3rd of 38 countries. Hence, the gap between weak and the smart pupils tends to remain or even grow.

Based on the analysis of the mathematics curriculum for the Indonesian junior secondary level, it can be concluded that there are large disconnects between the intended and the implemented curriculum, as well as between the implemented and the learned curriculum (experiential and attained curriculum). This also means that there is a gap between the ideal mathematics curriculum and the attained curriculum of the pupils. In order to reduce that gap it is important to focus on the intermediate stage of curriculum - the implemented curriculum (Ottevanger, 2001) - since this stage may have the greatest influence on closing the gap.

As stated in Chapter 1, there were three issues in secondary mathematics education in Indonesia, namely: quality of curriculum materials, teaching methods and assessment strategies. This means there is a gap between the intended curriculum and the implemented curriculum. This study intends to investigate how the gap between the intended and the implemented curriculum can be reduced by introducing RME.


2.2 UNDERSTANDING RME

This section explains the theoretical background of RME. First, the underlying philosophy and the five tenets of RME are given. Then, the concepts of RME curriculum materials and RME exemplary lesson materials are presented.

2.2.1 Philosophy and characteristics of RME

As a theory of teaching and learning in mathematics education, RME has its own philosophy and characteristics. It encompasses views on what mathematics is, how pupils learn mathematics, and how mathematics should be taught. This theory is strongly influenced by Hans Freudenthal's concept of 'mathematics as a human activity' (Freudenthal, 1991). According to Freudenthal, pupils should not be treated as passive recipients of ready-made mathematics, but rather that education should guide the pupils towards using opportunities to discover and reinvent mathematics by doing it themselves.

The characteristics of RME can historically be related to the levels that Van Hiele distinguished in learning mathematics (cf. de Lange, 1996): (1) pupils reach the first level of thinking as soon as they can manipulate the known characteristics of a pattern that is familiar to them; (2) as soon as they learn to manipulate the interrelatedness of the characteristics they will have reached the second level; (3) they will reach the third level of thinking when they start manipulating the intrinsic characteristics of relations. Traditional instruction is inclined to start at the second or third level, while realistic instruction starts from the first level. In order to start at the first level - the one that deals with phenomena that are familiar to the pupils - Freudenthal's didactical phenomenology that learning should start from a meaningful contextual problem, is used. Furthermore, by guided reinvention through progressive mathematization, pupils are guided didactically to progress efficiently from one level to another level of thinking through mathematization.

The combination of Van Hiele's three levels, Freudenthal's didactical phenomenology and Treffer's progressive mathematization (Treffer, 1991) result in the five characteristics (tenets) of RME (de Lange, 1987; Gravemeijer, 1994):

- the use of contexts in phenomenological exploration;
- the use of models or bridging by vertical instruments;
• the use of pupils’ own creations and contributions;
• the interactive character of the teaching process or interactivity; and
• the intertwining of various mathematics strands or units.

These characteristics can be used as a study guideline not only in the process of adapting RME curriculum materials to the Indonesian context, but also in the process of pre-service training for student teachers in teacher education. Each of the following sub-sections briefly describes a single characteristic.

**The use of contexts in phenomenological exploration**

In RME, the starting point of mathematics instruction should be experientially real to the student, allowing them to become immediately engaged in the contextual situation. This means that instruction should not start with the formal system. The phenomena by which mathematics concepts appear in reality should be the source of concept formation. The process of extracting the appropriate mathematical concept from a concrete situation is described by de Lange (1987) as conceptual mathematization. This process forces pupils to: explore the situation; find and identify the relevant mathematical elements; schematize and visualize in order to discover patterns; and develop a model resulting in a mathematical concept. By a process of reflecting and generalizing, the pupils will develop a more complete concept. It is then expected that the pupils will subsequently apply mathematical concepts to other aspects of their daily life, and by so doing, reinforce and strengthen the concept. This process is called applied mathematization (see Figure 2.1).

![Figure 2.1 Conceptual and applied mathematization (de Lange, 1996)](image-url)
The use of models or bridging by vertical instruments

The term model refers to situational models and mathematical models that are developed by the pupils themselves. First, the model is a model of a situation that is familiar to the pupils. By a process of generalizing and formalizing, the model eventually becomes an entity on its own. It then becomes possible to use this entity as a model for mathematical reasoning. Four levels of models in learning and teaching RME are described below (see also Figure 2.2):

- the situational level, where domain-specific, situational knowledge and strategies are used within the context of the situation;
- referential level or the level ‘model of’, where models and strategies refer to the situation described in the problem;
- general level or the level ‘model for’, where a mathematical focus on strategies dominates over the reference to the context; and
- formal level of mathematics, where one works with conventional procedures and notations.

As an example from Gravemeijer (1994), in the first level, long division is associated with real-life activities such sharing sweets among children. Here, the pupils bring in their situational knowledge and intuitive strategies and apply them in the situation. The second level is entered when the same division of sweets is presented as a written task and the division is modeled with paper and pencil. Then, the focus is shifted towards strategies from a mathematical point of view. Now, the pupil is just dealing with the numbers, without thinking of the situation. Finally, the fourth level would be composed of the standard written algorithm for
long division. This example shows how self-developed (or emergent) models of the pupils serve to bridge the gap between informal and formal knowledge (Gravemeijer, 1994).

**The use of pupils own creations and contributions**

Pupils should be asked to create concrete things. By making 'free production', pupils are forced to reflect on the their learning process. According to Streefland (1991), pupils show greater initiative when they are encouraged to construct and produce their own solutions. In addition, free productions can form an essential part of assessment. For example, pupils may be asked to write an essay, to do an experiment, to collect data and draw conclusions, to design exercises that can be used in a test, or to design a test for other pupils in the classroom.

**The interactive character of the teaching process or interactivity**

Interaction between pupils and between pupils and teachers is an essential part in RME instructional processes. Explicit negotiation, intervention, discussion, cooperation and evaluation are essential elements in a constructive learning process in which the students' informal methods are used as a vehicle to attain the formal ones. In this interactive instruction, pupils are engaged in explaining, justifying, agreeing and disagreeing, questioning alternatives and reflecting. For instance, pupils are encouraged to discuss their strategies and to verify their own thinking rather than focusing on whether they have the right answer. Such activities can enable pupils to depend less on the teacher to tell them whether they are right or wrong. Hence, the pupils find opportunities to develop confidence in using mathematics.

**The intertwining of various learning strands or units**

In RME, the integration of mathematical strands or units is essential. It is often called the holistic approach, which incorporates applications, and implies that learning strands should not be dealt with as separate and distinct entities. Instead, an intertwining of learning strands is exploited in solving real life problems. One of the reasons that student have such difficulty applying mathematics is that it is taught 'vertically'—that is, with the various subjects being taught separately, neglecting the cross-connections. In practical applications, one usually needs more than algebra alone or geometry alone.
The five characteristics or tenets of RME are used as a guideline in designing curriculum materials.

2.2.2 Designing RME curriculum materials

In order to design or redesign curriculum materials based on the realistic approach, they should represent the five characteristics of RME. Streefland (1991) developed realistic mathematics lesson materials (fractions in elementary school) using three levels of construction: the classroom level, the course level and the theoretical level.

The classroom level

At this level, instructional activities are designed based on all the characteristics of RME. Open material is introduced into the learning situation and opportunity is provided for carrying out free production. Then, characteristics of RME are applied to the lesson by:

- situating the intended material in reality which serves as source and as area of application, starting from meaningful contexts having the potential to produce mathematical material;
- intertwining with other strands or units such as fractions and proportions;
- producing tools in the form of symbols, diagrams and situation or context models during the learning process through collaborative effort;
- learning through construction is carried out by arranging student activities, so they can interact with each other, discuss, negotiate, and collaborate; and
- encouraging pupils to follow this kind of constructional activity by giving them an assignment that leads to free productions.

In summary, Figure 2.3 shows how all the characteristics of RME are pictured in a model for designing RME curriculum materials.
Course level
This level is also called the level of the instructional sequence. The materials constructed at the classroom level are now used according to their mathematical and didactical essence in order to shape the general outline of the course. At this level, after the materials from the classroom levels were tried out and revised, they are expanded to other contents and contexts in order to develop the instructional sequence of that topic. This means the measures taken to achieve contributions to the learning process at the local level must be continued at the general level.

Theoretical level
All activities that took place in both preceding levels, such as design and development, didactical reflection, and trying out in the classroom, form the source of theoretical production - the generative material for this level. Here, a theory in the form of a local theory for a specific area of learning is constructed, revised and tested again during additional cyclic developments.

The CASCADE-IMEI study focused on the classroom level, in which the exemplary lesson materials for some mathematics topics from the available realistic mathematics books were adapted to the Indonesian culture. The process of adaptation of these materials will be elaborated in Section 2.5.4.

2.2.3 RME exemplary lesson materials
RME exemplary lesson materials refer to learner materials and teacher guides. They can be used as a learning trajectory for teachers in the RME classrooms.
They usually consist of the following main components: content materials, learner and teacher activities, and assessment.

**Content materials**

RME materials are associated with real-life activities where domain-specific, situational knowledge and strategies are used within the context of a genuine situation. A variety of contextual problems are integrated in the curriculum right from the start. But, the sequence of the contextual problems has to guide pupils to the mastery of a mathematical concept. Furthermore, the difficulty level of the contextual problems should be appropriate for the goals of the particular mathematics topic. De Lange (1995) characterized three levels of goals in mathematics education: lower level, middle level, and higher order level. In the traditional program, the goals were classified as lower level goals that are based on formula skills, simple algorithms and definitions. In RME, goals also include 'middle' and 'higher' level goals. At the middle level, connections are made between the different tools of the lower level and the underlying concepts. It may not be clear in which strand the operations take place, but simple problems have to be solved without unique strategies. Moreover, the new goals also emphasize reasoning skills, communication and the development of a critical attitude. These are called 'higher order' thinking skills. In general, RME developers need to find contextual problems that allow for a wide variety of solution procedures – preferably those which, considered together, already indicate a possible learning process through a process of progressive mathematization.

**Activities: The role of the teacher and pupils.**

The role of the RME teacher in the classroom are (de Lange, 1996; Gravemeijer, 1994): a facilitator, an organizer, a guide and an evaluator. Generally, the roles of RME teachers can be seen from the following common teaching-learning processes:

1. Facilitate pupils with a contextual problem that relates to the topic as the starting point.
2. During an interaction activity, give the pupils a hint, for instance by drawing a table on the board, guiding the pupils individually or in a small group in case they need help.
3. Let the pupils find their own solution. This means that pupils are free to make discoveries at their own level, to build on their own experiential knowledge,
and perform shortcuts at their own pace.

4. Organize and stimulate the pupils to compare their solutions in a class discussion. Ask the pupils to communicate, argue and justify their solutions. The discussion refers to the interpretation of the situation sketched in the contextual problem and also to focus on the adequacy and the efficiency of various solution procedures.

5. Give other contextual problems.

The role of pupils in RME classroom is mostly that they work individually or in a group, they are active and should be more or less independent, they can not turn to the teacher for validation of their answers or for directions or for a standard solution procedure, and they are asked to produce free creations or contributions.

**Assessment**

In RME, the assessment functions not only in the margin of instruction, but it is also an integral part of the instructional process (de Lange, 1995; Van den Heuvel-Panhuizen, 1996). Ideally, during assessment activities, pupils can show their abilities to solve problems using different strategies. Moreover, through interactive discussions during the learning process, they can learn different strategies developed by other pupils. The strategies used by pupils can be good feedback for the teachers in order to improve the next lesson. In addition, pupils learn to use various strategies for solving problems during the exams.

De Lange (1995) formulated the following five guiding principles of assessment in RME:

1. The primary purpose of testing is to improve learning and teaching. This means that assessment should take place during the teaching-learning process in addition to at the end of a unit or course.

2. Methods of assessment should enable the pupils to demonstrate what they know rather than what they do not know. Assessment can be conducted by using problems that have multiple solutions and can be approached using multiple strategies.

3. Assessment should operationalize all of the goals of mathematics education: lower, middle and higher order thinking level.

4. The quality of mathematics assessment is not determined by its accessibility to
objective scoring. For that reason, the use of objective tests and mechanical tests should be eschewed in favor of assessments in which we can see whether pupils truly understand the mathematical concepts involved.

5. The assessment tools should be practical, fit into the usual school practice.

Assessment can be conducted in the classroom using strategies both during the interaction process (formative), and products of their solutions (summative). In RME, both the process and product are considered important. Hence, these two assessment strategies should be applied in tandem when developing assessment materials.

In summary, the characteristics of RME curriculum materials, described above, are assumed to be better aligned with the intended Indonesian mathematics curriculum as compared with the current mathematics education – especially in junior secondary education. Hence, introducing RME in mathematics education in Indonesia might reduce the gap between the intended and the implemented curriculum, or even between the intended and the learned curriculum.

2.3 CURRICULUM IMPLEMENTATION

As mentioned in Chapter 1, in order to introduce RME in Indonesia, some good implementation strategies are needed. This section presents the strategies for implementing the new curriculum.

2.3.1 Concept of curriculum implementation

Curriculum implementation can be defined as the translation of the intended curriculum into the operational curriculum, i.e. the classroom practice. Implementation is often presented as the second phase in a three-phase model of change: initiation, implementation and continuation (or institutionalization) (Fullan, 2001). Initiation is the process that leads up to and includes a decision to adopt or proceed with a change. In developing countries such as Indonesia, change programs are often initiated centrally, driven by political factors and by external agencies - especially if these agencies also provide funding for such programs. Implementation or initial use is the process that involves the first experiences of attempting to put an idea or reform into practice. Continuation or
institutionalization refers to whether the change gets built in as an ongoing part of the system or the normal practice of an institution or a school, or disappears, such as by way of an explicit decision to discontinue the change or through attrition. A continuation requires successful implementation and needs to be planned for and given ample attention during the implementation phase.

### 2.3.2 Strategies in curriculum implementation

Three strategies are often used when implementing an innovation in schools, that is: treating teachers as learners, using exemplary curriculum materials and learning by designing. Each of these strategies is briefly discussed below.

**Treating teachers as learners**

The teacher has a key role in the implementation of a curriculum innovation in the classroom (van den Akker, 1998). Putting a new curriculum into practice requires teachers to learn new roles. According to Fullan (2001), this requires a change in their beliefs, teaching approach and use of materials. Therefore, curriculum reform can be seen as a learning process for teachers. They are required to use new or revised materials and to make use of new teaching methods. In addition, in many cases curriculum reform will involve a change in teachers' beliefs about student learning. Professional development during the implementation of curriculum reform is therefore important.

Comiti and Ball (1996) suggested that pre-service teacher education must recognize student teachers as learners. They must have a chance to experience new approaches and to master new content in order to learn some important aspects of that approach. Also, they should be able to reflect with colleagues and others on what happens in the classroom. Peer collaboration can play an important role in this process (Thijs, 1999).

**Initial use of exemplary lesson materials**

Exemplary lesson materials can contribute to the additional support for teachers during an implementation process. Such materials are useful for teachers if they contain many so-called procedural specifications, which are very clear and specific directions for use, including instructional and technical guidelines. These directions for use should focus particularly on essential, yet vulnerable elements of
the curriculum innovation (van den Akker, 1998). From an implementation perspective, exemplary lesson materials can be seen as materials for teachers that serve as a catalyst for curriculum implementation (van den Akker, 1998; Ottevanger, 2001).

Furthermore, Ball and Cohen (1996) state that exemplary curriculum materials can better contribute to professional practice when they are created with closer attention to the process of curriculum enactment. A curriculum enactment is constructed jointly by teachers, students and materials in particular contexts, even if it seems to be only a partial reconstruction of supplied materials. Materials could be designed to place teachers in the center of curriculum construction and make teachers' learning central to efforts to improve education, without requiring heroic assumptions about each teacher's capacity as an original designer of curriculum.

As teachers enact curriculum in and with their classes, they work across five domains:

- teachers are influenced by the trajectory of their learning of the content, what they think about their students, about what students bring to instruction, and students' likely ideas about the content;
- teachers work with their own understanding of the material, which shapes their interpretations of what the central ideas are, and how to respond to students' ideas;
- teachers fashion the materials for students, choose tasks or models, and navigate instructional resources such as textbooks in order to design instruction;
- teachers must manage the classroom interaction in such a way as to increase the intellectual and social environment of the class; and
- teachers are influenced by their views of the broader community and contexts in which they work.

Functions of exemplary lesson materials were differentiated by van den Akker (1998): helping to create an image regarding the lesson organization; providing teachers with aids to realize an effective lesson in accordance with the initial intentions of the designer(s); and stimulating reflection on the teachers' roles and stimulation of any possible adaptations of the teachers' attitudes towards the
innovation. These functions should be represented both in the learner materials and in the teacher guide.

**Learning by designing**

After being treated as learners and having gained experience with the use of exemplary lesson materials, teachers may be involved in redesigning curriculum materials that they can use in their teaching practice. Wiggins and McTighe (1998) pointed out that in order to make learners fully understand what they are learning, they should be asked not only to explain and interpret, but also to apply their knowledge and skills by using and adapting what they know into different contexts. Before teachers teach a mathematics topic in the classroom, they have to consider the learning goal, the learning activities and the thinking and learning in which the pupils might be engaged. All of these aspects are brought together in a lesson plan. Simon (1995) refers to this plan as being a "hypothetical learning trajectory". Simon calls the learning trajectory hypothetical because the actual learning trajectory is still not known before the real instructional activities are carried out. Then, after the plan has been used in the classroom, it can be revised for use in the next subsequent lesson. This strategy shows similarities to one of the tenets of the RME: that learners need to be invited to reflect on what they have learned, by for example, designing exercises or mathematical problems that can be used in a test of for other pupils in the classroom.

Based on this line of reasoning, Gravemeijer and Cobb (2001) suggest lending support to teachers by creating a resource of exemplary lesson materials as a starting point, so they can redesign these materials to suit the specific needs of their situation. Moreover, Seegers and Gravemeijer (1997) suggest that the support for teachers in implementing the RME curriculum covers not only the content of the instruction (sequences of materials) but also the development of micro-didactic knowledge or the nature of instructional practice that deals with the character of the teaching/learning process. They argued that it is only on this micro-didactic level that beliefs may play an important role.

In this study, these strategies are used and integrated in the process of supporting student teachers in learning how to teach with a RME approach in the context of pre-service teacher education.


2.4 Teacher learning in pre-service education

This section describes processes and problems of pre-service mathematics teachers learning to teach for the first time according to a new approach. First, an elaboration on the concept of learning to teach is given. Then, the current practice in pre-service education in Indonesia is presented.

2.4.1 Pre-service Mathematics teachers learning to teach

In this context, learning means learning to teach while using new teaching methods in the classroom. According to Borko and Putnam (1996), learning to teach is a complex process. Novice teachers must learn multiple sets of knowledge, skills and attitudes in order to be well prepared to enter the teaching profession. They must learn enough classroom management skills to maintain order in a classroom, and to keep students motivated and productively engaged. They must learn about the subject matter that they will have to teach, as well as about their pupils and how they learn, and so on. Moreover, Arends (1994) pointed out that learning to teach can be seen as a process in which development progresses rather systematically through stages. An opportunity for growth can fail to yield fruit unless appropriate experiences occur.

Basically, new teachers have three types of concerns when in the process of learning to teach (Arends, 1994; Borko & Putnam, 1996). First, personal factors refer to the concern about their own personal survival when new teachers have their first classroom experiences. They worry about their interpersonal adequacy and whether or not their pupils and their supervisor respect and like them. Also, they worry about the adequacy of their content knowledge, pedagogical knowledge and beliefs required for teaching for understanding in ways that are currently advocated in the educational community. Secondly, beginning teachers have concerns about the teaching situation in the schools. Those aspects can include: too many students, inappropriate teaching materials, teaching method and assessment strategies. Finally, beginning teachers have concerns about their pupils. In this stage, they reach for higher-level issues and start asking questions about the social and emotional needs of pupils, being fair, and the match between the teaching strategies and materials.
2.4.2 Mathematics pre-service teacher education in Indonesia

The current Indonesian pre-service teacher education uses the curriculum from 1991. In the department of mathematics education, courses are categorized into four types (see also Table 2.1): (1) foundation of education studies or general education including theory of education, management of education as well as guidance and counseling; (2) subject matter studies or content mathematics courses such as Geometry, Calculus, Algebra, Statistics and Computation mathematics; (3) professional studies or method courses such as teaching approaches, development of teaching preparation, seminars in mathematics education, secondary education curricula and assessments; and (4) teaching practice as well as research or a final project in mathematics education. These categories are consistent with Ben-Peretz’s (1994) conclusion about teacher education curricula in the world, that most of them are categorized in four types: foundation of education studies, subject matter studies, method courses and teaching practice.

<table>
<thead>
<tr>
<th>Year / Course</th>
<th>Foundation</th>
<th>Content</th>
<th>Method</th>
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Practice in laboratory schools plays an important role in pre-service mathematics teacher education. It is usually conducted in one of two ways, either in the method courses or in teaching practice. In the method courses, student teachers perform both as curriculum developers and as teachers. They have to prepare the instructional activities along the traditional stages of curriculum development, that is: defining objectives, selecting content and learning experiences, choosing appropriate methods and classroom organization, gathering or developing the necessary materials, and making decisions about formative and summative evaluation. Then, they perform as teachers, trying out the materials using the new teaching methods in classroom practice. At the end of the course, they have to make a report and present it in front of their colleagues and teacher educators. Similar activities are carried out in the final year, when they are doing practice
teaching. In this time, student teachers also perform both as curriculum developers and as teachers, during which they have to develop their curriculum materials, implement them in the classroom and reflect on their experiences. These kinds of curriculum development activities (preparing lessons and accompanying materials, carrying out those plans and reflecting on what occurred) can increase the professional growth of student teachers (cf. McKenney, 2001).

Yet, the issue remains that pre-service mathematics teachers in Indonesia do not receive adequate preparation for their teaching practice. This could be caused by some obstacles that are often discussed among teacher educators. First, student teachers do not have enough resources for learning to teach, such as method books, lesson examples or electronic tools (e.g. video). Second, they have only limited time allotted for learning how to teach, since they also have to follow other courses that do not deal with teaching mathematics. Finally, they do not get a good teaching model from the method courses. Teacher educators often focus on the theoretical part but less on practical aspects. It is also mentioned by Borko and Putnam that teacher educators place greater emphasis on facts and procedures than on understanding the disciplines they need for teaching.

In conclusion, it is clearly understood that learning to teach using a new approach is not an easy task for student teachers. They have to master a set of skills related to the content to be taught, how pupils learn and how to teach. Besides, they have to learn how to develop their instructional activities and to teach using a new teaching method in the classroom practice. Therefore, the current approaches used in Indonesian teacher education could be improved upon in order to address these complexities in a better way.

2.5 Supporting Student Teachers in Learning RME

As discussed in the previous section, learning to teach is no easy task for mathematics student teachers in Indonesia. On the one hand, they have to perform both as curriculum developers and as teachers. Sometimes, they also have to perform as researchers in the seminar or the final project courses. On the other hand, they have only limited time and teaching resources. The situation becomes more complicated when they learn to teach with a new method such as
RME. As a new approach in Indonesia, there are no books, papers or other materials related to RME. It is assumed that these obstacles cannot be overcome by a short pre-service course. Hence, it is assumed in this study that a learning environment is needed in which student teachers can learn not only the theory of RME, but also the skills relating to how to use that knowledge in redesigning their own materials, and to teach using these materials in the classroom. The next section discusses the concept of the learning environment and the way this concept is applied in this study.

2.5.1 Learning environment

In general, a learning environment (LE) is a place where learning occurs. Wilson (1996) defines a 'constructivist' learning environment as a place where learners may work together and support each other as they use a variety of tools and information resources in their pursuit of learning goals and problem solving activities. He states that at a minimum, an LE contains: the learner and a setting or a space in which the learner acts using tools and devices, collecting and interpreting information, interacting with others, etc.

Moreover, Perkin (1991) makes a distinction between 'minimalist' and 'rich' LES:

- 'Minimalist' or 'traditional' LES emphasize information banks or sources of information (e.g. textbooks, videotapes), symbol pads or surfaces for the construction and manipulation of symbols and texts (e.g. drawing programs, word processors, databases); task managers - elements of the environment that set tasks, provide guidance, feedback and changes in direction (such as teacher, student, and computer-based instruction programs).
- 'Rich' or 'constructivist' LES contain more: construction kits or areas for presenting, observing and manipulating less natural phenomena (e.g. simulation programs and games); and phenomenaria, or areas for presenting, observing and manipulating natural phenomena (e.g. teaching simulation, teaching practice); as well as place more control of the environment in the hands of the learners themselves. Students in constructivist LES are typically engaged in multiple activities in pursuit of multiple goals, with the teacher serving the role of guide and facilitator. An example of a constructivist or rich LE is called a REAL (rich learning environment for active learning) (Grabinger, 1996). A REAL is one attempt to bring together thoughts, ideas and theories in
a way that will help teachers at all levels to develop classroom environments that foster higher-level thinking skills - especially reflection, problem solving, flexible thinking and creativity.

Finally, Wilson (1996) categorized LEs into three types.

- **Computer-based LE** such as computer microworlds. In these microworlds, students "enter" a self-contained computer-based environment to learn. These microworlds may be supported by a larger classroom environment, but may also stand alone.

- **Classroom-based LE**. In many settings, the classroom is thought of as the primary learning environment. Various technologies may function as tools to support classroom learning activities. An example of a classroom-based environment is Grabinger's (1996) Rich Environments for Active Learning (REALs).

- **Virtual LEs** that make use of the Internet. Some computer-based learning environments are relatively open systems, allowing interactions and encounters with other participants, resources and representations. In a virtual environment, students interact primarily with other networked participants, and with widely disseminated information tools. Open, virtual environments have tremendous potential for learning, but they carry their own set of design challenges and concerns.

The last two types of LE are used in this study, that is the RME course (classroom-based LE) and the web support (virtual LE).

### 2.5.2 Classroom-based learning environment (RME course)

As described in section 2.3.1 and 2.3.2, learning to teach using a new approach is not an easy task. It requires learning the approach not only theoretically, but also practically. The learners need an environment in which they can practice how to prepare teaching materials, how to use the materials, how to manage the classroom, how to deal with pupils, etc. Hence, it is important to provide such a classroom-based environment (e.g. RME course) that could assist student teachers in their learning.

In so doing, Borko and Putnam (1996) summarized their analysis results of facilitating teachers' learning to teach into five features that can contribute to successful learning opportunities for new teachers. These are:
1. addressing teachers' pre-existing knowledge and beliefs about teaching, learning, learners and subject matter;
2. providing teachers with sustained opportunities to deepen and expand their knowledge of subject matter;
3. treating teachers as learners in a manner consistent with the program's vision of how teachers should treat students as learners;
4. grounding teachers' learning and reflection in classroom practice; and
5. offering ample time and support for reflection, collaboration, and continued learning.

Points 3 and 4 are similar to the second strategy of the curriculum implementation (see also section 2.3.2). All points could be provided by a classroom-based learning environment (either in teacher education or school classroom).

In addition to these features, Comiti and Ball (1996), who organized their research about preparing teachers on three teacher education institutions in Germany, France, and the USA, suggest three ways of helping teachers to teach mathematics in pre-service teacher education:

1. help student teachers to learn all mathematics approaches and their views of how mathematics is taught and learned;
2. help student teachers to learn about pupils' mathematical thinking, and how to teach mathematics while taking into account the pupils' ability; constructing learning situations that give meaning to mathematical subjects; and
3. coach student teachers in developing their capacity to learn, in thinking about their actions and thereby transforming them, in thinking about what they wanted to do and what they actually did, thinking about their practice, and becoming able to search for and use resources.

The first two points are related to the first implementation strategy (see also section 2.3.2), i.e. that student teachers should have the learners role so they could learn both the materials and experience how to teach with those materials. In addition, the third point is similar to the second implementation strategy or the use of exemplary lesson materials.

In the context of RME, Goffree and Oonk (1999) reported that training for
developing RME teachers in the Netherlands should be based on the theory of RME itself. This is in line with Borko and Putnam's (1996), Comity and Ball (1996) and first strategy of the curriculum implementation (see also section 2.3.2) that student teachers should be treated as learners. During the time in which the student teachers learn RME, their learning process in the course should be analogous with mathematics learning of pupils in the classroom. The training has some main steps:

1. Use of real contexts. Give student teachers concrete situations and familiar contexts as a starting point of the training (the first characteristics of RME) so they are directly engaged and come up with their own informal solutions, which are affected by their earlier experiences with learning mathematics and teaching mathematics.

2. Mathematising and didactising. Guide student teachers by using sequences of problems into the process of both mathematising and didactising.

3. Reflection. Ask student teachers to carry out mathematical activities appropriate for pupils' ability levels, and then reflect on and discuss the results in small groups with their peers. These reflective discussions create a foundation for learning how to work with pupils. Reflections on childrens' learning process combined with the student teachers' own experiences in learning mathematics contribute to the creation of an educational basis for teaching mathematics to pupils. During this process, student teachers work with pupils and study their learning process while continually referring back to their own learning process.

During the training, student teachers not only learn how to mathematize but also how to didactize. While the former is related to the materials, the latter is related to the teaching/learning process, which Gravemeijer (1997) calls micro-didactic knowledge.

Finally, regarding the structure of the mathematics education course for student teachers, the suggestions given by Selter (1997, 2001) can be used. He suggests including four important sessions in teacher education, including sessions on:

1. understanding the new approach by providing a theoretical overview and by actually doing mathematics (the mathematical component);

2. designing instructional materials (the didactical component);
3. managing the new situation in the classroom during teaching practice (the practical component); and
4. understanding the ways that pupils learn mathematics in the school classrooms (the assessment or psychological component).

These four components are used in the RME course or the classroom-based learning environment. The course is mainly supported by another environment – that is a virtual environment or web support. The next section elaborates the web support and its development guidelines.

2.5.3 Virtual learning environment (web support)

It is assumed in this study that a web-based support tool can play a valuable role in improving the performance of student teachers in learning and teaching RME, and that such a tool can be used by mathematics student teachers in the long term.

Web-based support tools are strongly related to the domain of electronic performance support systems (EPSSs). As briefly discussed in the section 1.3.2, an EPSS is an electronic system that provides performance support such as information, advice, learning opportunities and tools to its users (Gery, 1991; Nieveen, 1997; Stevens & Stevens, 1995). The purpose of an EPSS is to support the performance of a job or task. In this study, the system aims to support the performance of mathematics student teachers learning and teaching using the RME approach.

In order to achieve this goal, the EPSSs include components which should be ideally available on demand at any time, any place, and regardless of the situation. An EPSS typically includes some or all of the following five components (Gery, 1991; Raybould, 1995):

1. Tools – referring to external applications that can help users carry out tasks, such as calculator, forms, templates, etc.
2. Information – referring to electronic access to reference information, which remains the same for various users.
3. Learning/ training opportunities – referring to embedded programs such as interactive tutorials and multimedia (e.g. video clips) used to improve learners’ or teachers’ knowledge and skills.
4. Advice – referring to heuristic and dynamic support materials, which are provided based on users' specific needs or questions.
5. Communication aids – referring to support for sharing knowledge with others or for using the mailing list in which they can communicate with each other.

A web-based EPSS is an EPSS that uses the Internet as its delivery platform. These EPSSs provide: (1) information and resources that can be accessed by users from all over the world and (2) tools for communication and exchange of ideas using e-mail facilities and newsgroups (Khan, 1997).

Generally, developing a system on the web offers distinct advantages. First, a large amount of resources are readily available. There are vast amounts of information online that can be repackaged and linked to the system’s users. Second, the web provides a system that can be reached by a large population. In addition, it offers the ability to easily update and add information without huge investments in time and resources (unlike republishing and distributing printed materials). Moreover, the web with its graphics and hyperlinks is fairly intuitive to use. Ease of use is important since many target users are not proficient web users or even computer users. Finally, the web offers communication capabilities such as e-mail and mailing lists. Web browsers often contain a built in set of tools that can be used for communication.

These advantages seem to match the needs of student teachers in Indonesia, which is a big country with a large and dispersed population. This means that developing web support for mathematics student teachers in Indonesian teacher education may provide an added value to the future of mathematics education in Indonesia. Hence, it is seen as worthwhile for the CASCADE-IMEI study to design and develop a web support system in addition to the RME course, in order to help mathematics student teachers in Indonesian teacher education in learning RME as a new approach in mathematics education.

Based on the five common components of an EPSS and studies of Kirkley and Duffy (1997), Khan (1997), Nieveen (1997), and Winnips (2001), several tentative guidelines for the support of the web site were formulated (see table 2.2).
Table 2.2 Guidelines for support offered via the web

<table>
<thead>
<tr>
<th>EPSS Components</th>
<th>Support offer by the LE</th>
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<tbody>
<tr>
<td><strong>Tools</strong></td>
<td>support users in performing their tasks in learning RME. For instance, tools can support student teachers in learning how to redesign RME lesson materials in order to meet their immediate teaching needs.</td>
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</tbody>
</table>
| **Information** | - provides general information about RME that is needed by users.  
  - includes web addresses (URLs) that consist of information that strongly relates to the job of mathematics student teachers. |
| **Training**    | provides opportunities for the users to learn how to teach RME in the classroom. |
| **Advice**      | provides facilities in such a way that student teachers can learn how to use the web site, how to deal with new concepts by asking questions directly to the developer, or by looking up a new RME term in a glossary. |
| **Communication** | provides users with some tools for communication and discussion. |

The interface of the web site should be designed: to accommodate users so they can easily access the support components on the web; to be user-friendly; and to easily navigate around the web. Table 2.3 summarizes the guidelines for the user interface of the web site (Khan, 1997; Winnips, 2001). They are categorized into four parts: general, content, navigation and lay out.
Table 2.3 Guidelines for the user interface of the web site

<table>
<thead>
<tr>
<th>General</th>
<th>The web-based LE should be:</th>
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<tr>
<td></td>
<td>• flexible, by the fact that one of the advantages of the web site is that the content can be constantly updated;</td>
</tr>
<tr>
<td></td>
<td>• simple in the use of colors, text and navigation; and</td>
</tr>
<tr>
<td></td>
<td>• consistent when using the graphics and text.</td>
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| Content | • The content of a site should be appropriate for its intended users. Appropriate relates not only to the material itself, but also to the way in which it is expressed. |
|         | • The web page should be designed for transmission of information in both directions. |

| Navigation | • Place navigational buttons on the same location on the screen throughout a program, so that the user can always find them in the same place. |
|            | • Don’t let the user get lost in the information; a web page should contain no more than two to three screens worth of information. |
|            | • Make sure the users have a good overview of the structure of a site, so that they can easily find their way to what they want. |
|            | • Keep the users oriented by using the logo on each page. |
|            | • Menus lose their value if they don’t carry at least four or five links; text or list-based menu pages can easily carry a dozen links without overwhelming the user or forcing users to scroll through long lists. |

| Layout | • Choose background and text so that there is enough contrast. |
|        | • Be consistent in the style of graphics used in a product. |
|        | • Set as few heading styles and subtitles as are necessary to organize the content, then use the chosen styles consistently. |
|        | • Use space effectively. |
|        | • Page design in HTML should emphasize the power of hypermedia links to take full advantage of this medium. |
|        | • The page should look attractive and inviting; making a structured pattern can help to accomplish this. |

All of these general guidelines have been and will be used in the design and development of the web support.

2.5.4 RME exemplary lesson materials

Ball and Cohen (1996) pointed out that curriculum materials are extremely important for the student teacher. In everyday teaching practice, curriculum materials are the essential substance of lessons and units, i.e. of what teachers and
Conceptual framework and problem analysis

pupils actually do. Moreover, curriculum materials are agents of instructional improvement. The design and dissemination of curriculum materials is one of the oldest strategies for attempting to influence classroom instruction, either for conventional teaching or as a means to shape what pupils learn. Also, curriculum materials and teachers' guides could support teachers' learning.

RME exemplary lesson materials can be seen as the main materials of the learning environment. The materials may be adapted either from RME books that were developed by Freudenthal Institute experts or from "Mathematics in Context" (MIC) books (mathematics books for student grade 5-8 in the USA). This series of books was developed during a collaborative project between the Freudenthal Institute and University of Wisconsin-Madison. Therefore, it is assumed that the materials are valid from RME theoretical point of view. However, some special alterations are needed before these materials are suitable for the Indonesian context, such as: examples, curriculum level and the number of mathematics problems.

The MIC curriculum materials consist of two parts: student materials and a teacher guide. Basically, the student materials have the same content as the teacher guide except for the following components, which are only found in the teacher guide (Romberg & de Lange, 1998a):

- logistical preparation of lesson such as topic and time;
- explanation of learner activities, goals and concepts addressed in the lesson;
- materials or media that are needed in the lesson such as student activity sheets, student assessment materials, etc.;
- learning trajectory about context used and learning activities;
- learning trajectory about assessment activities;
- alternative solutions of each problem and sample student work;
- explanation of how to execute the lesson for each problem such as grouping, homework and assignments; and
- hints and comments about problems.

In general, the RME exemplary lesson materials may be adapted based on the following guidelines concerning the content, support and organization of the
Conceptual framework and problem analysis

materials (Gravemeijer, 1994; 1997; Romberg & de Lange, 1998a; van den Akker, 1998):

- The content of the RME exemplary lesson materials should be adapted based on the junior secondary mathematics curriculum in Indonesia. The process of adapting materials should be guided by the characteristics of RME.

- The support part of the curriculum materials should consist of procedural specifications or essential characteristics on how to use them. For example, it should consist of concrete suggestions on the role of the teacher during the realization of the lesson. Also, the support should include information on the logistics of lesson preparation, such as what teachers should do before, during and after the lesson.

- The organization of the exemplary materials should help student teachers in putting them to use in the classroom. Preferably, the materials consist of student materials, teacher materials and assessment aids on various topics, parallel with the curriculum being used in schools.

Based on these guidelines, all prototypes of the lesson materials have been adapted and developed. These design guidelines should be taken into account when assisting student teachers to use the materials, to develop lesson materials by adapting the available materials and to implement those materials in classroom practice. The next section synthesizes all ideas and analysis results presented in the previous sections.

2.6 Implications for the Cascade-IMEI Study

This section summarizes the results of the problem analysis and literature study from all earlier sections, culminating in the conceptual framework of the study.

First, as a result of the literature study, there are problems in the secondary mathematics education in Indonesia that are related to the pupils' understanding and attitude towards mathematics. These problems are assumed to be (at least partly) caused by the gap between the intended curriculum and both the implemented curriculum and the learned curriculum. Second, this study intends to investigate how this gap can be narrowed by introducing RME in the secondary schools by mathematics student teachers. However, introducing RME as an
innovation in teacher education in Indonesia is a complex process that involves changes in use of materials, teaching methods and beliefs. Considering the fact that student teachers have no experience concerning the innovation, a learning environment in which they can learn the new theory, new lesson materials and learn how to teach using the new method is assumed to be indispensable. Finally, after student teachers learn RME in the learning environment, they may introduce the new approach in secondary school classrooms leading to better understanding of and attitude towards mathematics.

Figure 2.4 illustrates the conceptual framework of the study. The dashed line shows the main structure of the LE, being composed of three main components: the web support, the exemplary lesson materials and the RME course.

Figure 2.4 Conceptual framework of the CASCADE-IMEI study

First, an RME course should be designed including the following three domains: 1) RME theory, 2) domain knowledge needed for learning to teach in the pre-service education and 3) trends in curriculum implementation strategies. This course is
aimed at assisting student teachers learning RME theoretically and practically. This means that in addition to a theoretical session for learning RME theory, student teachers also have to be engaged in curriculum development activities, such as making teaching preparations, trying them out in the schools, and reflecting on their experiences.

Second, the web site has potential for supporting a pre-service course program. The web site is mainly formed by three concepts: EPSSs, RME theory and teacher learning in teacher education. With RME as the main content, the web should support student teachers learning RME in the context of Indonesian teacher education.

Third, exemplary lesson materials should be adapted based on the RME theory and the junior secondary mathematics curriculum in Indonesia. The process of adaptation should be based on the characteristics of RME. Together with the RME course, it can provide student teachers with an orientation on the RME, demonstrate the essential features of the RME and provide insight in how RME can be used.

In summary, these three main components form the LE of the CASCADE-IMEI study, which is intended to effectively promote pre-service student teachers learning RME as a new theory in teaching and learning in Indonesian teacher education. The next chapter discusses how the LE has been designed and developed using a development research approach.