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  Issues Involved in the Adoption of Realistic Mathematics Education in Indonesian Culture

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Abstract. Research on educational borrowing has been largely concerned with debates on the complexity of transferring educational models and approaches from one culture to another. This study aims to understand the issues involved in the adoption of a Dutch approach to mathematics instruction, Realistic Mathematics Education (RME), in Indonesian culture. The data collected include a questionnaire survey for Indonesian teachers who have been trained for RME implementation, and classroom observations and interviews at three schools in Jakarta. An analysis on how RME is reflected in an Indonesian RME-based textbook was also conducted. The findings show that while there are aspects of RME that can be adopted or adapted in the Indonesian context, many other aspects have been translated differently from what was originally phrased by the Dutch educators. This study discusses some factors that may explain how RME was effectuated in Indonesia, including one from the lens of culture.

Key words: educational borrowing, mathematics education, realistic mathematics education, influence of culture.

INTRODUCTION

In an effort to modernise and improve the educational system, policy makers and educators in many countries look to other countries for educational theories and approaches that are considered as delivering desirable results and try to adopt these practices in their own countries. In recent years, this phenomenon is even more prevalent following the results from international assessments such as TIMSS (Mullis et al., 2016) and PISA (OECD, 2016). Some countries have a tendency to mimic the excellent performers at the top of the league table, in the hope that their students would perform as well as those of their counterparts. Through this process, certain educational approaches, methods, models, theories or policies originally developed in a particular cultural setting are often transferred and applied to another culture (Steiner-Khamsi, 2004).

In response to the increasing trend of educational borrowing, recent research has highlighted that educational methods or approaches may not be universal and may not be easily implemented across all cultures. Even when an educational method is imported to another country that seems to be ready for such implementation, some inconsistencies caused by cultural differences may still exist. This implies that cultural factors play an even more important role when an educational model is transferred to countries with significant cultural differences. The failure to account for the significance of culture and the particular context of the countries involved might result in a ‘false universalism’ (Rose & Mackenzie, 1991).

To understand the extent to which an educational approach may be adopted in a context other than its country of origin, the present research explores the adoption of Realistic Mathematics Education (RME) – a Dutch approach to mathematics instruction – within the Indonesian context. In Indonesia, RME has been adopted through the PMRI project (*Pendidikan Matematika Realistik Indonesia*) since the late 1990s (Sembiring, Hadi & Dolk, 2008). In our earlier works (Revina & Leung, 2019) some features of PMRI classrooms such as methods of interaction, use of problems, and use of models and schemes have been compared to those in the Dutch RME classrooms. Our findings suggest that in order to gain a comprehensive understanding of RME adoption in the Indonesian context, it is important to study the major factors that may influence teachers' enactment of RME at the classroom level, such as teachers' attitudes towards RME, and the textbook that was inspired by the Dutch RME textbooks in its development and utilised by the PMRI schools to supplement the mandatory textbooks provided by the government.

Accordingly, this study addresses the following research questions: (1) In what respect are the RME principles as they were phrased in the Netherlands effectuated in Indonesian mathematics education? (2) What are the factors which may explain the effectuation of RME principles in Indonesia? It is hypothesised that: (1) the RME principles as they were phrased in the Netherlands might not be fully adopted in the Indonesian context. Due to various reasons, some features of RME might need to be adapted in Indonesia or may have departed from the original intentions; (2) factors that may explain how RME is effectuated in Indonesia include factors at the classroom, school education system, and cultural levels. In answering the research questions above, the present study will identify features of RME that are reflected in the PMRI textbooks and are perceived and interpreted by PMRI teachers as indicated in the questionnaire, during interviews and their classroom practice. Potential reasons at classroom, school and education system levels that may explain the findings are discussed. In cases that those factors may not be able to explain the findings adequately, some explanation are offered from a cultural perspective. In this study, culture is defined as the method of thinking, values, norms and beliefs that are related to education and mathematics education that may differ from one education system to another (Leung, Graf & Lopez-Real, 2006). The presupposition is that mathematics education in a particular social environment is influenced by the culture of such environment and may differ across places with different cultural backgrounds.

LITERATURE REVIEW

The Process of Educational Borrowing

In the literature, the term educational borrowing is broadly defined as transplanting, or importing, educational theory or practice that has been developed under a particular context to another context elsewhere (Steiner-Khamsi, 2004). Phillips and Ochs (2003, p.451) suggest that the term ‘borrowing’ can be used, “to cover the whole range of issues relating to how the foreign example is used by policy makers at all stages of the processes of initiating and implementing educational change”. Some research, however, distinguishes between ‘borrowed’ or ‘adoption’, and ‘learned’ from others or ‘adaptation’ practices (de Wet & Wolhuter, 2007).

In research in mathematics education, Atweh and Clarkson (2002) use the term ‘globalisation’ to discuss this educational transfer and borrowed the concept of ‘globalisation from above and below’ to distinguish between ‘adoption’ and ‘adaptation’ practices, as discussed by Falk (1993, cited in Taylor, Rizvi, Lingard & Henry 1997). Globalisation from above was defined as “the collaboration between leading states and the main agents of capital formation. This type of globalisation disseminates a consumerist ethos and draws into its domain transnational business and political elites” (Falk, 1993, cited in Taylor et al., 1997, p.75). On the other hand, globalisation from below “consists of an array of transnational social forces animated by environmental concerns, human rights, hostility to patriarchy and a vision of human community based on the unity of diverse cultures seeking an end to poverty, oppression, humiliation and collective violence” (Falk, 1993, cited in Taylor et al., 1997, p. 75). Atweh and Clarkson (2002) argued that globalisation from above is often associated with adoption, copying, or importation of a foreign practice that may include some international aid projects. On the other hand, globalisation from below is often associated with adaptation, in which a certain educational concept is translated differently depending on local traditions and interpretations (Atweh & Clarkson, 2002).

In relation to the present study, while one may see the transfer of RME to other contexts as a copying or adoption practice, some scholars may find the term 'adoption' to be inappropriate. Therefore, this study is sensitive to both adoption and adaption of RME in Indonesia. The present study focuses on identifying the degree of adoption of RME in Indonesia, and the adaptations that have been made by local educators and policy makers. This unified approach was selected to understand the extent to which RME ideas can be accepted and integrated into various aspects of mathematics education in Indonesia, as well as identify those aspects that have changed through the transfer process. The section that follow discusses the key principles that characterise RME.

Realistic Mathematics Education

According to Gravemeijer and Terwel (2000), the RME approach to mathematics teaching and learning is greatly influenced by Freudenthal's idea of mathematics as human activity (Freudenthal, 1968), which in turn was known to be influenced by the *Didaktik* philosophy. According to the *Didaktik* philosophy whatever is done or learned is aimed to develop one's individuality, and "to unfold the capabilities of I" (Klafki, 2000). Adopting this idea, RME suggests that students should be given opportunities to construct their own learning through the exploration of their informal knowledge, and then progress to gain a deeper understanding of mathematics. Thus, a learning route or trajectory has to be developed which allows learners to find the intended mathematics for themselves (Freudenthal, 1973). The emphasis is on constructing a learning process that allows learners to also acquire personal knowledge. Therefore, in RME it is not necessary for all learners to learn the same mathematics and reach the same level of development at the same time. Instead, they may have their own route to acquire their personal knowledge (van den Heuvel-Panhuizen & Wijers, 2005).

Van den Heuvel-Panhuizen and Wijers (2005) and Van den Heuvel-Panhuizen and Drijvers (2014) suggested six principles of RME to characterise the approach at the implementation level. The six principles include the Activity principle, Reality principle, Level principle, Intertwinement principle, Interaction principle, and Guidance principle. Van den Heuvel-Panhuizen and Wijers (2005) also discussed how RME differs from the content-based approach.

Reality Principle. This principle is derived from a concept which emphasised that the starting point of learning should be experientially real. According to van den Heuvel-Panhuizen (2000), the word 'real' or 'realistic' here comes from the Dutch word '*zich realiseren*', which means 'to imagine' or 'make real in one's mind'. Teachers may provide learners with contextual situations that are imaginable, and so give them opportunities to explore their informal knowledge within the context. In RME, the conceptual procedures and facts should not precede the contextual problems or real-life examples, a problematic ordering that leads to rote learning which is often used in traditional approaches to teaching and learning mathematics. Moreover, van den Heuvel-Panhuizen and Wijers (2005) suggested that the application problems given must be meaningful, informative, and suitable for mathematisation. The problem might not be solvable if students do not place themselves in the context or if they simply apply a certain fixed procedure.

Level Principle. According to Gravemeijer (1994), there are four levels of 'emergent models' in RME. The label 'emergent' in the 'emergent models' refers to the process by which models emerge within RME-based activities (model *of*), as well as how the models support the emergence of a more formal mathematical knowledge (model *for*). At the situational level, students are expected to use their informal knowledge and intuitive strategies within the context of the problem. At the referential level, students are expected to come up with mathematical symbols or models referring to the real-life situation. At the more general level, students develop models that could be used in different situations. At the formal level, students use their experience with the three previous levels to do reasoning. This is where they are finally ready to work with procedures, algorithms or notations. In a traditional content-based approach, teachers usually teach the algorithm or procedure as something that students have to follow without sufficient exploration at the situational or referential level.

Activity Principle. According to this principle, learners are responsible for acquiring and constructing their personal mathematics knowledge. In RME, learning is facilitated by the individual learner's thought process and that of others. In doing so, teachers are expected to provide appropriate learning environments so that learning is meaningful for students. On the other hand, in the traditional approach, teachers often steer the process in a fixed way or demonstrate what students have to do or learn. In RME, the activities should give opportunities for students to come up with their own construction and production in solving mathematical problems.

Interactivity Principle. In a more traditional classroom discourse, the teacher is expected to ask questions and then ask one student to answer, after which the teacher gives feedback. Classroom interaction in RME is different. The teacher is expected to stimulate students to listen and learn from each other. From this perspective, an answer without an explanation is unacceptable. Differences of opinion are encouraged. This may provide more productive discussion so that students can learn from each other and reflect upon their own answers.

Intertwinement Principle. The Intertwinement principle suggests that contextual situations should involve the application of multiple mathematical concepts. The mathematical domains should not be taught as distinct entities, instead the teaching should incorporate an intertwinement of mathematical domains to give a broader understanding of mathematics to the students. In a content-based approach, mathematics is organised in topics and units rather than as an inter-related concepts.

Guidance Principle. According to the Guidance principle, teachers must anticipate that their guidance does not conflict with the Activity principle. Teachers should actively guide the learning process, but not steer the learning process in a fixed way for all students in a similar manner, which often occurs in a traditional classroom.

METHODS

To understand the extent to which RME was adopted in various aspects of mathematics education in Indonesia, that is to answer our first research question, this study investigated how RME was reflected in the curriculum and textbooks, perceived by the teachers, and enacted at the classrooms. The data collected include primary mathematics curriculum documents and textbooks, questionnaire on teachers' attitudes towards RME, video-taped lessons, and interviews with three teachers. The curriculum materials studied include the current Indonesian primary mathematics curriculum document (KTSP). The textbook studied was for grade one, and the teachers being observed were all teaching grade one too. In this study, the documentary analysis primarily looked at how RME ideas are reflected in the curriculum guideline, and how they are being expressed in the textbooks. This study employs a modified framework by van Zanten and van den Heuvel-Panhuizen (2015) for the analysis of the textbook. The framework has been utilised to analyse some RME and non-RME textbooks in the Netherlands.

To study the teachers' attitudes towards RME, a set of questionnaires was adopted from Verbruggen, Frickel, van Hell and Boswinkel (2007) which investigated Dutch primary school teachers' attitudes towards RME. The questionnaire was developed based on the six principles of RME, with each principle represented by several items. There were 48 items in the questionnaire, and a 5-point Likert scale was used. In the present study, the questionnaire was translated from its original Dutch language into Bahasa Indonesia. The completed questionnaire responses were analysed statistically and exploratory factor analysis was conducted. The factors extracted were compared to the RME principles suggested in the literature to give meaning to them.

The questionnaire was administered to PMRI teachers who had been trained in PMRI-related workshops in twelve big cities in Indonesia. Hadi (2012) reported that there were not less than one thousand teachers who have been trained in PMRI-related workshops all over Indonesia. The authors sent the questionnaires to the PMRI local team in each city and the representatives of the PMRI local team helped out to administer the survey. In total, there were 220 PMRI teachers identified for the survey with 202 teachers agreed to participate in the survey. The teachers were all teaching at PMRI pilot schools that served as laboratorial sites for PMRI research projects and have been engaged in PMRI related activities since its first implantation in the early 2000s. Although they were the PMRI agents, they do not only teach mathematics at school, but also all subjects. Of the 202 teachers, only about 10% had mathematics or mathematics education background. The 202 completed responses were analyzed quantitatively in which exploratory factor analysis was conducted on the 48 items

From the result of the factor analysis, four factors were extracted and labeled as Teacher Intention of Realistic Education (ITN), Guidance (GDN), Students' Self-Development (SDM), and Interactivity (INT) respectively. The reliability of the overall questionnaire and of each factor were also examined. Overall, the Cronbach Alpha is 0.827, while for each factor it is 0.882 for ITN (18 items), 0.819 for GDN (12 items), 0.809 for SDM (11 items), and 0.756 for INT (7 items) respectively. This result show that the reliability of the questionnaire in the present study is slightly lower than that in the original language, but is still deemed to be satisfactory as the Cronbach Alpha > 0.7 (Peterson, 1994).

To study how RME was enacted in the classroom, four consecutive lessons of each of three teachers in Jakarta were recorded. Through observing multiple lessons, what normally happens in a lesson could more likely to be observed. The three schools in Jakarta are all 'A' accredited, which means ‘excellent’ in national standard. Two schools were private schools, and one was a state-funded school. The facilities in the three schools did not differ significantly from one to another, although variations in terms of seating arrangement and class size were apparent. The class sizes were 32, 20 and 43, respectively. By design, all observed lessons covered the topic of addition and subtraction, and the average duration of the lessons was 55 minutes. The medium of instruction was *Bahasa* Indonesia. The classroom observations were supplemented with an interview with each teacher, conducted at the end of the lesson series. This study adapts a coding scheme developed by de Ridder and van Walleghem (2010) that was developed based on the RME tenets to analyse the lessons.

To ensure the reliability and validity of the classroom observation data, inter-rater reliability analysis was conducted for the lesson coding. The first author and a PMRI expert in Jakarta coded three lessons independently and their coding results were compared. Differences and confusion on the coding were addressed through extensive discussion. The descriptions of the codes were further clarified and refined before the lessons were analysed using the final coding. As for the validity of the interview data, the authors applied a member-checks strategy. The teachers read, corrected and commented on the interview transcripts as well as the interpretation made by the authors, and the interpretation of data was adjusted accordingly. This strategy can minimise the bias of the authors’ interpretation.

As for the interview, the questionnaire as well as some selected classroom incidents from the class observation were utilised as a base or the interviewing questions. The interview schedule is a reflection of the characteristics of RME and includes the following topics: (1) The use of the realistic approach; (2) The use of contextual problems; (3) The worked sample questions; (4) The uniform tasks; (5) The interaction between students; and, (6) The content-based approach. The analysis of the interview was aimed primarily at identifying how teachers responded to the questions within the themes.

To answer the second research question, the findings on the implementation of RME in various aspects of mathematics education in Indonesia are then interpreted. The discussion below will start with a summary of the findings, and then the findings will be analyzed and then discussed to seek explanations.

RESULTS

Results of the Curriculum and Textbook Analysis

The Indonesian primary mathematics curriculum suggests contextual problems to be used both as a source of learning and as application of the mathematics content covered. In the PMRI textbook, 22% of the tasks are situated in a real-world context. Yet, the curriculum guideline suggests problem solving as a different competency to be taught at the end of a topic. In relation to the Level principle, the Indonesian curriculum encourages the use of models and schemes when teaching and learning mathematics. Many tasks (35%) in the PMRI textbook are also presented with models or schemes. This can be anticipated since the development of the PMRI textbook was inspired by the Dutch RME-based textbooks. In the PMRI textbook, some schematizations or strategies suggested include empty number line and split table (for number structure) that allow students to use a flexible strategy in doing addition and subtraction. The textbook provides a few tasks that allow students to learn through an ‘own production’ process. However, there is no differentiation in terms of tasks provided for students with different abilities. The Indonesian curriculum also highlights the importance for teachers to guide students to gradually master the mathematical concepts. In the textbooks, this is reflected by many examples provided for students before they have to solve a given task. Although the Indonesian curriculum suggests a topic-based structure, unsurprisingly, the PMRI textbook does not follow this topic-based structure. Rather, it incorporates various mathematical domains into learning units under certain themes, as suggested by RME.

Results of the Teacher Questionnaire

The survey results suggest that Teacher Intention (ITN) has a positive correlation with Students' Self Development (SDM), with r = 0.361. The Guidance (GDN) factor is positively correlated with Interactivity (INT), with r = 0.316. The positive correlation between ITN and SDM means that the higher the commitment of the teacher towards the use of RME in their classroom, the higher their commitment to providing more opportunity for their students to learn within the RME environment. The positive correlation between GDN and INT means that the higher the teacher's commitment to providing appropriate guidance consistent with RME ideas, the higher their commitment to enact the idea of interactive education. The correlation shows that the four factors might not be independent and are actually related to each other.

The results from the teacher questionnaire are summarised in Table 1.

The survey results show that the teachers displayed a high intention to use the RME approach in general, and to use contextual problems in particular. From the results of the survey, it is found that the teachers had the intention to give students opportunities to be active learners, as can be seen from the high mean of the items related to the Activity principle. In the survey, the PMRI teachers actually had a generally low mean score (M = 2.96, SD = 0.57) in items related to the Guidance principle. Within this factor, the items are associated with the teacher's intention to use a standard method, to give rigorous examples, putting a high value on the right answer, to provide tasks in a formal manner, and to direct the lesson strictly. From the survey results, the PMRI teachers actually had moderate scores in items related to the interactivity factor (M = 3.26, SD= 0.57).

Results of the Classroom Observation and Teacher Interview

The results from the classroom observation are displayed in Table 2.

From the classroom observations, four of the twelve PMRI lessons were found to utilise contextual problems as a source of learning, and six out of twelve lessons utilised them as application of the content (see Table 2). But at the same time, ten out of the twelve lessons also provided bare number problems for students. Bare numbers of course may at some point be part of RME. When students have created mathematical meaning, they are ready to work with more formal mathematics in the form of bare number problems. In the PMRI classrooms in our study, however, bare number problems often preceded the contextual problems or real-life examples, a problematic ordering that leads to traditional approaches to teaching and learning mathematics.

In the interview, one teacher mentioned that as most questions in the end-of-semester examinations were in the form of bare number problems, she thought it was useful for the students to have exercise similar to the examination questions. As she said, "I think problems with context are good. It is meaningful. But, I usually give it at the end of a topic. I give a lot of non-contextual tasks for my students as also suggested by the [national] textbook and as presented in the [end-of-semester] exams, if you know." Below are some examples of the contextual problems provided in the classrooms:

"I have 48 straws and my friends have 26 straws. If we combine our straws, how many (straws are there) altogether?"

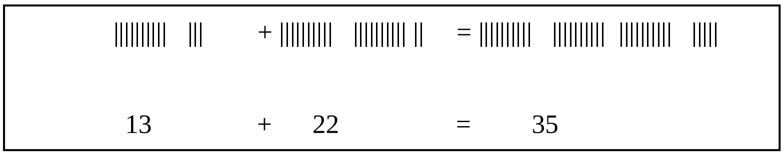
"On the table, there were 15 donuts. Mom put another 9 donuts (on the table). How many donuts are there now?"

"There are 26 star shapes in box 1, and there are 21 star shapes in box 2. How many star shapes (are there) altogether in the two boxes?"

It can be seen from above that the contextual problems provided had one answer and were in the form of 'word problems' as discussed by van den Heuvel-Panhuizen (1996). This kind of problems, in fact, is often presented as application problems in traditional classrooms: "One context can be exchanged for another without substantially altering the problem" (p.20). For instance, the problem involving straws may be replaced by the problem involving donuts, or star-shaped objects. This shows that the Indonesian teachers are still coming to grips with what contextual problems are in the RME context. In the interviews some teachers explained that while they agreed that contextual problems were meaningful, they thought they were too difficult for young students who are still developing their language capabilities. On the other hand, students may not be able to cope with their learning if they are provided a problem with context before the content has been introduced. Without a solid content mastery, it is difficult for students to solve the given problem. As one of the teachers said, “I usually teach all the content first, especially for teaching mathematical operation. Without strong understanding, it is difficult for students to solve problems with context. This is also what the syllabus recommends”.

In the interview, teachers were also found to be in favor of the Level principle of RME. However, during classroom observation, the models utilised were uniform and artificial, and the schemes or methods utilised required students to follow fixed steps closely, resulting in students learning through a single solution method. The teachers did not use any of the schematization suggested by the PMRI textbook. Instead, they simply used ‘straws’ as the models when teaching addition of numbers and then introduced the ‘column method’ (which often appears in a traditional content-based teaching) right after the use of straws. Below is an example:

Teacher put some straws stucked on the board, 13 straws and 22 straws, as visualised below.



T	OK. Now I have some straws in here. How many straws do I have? Let’s count together. Ten…
Ss	Ten, eleven, twelve, thirteen…

T	Thirteen, plus what?
Ss	Twenty
T	Twenty? Let's count together. (her finger pointed to the straws on the board). Ten, twenty…
Ss	Ten, twenty, thirty
T	Thirty?
Ss	Eh, twenty-one, twenty-two
T	Be careful. You have tens and ones, tens and ones. (pointing to the straws that are tied up in tens). If you add them, you put them together. Now, how many ones and how many tens?
Ss	Five
T	Ok. One, two, three, four, five. How many tens?
Ss	Thirty
T	Smart. Let's count together. Ten..
Ss	Twenty, Thirty, Thirty-One, Thirty-two, Thirty-three, Thirty-four, Thirty-five. (teacher was pointing to the straws while guiding students to count on)
T	Actually if you put them together, it will look like this (she drew the tally as representation of the straws on the board). So, how many tens? Added, put together, so again, how many tens?
Ss	Three
T	So, how many ones?
Ss	Five
T	Five. Let's count again. Ten.. (pointing to the straws)
Ss	Twenty, thirty
T	Thirty one (pointing to the straws)…
Ss	Thirty-two, Thirty-three, Thirty-four, Thirty-five
T	Thirty-five. It's like this. So, if you add them together, you have to see how many tens and how many ones. Combine them.

In the excerpt above, the teacher aimed to introduce how to add two numbers using the tens and ones structure. It can be seen that instead of directly telling students how to add the numbers, the teacher first involved her students to count the straws she had on the board, and then make a conclusion on how to do it. Here, the teacher used the straws as the concrete object, and the illustration represents the model *of* the contextual situation which may lead to the use of a model *for* more general counting (i.e., schemes). However, it is not very clear how the model can help the students to count numbers up to 100. She mentioned in the interview that in following this scheme, the students would learn the 'column method'. From the interviews, it is evident that teachers intended to give students a joyful learning experience in their lessons and provide opportunities for students to actively participate in the learning process.

During the observations, as shown in Figure 1, PMRI teachers allocated a significant amount of time for practicing (31.43%). However, the focus of the lessons was mainly on presentation (37.14%), and exploration or 'doing mathematics' activities was barely observed. Furthermore, while this feature of RME suggests teachers to treat students as individuals who are given opportunities to build their personal knowledge, the tasks provided for all students in the classrooms were the same. There was no differentiation of tasks provided for students with different abilities. As one teacher explained, "The tasks are, of course, the same. The textbooks do not [differentiate the task] either. Some students may think that it is unfair (*tidak adil*) if I gave easy questions to others while giving difficult questions to them". Another teacher explained, "In the class, everyone will learn the same thing, the same standard. In our school, teachers have an assistant. In my class, my assistant usually helps the weak students to solve the tasks. But the tasks are the same. The textbooks also do not differentiate tasks for students, right? They may have remedial or enrichment after school, if needed."

While two teachers observed in this study had a high score in items related to Guidance principle, the implementation in the lessons was similar to that of teachers with low scores in the survey. Ten out of the twelve lessons in PMRI classrooms required students to follow teachers' instruction closely, and seven out of the twelve lessons introduced standard methods (see Table 3). For the 'practice' sessions, the teachers were observed to be providing assistance while students were completing the tasks, but the teachers' focus during these contacts was often on checking if students had the correct answer. From the teacher interviews, it is also found that all teachers agreed that working sample problems, or giving examples and solutions, was very important in their mathematics lessons. As one of the teachers said, ”it is important I think to give them examples and more importantly on how to solve it. Without my example, you know, how can they solve the problem?”

In the classrooms, as shown in Figure 2, the method of interaction was mostly in the form of ‘teacher-whole class’ interaction (25.9%), and ‘teacher-individual student’ interaction (30.5%). Students did not show initiative to ask questions or begin a discussion (‘individual student-teacher’ interaction was 0%), and no interaction between the students was observed. From the teacher interview transcripts, it is found that while teachers thought that interaction between students is important, teachers also thought that students are too young and immature to have a discussion, and so this teaching strategy may cause students to distract each other. As one teacher said, “If there is a naughty student in the group, sometimes students fight when they talk to each other. They cannot be quiet. I think later in the upper grades it is possible to have more interaction between students. In these grades, students will also have more hours to learn math, so teachers may have more time for longer discussion.” Another teacher explained, “When I asked the whole class whether they agreed or not with an answer given by a student or a group of students, they usually agreed or simply said the answer was correct. If some students found an answer to be incorrect, they would not point out what is wrong, instead they would give out the correct answer right away. I think my students are not used to giving comments to each other. This aspect may need to be improved in my class.”

The observation results also suggest that PMRI lessons were structured in a topic-based manner, and none of them incorporated connecting mathematical concepts from other units[1].

[1] In Indonesia, in late December 2014, the Ministry of Education suspended implementation of the 2013 curriculum following massive criticisms from teachers on their readiness to implement the curriculum. As a result, in the 2015/2016 academic year, most schools, if not all, implemented the old 2006 KTSP curriculum. In the KTSP curriculum, lessons are structured in a subject-based manner and not in themes as it is in the case of 2013 curriculum. Thus, in teaching mathematics, lessons are taught in units (numbers, geometry, etc).This study was conducted in January-February 2016 and the PMRI schools we contacted were all implementing the 2006 curriculum.

During the interviews, the teachers mentioned that they preferred self-contained units in order to give the opportunity for their students to gain mastery of one unit before they are introduced to another. It was felt that intertwinement of topics might make students confused. One of the teachers explained, “The principle is mathematics is a tool. A student can only solve a problem when they know how to use the tool. They have to master the concept. I will not teach another math topic unless my students have good understanding in the topic they are learning.” Another teacher argued that she tried to comply with the suggestion from the curriculum, as she said “I think it is the standard, as suggested by our curriculum and textbook, teaching mathematics must be in order. Let me give you an example, in grade one students learn place value, then addition and subtraction, then problem solving related to addition and subtraction [word problems]. After this chapter then they will learn about Geometry topics. This cannot be reversed or combined.”

Summary of Major Findings. The major findings in this study are summarised in Table 3.

The above findings show that the Reality principle had been adopted to some extent in Indonesian education, while the Level principle, Activity principle, Guidance principle, and Interactivity principle in RME seemed to be translated differently by the Indonesian teachers and textbook authors. Teachers agreed that those aspects are important in a mathematics lesson but they enacted them differently from what was phrased in RME. As for the Intertwinement principle, while the PMRI textbook has adopted this principle in its content, teachers preferred the content-based lesson that teaches mathematics according to the topics rather than incorporating various topics in one lesson. To understand the reasons that may explain the way RME was effectuated in Indonesia, this study examines factors at the classroom, school and education system levels. In addition, explanation from a cultural perspective is also discussed. It is worthy to note that although this study discusses factors at different levels in Indonesian education, the study does not aim to extend the results to general education in Indonesia, rather, most discussion is only applicable to mathematics education. For example, the use of rigorous examples and fixed procedures may not be found in other subjects such as language or social sciences. However, some findings such as lack of interactions between students or uniform tasks for all students could well be applicable to different subjects and different levels of education in Indonesia, as revealed by previous studies (e.g., Farver et al., 1997).

DISCUSSION

In relation to the adoption and non-adoption of RME principles in Indonesia, this study identifies factors at the classroom, school, education system, and cultural levels. Each of these factors is discussed below.

Factors at the Classroom Level

One of the factors affecting teachers' implementation of RME may be related to their attitudes towards RME and their background. Some teachers may be less enthusiastic about RME than others and this attitude may cause some variations in the enactment of RME. On the other hand, in the Indonesian educational context at primary school level, teachers are generalists and there is little expectation that they should be solidly competent in the subject matter, such as mathematics. Very often, pedagogical skills to deliver the content are considered more important than competencies in the content itself. Thus, while teachers are expected to intertwine various mathematical domains into a meaningful lesson, they may not have adequate knowledge to do so. Consequently, teachers may resort to teaching the lesson by using the available resources that do not adopt the RME Intertwinement principle.

Factors at the School Level

In relation to the findings related to the use of models that are rather uniform, one may argue that this can be explained by the unavailability of teaching resources. The absence of technical supports in Indonesian schools may influence teachers when enacting this aspect of RME as they have to put in more effort, resulting in increasing their already heavy workload.

The availability of teaching aids and resources in schools may also influence how the teachers enacted inquiry learning or provided activities for exploration in their lessons. For example, to enact the idea of using concrete teaching aids in introducing the topic of addition and subtraction, the teachers in Jakarta asked students to bring some bundles of straws by their own. The teachers intended to use the straws as model to help students scaffold their learning. However, as teachers required all students to use the straws in adding the numbers regardless of whether they need them or not, the lesson resulted in the use of a uniform model and an artificial use of the model.

Furthermore, one may argue that the typical large class size in Indonesia would inhibit a teacher from providing individualised learning paths for students with different abilities. It is difficult for a teacher to take care of the progress of students with different abilities in a large class if students are working on different tasks, or following different paths or levels. Policy on class size may sometimes be a school decision, but the limitation comes from the financing by the government. Small classes are obviously more expensive to run than classes with more students. In a country with large population, the solution for Indonesia was for teaching to be conducted in large classes so that more children could receive education.

Factors at the Education System Level

In Indonesia, summative assessment is arranged by the local government in which the items are often presented as simple bare number problems that require a single answer. The teachers in Indonesia might feel the pressure of the need to prepare their students for the examination held by the government, and so provide their students with items that are similar to those found in the examinations. Moreover, teacher's emphasis on teaching the mathematical content and structuring the lessons in working units might be merely an effort to comply with the curriculum suggestions that follow a content-based approach.

Another aspect that might also explain the findings in the present study is the limitation of time. Some teachers might use time constraint as an excuse for the lack of interaction in their classrooms. The total number of hours in the Indonesian school is 26 hours per week, and the Indonesian curriculum only allocates two-three lessons per week to mathematics. The remaining hours are allocated to Indonesian language, art, civic education and religion studies. With this limited time, teachers must focus on delivering the content demanded by the curriculum efficiently, and so may not have time for discussion or group work.

Factors at the Cultural Level

The above discussion showed that some findings might be explained by a combination of factors operating at the classroom, school and education system level. However, some findings could be explained by factors at cultural level as follows.

The argument of class size, for example, fails to explain the phenomenon in one of the observed classrooms. At pointed out above, one of the schools in this study is in a private school with classes of only 20 students, and the teacher was helped by a teaching assistant. But even for this school, the teacher still did not provide individualised learning paths for students with different abilities. More plausible explanations can be offered from a cultural perspective. The preference for uniformity in the Javanese culture may hinder the enactment of individualised learning in PMRI textbooks and classrooms. In the Indonesian culture, the predominant belief of fairness in education means that students should receive the same educational standard (Swadener & Soedjadi, 1988). It is also interesting to note that the feature of providing tasks for students with different levels were not adopted by the PMRI textbook, although this feature was apparent in the Dutch RME textbook that inspired the development of the PMRI textbook. Thus, whereas RME suggests students to be encouraged to learn at their own level, giving tasks of different levels of difficulty during the lesson is seen as inappropriate in Indonesia because this is considered to be unfair for some students, and thus will affect the harmony of the classroom. In the interview, the teachers revealed that they usually would provide remedial or enrichment teaching to some students after school, but not in class, to avoid ‘jealousy’ from other students.

The teachers’ concern on the harmony of the classroom may also explain why horizontal interaction was not observed in the PMRI classrooms. If the teachers have constraint on time allocation so they did not have time for class discussion, why did the teachers in the private schools in this study, with more flexibility in determining school programs and additional hours to mathematics, still did not fully adopt the RME interactivity feature in their classrooms? Again, a cultural explanation is offered below.

From a cultural perspective, indirect communication is preferred among the Indonesian people and this may restrict the take-up of horizontal interaction during classroom discussion. In the interview, one teacher mentioned that the students are not used to giving comments to each other. This is in line with what was observed by Farver et al. (1997) who found that expressing direct opposition is not socially acceptable in Indonesian classrooms. Thus, in cases where children have a different opinion from others, they may want to have a conversation in private, not in public. On the other hand, the Interactivity Principle in RME suggests that students should openly express their opinions, give and receive criticisms from others, and support their explanation with argument and justification. While this feature is in line with the Dutch culture which tends to resolve conflicts by compromise and direct communication, it diverges from the Indonesian-Javanese culture (Koentjaraningrat, 1985; Wiryomartono, 2016; Geertz, 1961).

This expectation for compliance may also cause teachers to have an inappropriate interpretation of how to carry out the Guidance principles in RME. Introducing rigorous examples, fixed procedures and standard methods are not in line with the RME Guidance principle, yet they are seen as important in Indonesian classrooms. In a collectivist society such as Indonesia, where educational practice is heavily centralised, the tendency towards compliant behaviour of the Javanese tradition might explain why teachers' practice seems to be aligned more with suggestions from the curriculum than from RME ideas, regardless of their beliefs towards RME. This compliant behaviour, where teachers tend to follow the suggestions provided by the curriculum and textbook rigorously, may be an asset, but only when the curriculum and textbook structure and contents are in line with the reform ideas. However, when the curriculum and textbook are inconsistent with the reform ideas, they may put the teachers into a problematic situation when they try to implement the reform ideas.

Regarding the teachers' tendency to follow content-based teaching, one may argue that this phenomenon also occurred in non-collectivist nations, such as some European countries, a few decades ago. This perspective may be supported by the fact that RME itself evolved from a reform movement in the late 1960s in reaction to the mechanistic and traditional teaching approach popular during that era. Given that RME has taken root in the Dutch education system after more than forty years since its incarnation, while in the Indonesian system RME has only been implemented it for less than two decades, it is foreseeable that in the coming years Indonesian teachers may enact RME in a similar way to what the Dutch teachers are doing today. In the same spirit, if the mathematics educators in Indonesia also consistently develop PMRI, as the Dutch educators did with RME, someday realistic methods will also be rooted in Indonesian education. However, as we argue elsewhere (Revina & Leung, 2019), and as described by Gravemeijer and Terwel (2000), today's RME is greatly influenced by the *Didaktik* tradition that is rooted in an individualistic society such as the Netherlands and Germany. Thus, when RME is transferred to a system without this tradition, such as Indonesia, it may not develop in a similar manner.

It is not suggested above that the cultural explanation is the only explanation of how RME was effectuated in Indonesia, but any explanations that ignore factors at the cultural level are undoubtedly inadequate. The most probable cause for the findings is probably a combination of cultural and non-cultural factors.

Finally, it is important to note that research shows not all RME principles are perfectly reflected in Dutch math education. For example, van Zanten and van den Heuvel-Panhuizen (2015) reported that most, but not all, of the RME characteristics included in their analysis framework were found to be present in the researched contemporary RME-oriented textbook. While the textbook uses contexts as a source for learning, utilises model and visualization, and makes connections between different mathematical domains, students were hardly invited to choose by themselves what type of calculation to use to solve a problem provided in the textbook. Our earlier findings also show that variations of RME implementation among Dutch classrooms were apparent due to classroom and school factors, but wider gaps were observed between the RME implementation in the Dutch and Indonesian classrooms (Revina & Leung, 2019).

CONCLUSION

This study provides evidence that approaches to mathematics instruction such as RME are not universal to be implemented across all cultures. Findings of this study show that the Reality principle in RME had been adapted to some extent in Indonesian education, while the Level principle, Activity principle, Guidance principle, and Interactivity principle seemed to be translated differently by the Indonesian educators. They agreed that those aspects are important in mathematics lessons but they enacted them differently from what was phrased in RME. As for the Intertwinement principle, while the PMRI textbook has adopted this principle in their content, teachers preferred the content-based lesson that teach mathematics according to the topics rather than incorporating various topics in one lesson.

Factors at classroom, school, education system and cultural levels may explain how RME was effectuated in Indonesia. The study shows that in discussing potential factors that explain the adoption and non-adoption of RME in Indonesia, factors at the cultural level cannot be ignored. The most probable cause for the findings is a combination of both cultural and non-cultural factors. Moreover, it is argued that while the non-cultural aspects may be temporary and changeable, culture is deeply embedded in the everyday life interactions of the teachers, and hence could be more enduring. Hence, the extent to which an educational approach such as RME can really be adapted in a certain culture is likely to be unique rather than universal (Steiner-Khamsi, 2004; Phillips & Ochs, 2003).

It should be pointed out that this study has a number of limitations. The authors understand that careful interpretation of the data is needed when referring to the Indonesian context. The survey in this study was administered to the teachers who had been prepared for RME implementation in twelve big cities in Indonesia, and the interviews and classroom observations only included teachers at three schools in Jakarta. For the survey, only PMRI teachers who were contactable by the PMRI local teams were recruited. The results of the survey may be different if it had involved the uncontactable teachers who might show different enthusiasm towards RME. For the second part of the study, only three cases were used to explore issues relating to the adoption of RME in Indonesia, and so the interview and classroom observation data should be interpreted as such. Furthermore, the interview which supplemented the survey data was only conducted with the teachers whose lessons were observed, due to time and resources constraints. Interviewing more teachers might give additional insight into how the teachers perceive and interpret RME. For the implementation of RME, lessons were was only observed in a lower primary grade. The teachers for this grade mentioned that the students are too young to be taught in a fully RME style (although the RME curriculum is implemented in the Netherlands from kindergarten level, or age of 4-5 years old). Similar research for teachers teaching in higher grades may arrive at different results.

Despite these limitations, as a concluding remark, findings of this study point to the need to look at and reflect on one's own situation in learning from experiences in other countries, rather than simply adopting the practices from the countries concerned. Given that the Indonesian educational context is remarkably different from those in Western cultures, Indonesian educators should be very self-critical and make reference to their own cultural context when identifying what is best for their local conditions.

References

Atweh, B., & Clarkson, P. C. (2002). *Globalisation and mathematics education: From above and below.* Paper presented at annual conference of the Australian Association of Research in Education, Brisbane.

de Ridder, I., & Vanwalleghem, S. (2010). *Realistisch rekenen in de klas. Een studie naar het handelen van leerkrachten in het vierde leerjaar* [*Realistic mathematics education in the classroom. A study of teacher's practice in grade four*] (Unpublished Thesis). Universiteit Gent, The Netherlands.

de Wet, C., & Wolhuter, C. (2007). From 'borrowing' to 'learning' in international comparative study: A critical reflection. *South African Journal of Education*, *27*(2), 317–328.

Farver, J., Welles-Nystrom, B., Frosch, D., Wimbarti, S., & Hoppe-Graff, S. (1997). Toy stories: Aggression in children's narratives in the United States, Sweden, Germany, and Indonesia. *Journal of Cross-Cultural Psychology*, *28* (4), 393-420.

Freudenthal, H. (1968). Why to teach mathematics so as to be useful. *Educational Studies in Mathematics*, *1*, 3-8.

Geertz, H. (1961). *The Javanese family: A study of kinship and socialization.* New York: Free Press of Glencoe.

Gravemeijer, K. (1994). *Developing Realistic Mathematics Education*. Utrecht: CD-ß Press/Freudenthal Institute.

Gravemeijer, K., & Terwel, J. (2000). Hans Freudenthal a mathematician on didactics and curriculum theory. *Journal of Curriculum Studies*, *32*(6), 777-796.

Hadi, S. (2012). *Mathematics Education Reform Movement in Indonesia*. Regular Lecture, ICME-12 Seoul, South Korea.

Klafki, W. ([1958]2000). Didaktik analysis as the core of preparation of instruction. In I. Westbury, S. Hopmann & K. Riquarts (Eds.), *Teaching as a reflective practice: the German Didaktik tradition*. Mahwah, NJ: Lawrence Erlbaum.

Koentjaraningrat, R. (1985). *Javanese Culture*. Singapore: Oxford University Press.

Leung, F. K. S., Graf, K.-D., & Lopez-Real, F. J. (2006). Mathematics Education in Different Cultural Traditions: A Comparative Study of East Asia and the West. In F. K. S. Leung, K.-D. Graf, & F. J. Lopez-Real (Eds.), *Mathematics Education in Different Cultural Traditions. A Comparative Study of East Asia and the West*. *The 13th ICMI Study* (pp.1–20). New York: Springer.

Mullis, I. V., Martin, M. O., Foy, P., & Arora, A. (2016). *TIMSS 2015 International Results in Mathematics.* Boston, US: International Association for the Evaluation of Educational Achievement.

OECD (2016). *PISA 2015 Results (Volume I): Excellence and Equity in Education*. Paris: OECD Publications.

Peterson, R. A. (1994). A meta-analysis of Cronbach's coefficient alpha. *Journal of consumer research*, *21*(2), 381-391.

Phillips, D., & Ochs, K. (2003). Processes of policy borrowing in education: Some explanatory and analytical devices. *Comparative Education*, *39*(4), 451-461.

Revina, S., & Leung, F.K.S. (2019). How the same flowers grow in different soils? The implementation of Realistic Mathematics Education in Utrecht and Jakarta classroom. *International Journal of Science and Mathematics Education, 17*(3), 565-589.

Rose, R., & Mackenzie, W. (1991). Comparing forms of comparative analysis. *Political Studies*, *39*(3), 446–462.

Sembiring, R., Hadi, S., & Dolk, M. (2008). Reforming mathematics learning in Indonesia classroom through RME. *ZDM*, *40(6)*, 927-939.

Steiner-Khamsi, G. (2004). Globalization in education: Real or imagined?. In G. Steiner-Khamsi (Eds.), *The Global Politics of Educational Borrowing and Lending* (pp.1-11). New York: Teachers College Press.

Swadener, M., & Soedjadi, R. (1988). Values, mathematics education, and the task of developing pupils' personalities: An Indonesian perspective. *Educational Studies in Mathematics*, *19*, 193-208.

Taylor, S., Rizvi, F., Lingard, B., & Henry, M. (1997). *Educational policy and the politics of change*. London UK: Routledge.

van den Heuvel-Panhuizen, M. (1996). *Assessment and realistic mathematics education*. Utrecht: CD-ß Press Utrecht University.

van den Heuvel-Panhuizen, M. (2000). Mathematics education in the Netherlands: A guided tour. *Freudenthal Institute Cd-rom for ICME9*. Utrecht: Utrecht University.

van den Heuvel-Panhuizen, M., & Drijvers, P. (2014). Realistic Mathematics Education. In S. Lerman (Ed.), *Encyclopedia of Mathematics Education* (pp. 521-525). Dordrecht, Heidelberg, New York, London: Springer.

van den Heuvel-Panhuizen, M. & Wijers, M. (2005). Mathematics standards and curricula in the Netherlands. *ZDM*, *37*(4), 287-307.

van Zanten, M., & van den Heuvel-Panhuizen, M. (2015). Past and current approaches to decimal numbers in Dutch primary school mathematics textbooks. *Nordic Studies in Mathematics Education, 20*, 57-82.

Verbruggen, I. L., Frickel, M., van Hell, J., & Boswinkel, N. (2007). Realistischreken-wiskundeonderwijs in het specialbasisonderwijs- attitude van leerkrachtenenlesgedrag in de klas [Realistic mathematics education in special needs primary school – teachers' attitudes and practice in the classroom]. *Panamapost*, *26*(3), 37-46.

Wiryomartono, B. (2016). *Javanese culture and the meanings of locality: Studies on the arts, urbanism, polity, and society.* London: Lexington Books.

Table 1

Summary of Scores of Survey on Teachers' Attitudes towards RME (N=202)

Factor	Mean	SD
Overall	3.67	0.31
Teacher Intention on RME	4.25	0.35
Guidance	2.96	0.57
Students' Self-Development	3.56	0.41
Interactivity	3.26	0.57

Table 2

Occurrences of lesson events related to RME

Activities/ Events	**Of 12 Lessons**
Use of problems	
a. As a starting point of learning	4
b. As application during practice	6
Use of bare number problems	10
Use of model or scheme	
a. Concrete manipulatives	12
b. Introduction of schematization	7
Working step by step	
a. Fixed instruction or procedures to follow	10
b. Introduction of standard method	7
Making connection	0

Table 3

Summary of the findings

RME Principles	**Findings in this Study**	
	Consistency	**Inconsistency**
Reality Principle	PMRI textbook provided considerable number of contextual problems	Contextual problems were more often utilized as application rather than as a source for learning
	Teachers agreed contextual problems as important element in learning mathematics	The contexts provided were not meaningful
		Bare number problems were emphasized during practice activity
Level Principle	PMRI Textbook provided models and schematization	The teaching aid and models were uniform and artificial
	Teachers agreed models and schematization are useful in learning mathematics	Teacher only teach single solution method. No flexibility in chosing models/scheme that work for different students

Activity Principle	Teachers agreed that students have to be active learners and learning must be joyful	Learning activities did not allow students to actively build their own knowledge. Teacher fully lead the lessons. The tasks were uniform. No differentiation for students with different abilities
Guidance Principle	Teacher provided individual and whole class guidance	Teacher provided rigorous examples and students have to follow standard methods The lessons were result-oriented
Interactivity Principle	Teacher involved students in whole-class discussion	Teacher did not ask for students' explanation to their answers No initiaves from individual student in asking questions to their teacher Lack of students-students interaction Lessons were content–oriented
Intertwinement Principle	-	Absence of exploration/ intertwinement activities

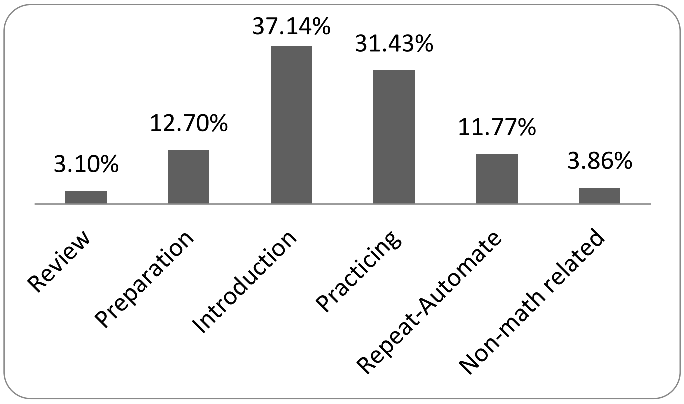


Figure 1 Percentage of lesson time devoted to different teaching formats

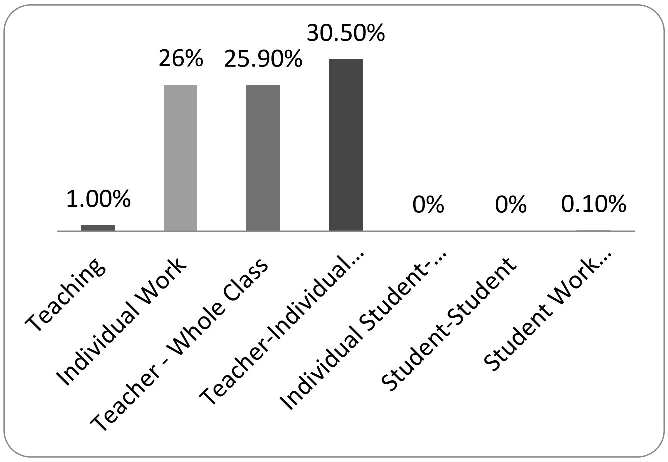


Figure 2 Methods of Interactions (percentage of total time) in PMRI classrooms