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What Do Indonesian and Dutch Teachers Find Challenging When Implementing Realistic Mathematics Education?

Puri Pramudiani[1], Tatang Herman[2], Turmudi[3], Maarten Dolk[4], Belinda Terlouw[5]

[1, 2, 3]Elementary Education Department, School of Postgraduate Studies, Universitas Pendidikan Indonesia
[4]Freudenthal Institute, Utrecht University, Netherlands
[5]Hogeschool KPZ Zwolle, Netherlands
Email: turmudi@upi.edu

Abstract

At the end of the sixties of last century, the development of Realistic Mathematics Education (RME) started in the Netherlands. At the beginning of this century, the Indonesian adaptation of RME, *Pendidikan Matematika Realistik Indonesia* (PMRI), started. The implementation of RME / PMRI has proven to be challenging. In this research, a qualitative case study was used to investigate teachers' perceptions and experiences in implementing RME/PMRI in their classes. Semi-structured interviews were conducted with several Dutch and Indonesian teachers who have joined the RME/PMRI training. We found similarities and differences between the two groups of teachers. Both groups of teachers understand the use of context as a starting point for students to construct mathematical understanding. The Dutch teachers considered the construction of interesting mathematical problems and the use of the guided-reinvention principle as the difficulties but motivated them to do more practice. Indonesian teachers mentioned that for them, the integration of mathematics with other subject areas for integrated thematic learning in the 2013 curriculum was their constraint but it was also a challenge for them to be more creative. These perspectives can become a reference for the development of a localized implementation of learning trajectory in classroom practices.

Keywords: Context, Primary School Teachers, Realistic Mathematics Education

Abstrak

Pada akhir tahun 1960-an abad lalu, pengembangan *Realistic Mathematics Education (RME)* dimulai di Belanda. Pada awal abad ini, RME mulai diadaptasi di Indonesia menjadi Pendidikan Matematika Realistik Indonesia (PMRI). Implementasi RME/PMRI menunjukkan sebuah tantangan. Dalam penelitian ini, studi kasus kualitatif digunakan untuk menyelidiki persepsi dan pengalaman guru dalam menerapkan RME/PMRI di kelas mereka. Wawancara semi terstruktur dilakukan dengan beberapa guru di Belanda dan Indonesia yang pernah mengikuti pelatihan RME/PMRI. Kami menemukan persamaan dan perbedaan antara kedua kelompok guru tersebut. Kedua kelompok guru memahami penggunaan konteks sebagai titik awal bagi siswa untuk membangun pemahaman matematis. Para guru Belanda menganggap konstruksi permasalahan matematika yang menarik dan penggunaan prinsip penemuan secara terbimbing sebagai suatu hal yang sulit namun memotivasi mereka untuk terus berlatih. Para guru Indonesia menyebutkan bahwa bagi mereka integrasi matematika dengan mata pelajaran lain pada pembelajaran Tematik Terpadu dalam kurikulum 2013 merupakan kendala yang sekaligus menjadi tantangan tersendiri bagi mereka untuk lebih kreatif. Perspektif ini dapat menjadi referensi untuk pengembangan implementasi lokal pada lintasan belajar dalam praktik di kelas.

Kata kunci: Konteks, Guru Sekolah Dasar, Pendidikan Matematika Realistik

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INTRODUCTION

The scientific development of mathematics continues to grow from year to year. At the end of the sixties of last century, the Wiskobas group – under the leadership of Hans Freudenthal – started to

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develop a theory of mathematics education that focused on mathematics as a human activity (Van den Heuvel-Panhuizen, 2020a). It means that everything in daily human life is related to mathematics. In Indonesia, this theory was adapted into *Pendidikan Matematika Realistik Indonesia*/*PMRI* (Sembiring et al., 2000). Over the past two decades, there were many processes of adapting, implementing, and developing PMRI in Indonesia that involved many stakeholders. Those were elaborated in Zulkardi et al., (2020) describing several people from universities who synergized with education practitioners in disseminating PMRI and developing the topics that were focusing on socio-mathematical norms in mathematical teaching in primary school for mathematics and science literacy in teacher education.

There has been much research related to RME/PMRI. Prahmana et al., (2020) conducted a systematic literature review of two decades of realistic mathematics education research in Indonesia that involved more than 100 articles by ten highest rank accredited journals by the Ministry of Research, Technology, and Higher Education of the Republic of Indonesia. There were various kinds of RME/PMRI research focusing on mathematical ideas, students' abilities, teacher's role, design research, and the implementation of RME/PMRI itself. For instance, Pambudi et al., (2022) found that their research results indicated that the implementation of RME in classrooms made students more physically, socially, and mentally active. Another research by Haji (2013) showed that the use of the iceberg approach in RME could ease the difficulties of primary school students in understanding division of fractions.

From the teacher's point of view, there has been also much research related to RME/PMRI. For example, in Indonesia, Fauziah et al., (2018) indicated that the teachers, who were being their target research, agreed that RME/PMRI principles supported their mathematical understanding in certain topics. It means that as a domain-specific instruction theory, RME was successful to help the teachers to conceive the mathematical concept that would be taught to their students. Besides that, the study of Putri et al., (2015) pointed that professional development of PMRI can make the teachers more confident in applying socio-mathematical norms in their class.

A new approach to primary teacher education in the Netherlands was introduced in 1971 initiated by IOWO, the first predecessor of the Freudenthal Institute (Oonk et al in Van den Heuvel-Panhuizen, 2020). One of the examples of teacher education program by Terlouw (2010) described the two important things when she started to conduct professional development for teachers in the Netherlands by strengthening teachers' consciousness and teachers' reflection toward the mathematical teaching. According to Terlouw's experience as a Dutch teacher educator, those could help the teachers to improve their ability in understanding of students' thinking in mathematics. This is very important since teacher is an agent of change for education (Iskandar & Zulela, 2021; Vandeyar, 2017).

According to van den Heuvel-Panhuizen et al., (2014), there are six principles that have to be mastered by teachers in implementing RME: 1) the activity principle, 2) the reality principle, 3) the level principle, 4) the intertwinement principle, 5) the interactivity principle, and 6) the guidance

principle. The activity principle is defined that in RME, students are managed as active participants in the learning process. The reality principle can be identified as the purpose of mathematics education including students' ability to apply mathematics in solving "real-life" problems which are meaningful to them. In this part, context plays an important role (Zulkardi & Putri, 2006). The level principle emphasizes that learning mathematics means students get through progressive mathematization starting from informal level to formal level (Gravemeijer, 1994). The intertwinement principle means that mathematical content domains are integrated. Students are offered various problems in which they can use several mathematical models and strategies. The interactivity principle of RME means that learning mathematics is not an individual activity; class discussions and group work enable students to share their strategies with others and developing deeper insights. The guidance principle refers to Freudenthal's idea of "guided re-invention" of mathematics (Van den Heuvel Panhuizen et al., 2014) in which through realistic contextual problems containing certain mathematical topics provided, students are given the opportunity to build and reinvent mathematical ideas and concepts. RME also was defined in five tenets or characteristics by Treffers (in Bakker, 2004): 1) phenomenological exploration, which means developing a mathematical learning context; 2) using models and symbols for progressive mathematization means the use of models (model-of and model-for) by students; 3) using students' own constructions and productions, which means encouraging students to actively contribute to solve mathematical problems; 4) interactivity that involves class discussion as well as interactions among students; and 5) intertwinement, which means making connection between mathematical concepts or topics.

There were many activities during two decades of PMRI. PMRI has been disseminated in Indonesia involving students, pre-service teachers, teachers, lecturers, and other practitioners from several universities in Indonesia. There were more than 20 provinces in Indonesia involved in these activities (Zulkardi et al., 2020). This year, PMRI continues to develop the program intensively partnered with 13 provinces in Indonesia (Aceh, North Sumatra, West Sumatra, Riau, South Sumatra, West Java, DI Yogyakarta, East Java, South Kalimantan, South Sulawesi, West Nusa Tenggara, East Nusa Tenggara, and Maluku), involving 26 primary schools with 78 primary school teachers in total. These teachers were expected to become the role models who have expertise in implementing PMRI. They were coached by PMRI experts through regular workshop and in-service training both at the local and national levels. Therefore, we called them as PMRI teachers who have commitment to implement PMRI in their class. Since PMRI becomes trend in Indonesia from time to time, the researchers need to investigate further about its implementation.

However, according to some previous research, the implementation of PMRI did not always run smoothly. Ekawati & Lin (2013) found that after being introduced to PMRI and the use of contextual situations as a starting point for the development of mathematical insight, some Indonesian teachers returned to teach using formal procedures. Based on Ekawati & Lin' research result, there was a need for teachers to learn about how to understand the students and the strategy of mathematical teaching.

One of the reasons of why some Indonesian teachers did not implement a more active teaching-learning practice was because their workload (Revina & Leung, 2019). The similar research result was showed by Purnomo et al. (2020) who found a gap between educational research findings and the teaching practice of Indonesian teachers that tended to follow the "traditional paradigm" in which teachers only transferred their knowledge. Meanwhile, the Indonesian 2013 curriculum emphasized on how to apply higher-order thinking skills (HOTS) in mathematical learning, the contextual situation, and collaborative learning (Putri & Zulkardi, 2019).

Zolkower (in Van den Heuvel-Panhuizen, 2020a) stated that obtaining RME can extremely change one's view on mathematics and make mathematics teaching become more understandable both for teachers and for students. In this case, the teacher's creativity in applying good mathematical context is very important. Creative teachers can support the learning process, especially in mathematics (Aziiza et al., 2022), which is known as a difficult subject and a complicated process that demands various cognitive challenges (Salihu et al., 2018).

The problem is that creativity is rarely shown in teaching and learning mathematics (Eligio, 2017). Teachers prefer to be in the comfort zone carrying out their role as implementer. This is in line with Bakker (2018) who noticed that teachers rarely act as researcher or (co-) designers. Meanwhile, this condition cannot be ignored since it will give impact for students' ability. It is confirmed by Astari et al., (2021), showing that the traditional learning made students passive. As a consequence, students who were less active in mathematical learning usually have low mathematical connection abilities (Pambudi et al., 2020). Therefore, teachers' creativity can be provoked by implementing problem-solving approach and providing structured assignments using meaningful context (Jupri & Hidayat, 2022; Murtafiah et al., 2021).

Another problem found by Revina & Leung (2018) indicated that the implementation of RME in the Netherlands and PMRI in Indonesia seem identical but indeed differ in many cases. They found in some areas, PMRI in Indonesian culture had been translated differently from original RME described by the Dutch educators (the level principle, activity principle, guidance principle, interactivity principle, and intertwinement principle). Especially in terms of the intertwinement principle, although the PMRI textbook has adopted this principle in their content, teachers preferred the content-based lesson that teaches mathematics according to the topics rather than incorporating various topics in one lesson (Revina & Leung, 2019).

Regarding the lack of teachers' creativity in exploring contextual situation as a starting point in mathematical teaching, and regarding the differences between the implementation of RME in the Netherlands and Indonesia found by previous researchers, the researchers in this research investigated teachers' perceptions toward principles of RME/PMRI as their views and experiences with the implementation in their class. Therefore, we formulated the following research question: "What are the challenges faced by Indonesian and Dutch teachers in implementing RME/PMRI?". Meanwhile, the three sub-questions were: 1) What are teachers' perceptions of RME/PMRI?; 2) What are

teachers' experiences in implementing RME/PMRI?; 3)What are similarities and differences between Indonesian and Dutch teachers in implementing RME/PMRI?. The purpose of this research was to investigate teachers' perceptions of and experiences in how RME/PMRI was implemented in Indonesia and in the Netherlands. Furthermore, the teachers' perspectives in two countries were elaborated in order to become a reference for the development of a localized implementation of learning trajectory in classroom practices.

METHODS

This research used a qualitative case study approach to investigate teachers' perceptions of and experiences in how RME/PMRI was implemented in Indonesia and in the Netherlands by applying semi-structured interview to some Dutch primary school teachers and Indonesian primary school teachers who had experienced in joining the training of RME/PMRI. The qualitative case study, as Creswell (2012) described, is an approach that centers on an event, location, issue, time, or other physical limitations. Semi-structured interviews were used to investigate teachers' perceptions and experiences in implementing RME/PMRI. Qualitative research methods used the inductive process in the collection, exploration, study, analysis, and interpretation of teachers' perceptions and experiences.

The data were collected at different times. From Indonesian primary school teachers, the data were collected during the national workshop held in November, 2021. There were 78 primary school teachers involved from 13 provinces (Aceh, North Sumatra, West Sumatra, Riau, South Sumatra, West Java, DI Yogyakarta, East Java, South Kalimantan, South Sulawesi, West Nusa Tenggara, East Nusa Tenggara, and Maluku) who become the role models of PMRI teachers. During the workshop, the researchers asked all the participants to share their perceptions of and experiences in implementing PMRI in the class. However, there were five primary school teachers from Aceh, Riau, and Maluku who become the volunteers (IA: Primary School Teacher in Aceh, IB: Primary School Teacher in Maluku, IC: Primary School Teacher in Maluku, ID: Primary School Teacher in Riau, IE: Primary School Teacher in Aceh).

Meanwhile, the data about Dutch primary school teachers were collected from August to October 2022. In the Netherlands, when the research was conducted, there were schools in several regions that were successfully studied by the researchers. There were 60 primary school teachers who became mathematics coordinator teachers (mathematics specialist) from several primary schools in Zwolle, and several primary school teachers from Amsterdam and Utrecht who actively followed the in-service training coached by Dutch RME experts. Of those teachers, there were 5 primary school Dutch teachers that had been successfully contacted by the researchers to give their detail experiences in mathematical teaching (DA: Primary School Teacher in Utrecht, DB: Primary School Teacher in Utrecht, DC: Primary School Teacher in Zwolle, DD: Primary School Teacher in Zwolle, and DE:

Primary School Teacher in Zwolle).

Using an interview protocol (Creswell, 2012), questions were used to collect data on how the principle or characteristic of RME/PMRI impacted the teachers' perceptions in implementing RME/PMRI. Data were recorded and transcribed. A video tape was used to record all interviews. After several open questions about teachers' perceptions of and experiences in implementing RME/PMRI were asked to some primary school teachers in the Netherlands and Indonesia, the answers were analyzed and categorized in the next stage. We also analyzed their experiences in using context as a starting point to construct mathematical understanding.

RESULTS AND DISCUSSION

In this section, the implementation of RME/PMRI in both countries, including the teachers' perceptions of RME/PMRI and their experiences in implementing it, was elaborated. There were also the sharing experiences of contexts used by the teachers as starting point to implement RME/PMRI.

The Implementation of Realistic Mathematics Education/ Pendidikan Matematika Realistik in Indonesia

For Indonesian teachers, when the national workshop was conducted, the researchers asked about their perceptions toward PMRI. The workshop was conducted virtually via Zoom meeting because at that time, it was still in pandemic covid-19 situation. The question was: *"What was the biggest challenge in implementing realistic mathematics learning in the class you teach (related to principle or characteristics of RME/PMRI)?"*. Of 78 primary school teachers, there were 67 participants who gave the answers. From the participants' answers, 15 participants answered developing a mathematical learning context (based on local wisdom); 11 participants answered the use of models (model-of and model-for) by students; 10 participants answered encouraging students to actively contribute to solve mathematical problems; and 31 participants answered making connection between mathematical concept and other subjects.

To further explore their perceptions and experiences in implementing PMRI, the researchers asked the volunteer teachers to share in detail. There were five primary school teachers from Aceh, Riau, and Maluku who become the volunteers (IA: Primary school teacher in Aceh, IB: Primary school teacher in Maluku, IC: Primary school teacher in Maluku, ID: Primary school teacher in Riau, IE: Primary school teacher in Aceh).

When the Indonesian teachers were asked about their experiences in implementing PMRI, most of them related it to the curriculum used in which at that time, they implemented the 2013 curriculum (*Kurikulum 2013*) within integrating thematic (*Tematik Terpadu)* learning. In Indonesian 2013 curriculum, Mathematics (*matematika*), Cultural Arts and Crafts (*Seni Budaya dan Prakarya/ SBdP*),

Pancasila and Civic Education (*Pendidikan Pancasila dan Kewarganegaraan/ PPKn*), Sports Physical Education and Health (*Pendidikan Jasmani, Olahraga dan Kesehatan/ PJOK*), and Indonesian language (*Bahasa Indonesia*) were integrated in one theme. The theme, sub theme, and basic competency mapping has been provided in the teacher's guide book (Pusat Kurikulum dan Perbukuan, Balitbang, 2016).

According to participants' answers, some of them said that integrating mathematics with other subjects in *Tematik Terpadu* was interesting, as stated by IA as follows:

IA: (in integrated thematic learning), we should not separate mathematics from the other lessons, because through that way we can also embed students' character, for example by using sharing food context in subtraction topic, etc.

Based on IA's statement that integrating mathematics with other subjects may have opportunity to expand goodness such as strengthening students' character by using sharing food context in subtraction topic, and many others.

Another perspective came from the other teacher who thought that integrating mathematics with other subjects was difficult, as stated by IB as stated as follows:

IB: The problem is that in grades 1, 2, and 3, the content of learning mathematics does not stand alone, it means that it is combined with other subjects. For example, one sub-theme consists of several basic competencies that include several subjects. I do not know how to create a lesson plan using the iceberg model (for example Iceberg model made by Frans Moerlands in Saleh, 2013), and at the same time, I have no idea how to integrate all subjects into the lesson.

The same case was encountered by IC who expressed that integrating PMRI with the theme provided in the textbook was difficult since PMRI suggests the use of local cultural wisdom, as stated as follows:

IC: The main problem in learning mathematics in primary schools in the 2013 curriculum is that mathematics must be integrated into a theme together with other subjects (Cultural Arts and Crafts, Pancasila and Civic Education, Sports Physical Education and Health, and Indonesian language). All of them should be taught continuously. For example, to learn about shapes, the theme being taught was cleaning tools. Students were asked to find various cleaning tools in the form of shapes. However, PMRI suggests the use of local cultural wisdom. That makes me confused. How can I include the local cultural wisdom, especially in Maluku, that is related to shape in the theme of cleaning tools?

Even though most teachers admitted that integrating mathematics and other subjects in PMRI was difficult, but some of them proposed the solution to develop the PMRI context using their local wisdom, like expressed by ID as follows:

*ID: When we used an integrated theme, we start considering the mathematical ideas. We hoped that the students would develop their thinking and the strategies they might use. So, when we introduced shapes, we use the "Setatak Game", "Galah Panjang" or Gobak Sodor game *). These are local games that make the use of shapes. So, in this example we separated learning mathematics from the other subjects although the other subjects were still included in a theme. So, if we were able to integrate mathematics learning using PMRI with other subjects, then we included it; but if it was not possible, we taught mathematics using PMRI separately from other (subjects).*

*Note: Setatak/ Galah Panjang/ Gobak Sodor *) are Indonesian traditional game that have similar characteristics in which before the game starts, children usually work together to make a line in the ground in the certain of shapes as a playing field.*

Another solution was proposed by IE who had the idea about teaching shapes using the PMRI context of building Acehnese traditional house as follows:

IE: What we usually do in Aceh when we conducted mathematical learning using PMRI about shapes, and also how to integrate PMRI with other subjects, first of all (is that) we used the objects around the students such as rectangular blackboard or window, a circular globe, etc. Furthermore, we used the traditional houses in Aceh which consists of various shapes, and for (basic competency) of PPKn (Pancasila and Civic Education), we made relationship to mutual cooperation system in building traditional houses in Aceh, then they read the history of the traditional house to learn Bahasa (Indonesia) or Indonesian language, while for the arts, culture and crafts, the students were asked to coloring the traditional house. So, in this case the teachers must have creativity. Before conducting the teaching and learning process, the teacher must think about how to develop the material in order to use PMRI based on local wisdom, and also how to integrate it with other subjects.

According to Indonesian teachers' answers, it indicated that the most difficulty for the teachers who already implemented PMRI in their class was integrating mathematics using PMRI context with other subjects because in Indonesian 2013 curriculum, Mathematics, Cultural Arts and Crafts, Pancasila and Civic Education, Sports Physical Education and Health, and Indonesian language were integrated in one theme. The theme, sub-theme, and basic competency mapping have been provided in the teacher's guide book. So, for some cases they had difficulties in exploring more mathematical ideas using their local wisdom context.

In the meantime, according to the participants who had experiences in implementing PMRI, the difficulties also become challenges for them to think creatively in applying the context of PMRI. The examples proposed by ID and IE could become the alternative solution for the teachers who encountered the difficulties in implementing PMRI in 2013 curriculum.

The Implementation of Realistic Mathematics Education in the Netherlands

The researchers asked Dutch teachers open-ended questions related to their perceptions of and experiences in implementing RME. There were five teachers who participated in giving detailed information about mathematical teaching (DA: Primary school teacher in Utrecht, DB: Primary school teacher in Utrecht, DC: Primary school teacher in Zwolle, DD: Primary school teacher in Zwolle, and DE: Primary school teacher in Zwolle). They have been interviewed in different time using one-to one semi-structured interview.

According to Dutch Teacher A (DA), one of the difficulties for Dutch RME teachers was to find a good problem to get the lesson and how to get more mathematical ideas confidently (beyond what was in the textbook). DA is a senior teacher who has experiences in teaching using RME for around twenty-five years. Currently she has been working with some primary school teachers in one school in Amsterdam and one school in Utrecht to give RME lessons. Below is the transcript between the researcher and DA:

R: "Would you mind sharing your experience in teaching mathematics using RME in primary school? If you would not, please"

DA: It's a long time ago now, but at that time, every Wednesday I worked with a Dutch RME expert (he is a researcher, designer, and lecturer). We made the lessons, we filmed the lessons, and he gave me feedback on the lessons. And one of the difficulties for me (at that time) was to find a good problem to get the lesson. And on and on I was… I got more things for myself to work with the kids and I was getting more confident and knew how to be able to get more (mathematical ideas), asking the questions to kids, and how did I get more understanding of how the students' thinking was. And that's quite difficult, but that is important, how I'm thinking, how to associate with thing, sometimes it is very weird, and sometimes it's very… you see what you presumed well how it was quite difficult for them. And that was for me, I find out that I am very curious to that.

According to DA, finding a good problem for supporting students' mathematical understanding and asking the good questions for children were quite difficult for teachers, but those were important for the teaching and learning process. Based on her experience, the difficulties emerged because the teacher did not know the children's thinking. When the teacher had to interact with children, he or she has to ask how they were thinking in a proper way and must connect them with their thinking. Furthermore, DA suggested that it could be done if the teachers really knew a lot of mathematics. It means that the teachers had to learn by themselves and be curious to understand the students' thinking in learning mathematical concept. DA described another solution to this problem was through practicing more in posing some questions to the children. DA also shared her experience when she gave the RME courses with other teachers who worked with her such as follows:

DA: "The most difficult part for Dutch primary school teachers is didactical phenomenology, because when the teachers were asked, for instances, whether they can imagine why they found out the comma numbers, they did not know or when they were asked what the combination between cubic system and liter system is, they did not know either. Therefore, if they did not know and they have to explain to the children, they just used what was in the textbook and they read it, but sometimes the children did not understand them. So, the teachers stayed coming with the question. If they did not know what the relation as well, it would be very difficult."

Referring to Freudenthal's idea (1991) that mathematics is a human activity, teachers have to notice that our surroundings around the world are related to mathematics. The teachers have to encourage themselves to be more precise to understand the surrounding environment and to make the good question for the children in order to provoke the children' thinking in solving mathematical problem.

One of the principles in RME is the guidance principle which refers to Freudenthal's idea of "guided re-invention" of mathematics (Van den Heuvel Panhuizen et al., 2014). It means that in RME, teachers must have an active role in students' learning and should accommodate the proper plan that enable the shifting of students' comprehension. To reach this purpose, the teaching program should be based on suitable learning trajectories that can be applied in long time. Below is DA experience in implementing RME:

DA: We made the fantastic lessons about comma numbers and I did it twice, two years, after one year and others, I remember that the students became more understanding, so the other year we got less question. Another example, we made investigation, about what your favorite day of school was, your school today, where you were on holiday, and we always said we did ask in our class, so where you were, and then we compared it with Utrecht, and we found the real numbers, and they had to compare those things, so they learn to do with fractals (fractions), or percentages, or whatever, or they did it with a line and they counted and put it, whatever, and first of all they got difficulties. So, every year, I think two years, I knew the boy or the girl who said we must find a very nice fractals to compare with, then I just have to say the lessons after. And then they could find out, and they said it was so easy.

According to DA's experience, being enthusiastic to become a teacher also can overcome the difficulties in making good problem in the lessons. When the teachers were enthusiastic, they could still struggle to solve the difficulties that they encountered. To be more enthusiastic, the teachers have to find out what the didactical phenomenon was in the problem. This could make them enthusiastic enough to proceed. The teachers who worked with DA promised to each other to practice every week with the RME lessons and they practiced to make a good lesson and know how they can find out their own level and what was difficult for them, and after that, some of them learned the smaller steps of

students' mathematical thinking. DA suggested that what was so difficult for teachers was that they had to explain how mathematical concept works and then they had to see what was happening in the lessons with the children. DA stated that her colleagues were very good, very enthusiastic, and they had good spirit in doing exercise RME lessons. When they had in-service training, each teacher presented and looked to the lessons together, and then they analyzed the good thing or something they had a question about. So, based on DA's experience, when the teachers work together, perhaps they can solve mathematical problem logically by sharing their thoughts.

Based on the observation conducted by the researchers, the teachers who became the research subjects used *de grote rekendag book* (Boswinkel et al., 2006), a yearly theme book where several schools in the Netherlands involve all students around one idea. For instance, the theme in this book discussed about who the average student in the class is (average in weight, age, length, largest jump, fast run around the school, etc.). In this case, students can start to think of what is the theme of average? Of course, once they collect data, the issue becomes what is average in this context (middle number, average number, frequent number, etc.). So, the students could explore the data.

Another example theme in *de grote rekendag book* (Boswinkel et al., 2006) is about introducing the numbers to young children through the story of *"het Grote Getallenbos"* (the Great Numbers Forest). In this activity, the researchers made observation class in one primary school in Utrecht, in which the teacher used this context. We called the teacher as Dutch teacher B (DB). DB has become a teacher for six years, and has been working with RME approach for almost two and a half years. In DB's class, the children experienced for themselves what the numbers looked like in the story of *het Grote Getallenbos* presented by the teacher, and they had to figure out how many pictures in the story were pairs to the numbers. Based on the observation, the children were very interested in finding the shape of numbers, how they could form the numbers, what are the numbers, and where they could find them. In addition, something beautiful was made because the teacher was very creative in presenting the story. Below is the transcript between researcher (R) and one Dutch teacher B (DB) in Utrecht:

R: *I heard that you are really interested in teaching the children using RME approach. Maybe you can say more about your experience in teaching using RME approach?*

DB: *Yes, we tried a few lessons with the coaching of RME expert, and we built place in our school, and this is a place where the children can go to the teacher, and do the mathematics class together and for us it is very important that we learn how to ask the good questions in order for the children to come up with their own ideas and to come up with their own critical thinking and this is still a process we were working on.*

R: *Okay, I observed the children were very enthusiastic using this approach, RME, but in your opinion or in your perspective, what is the challenge for teaching young children using RME?*

DB: The challenge is mostly what questions to ask because you want to engage them but you also want them to be fully engage in the story you are telling, so you have to make a switch between what question you asked and what subject or topics of mathematics but also you have to deal with the management of the classroom, therefore you have to do both things at the same time and then you are also want them to do their own science of research about it, so you don't want to tell them just everything you want them to research the topic themselves, and this is sometimes difficult, what are the thing that you are going to tell and what are the thing that you let them research.

According to DB, the most difficult part which was also challenging for her in implementing RME was posing question (in guided principle). However, based on the observation class conducted by the researcher, she could make a good question to investigate how children's thinking was. The researcher did observation class with her RME coach, and she also confirmed that DB could develop her ability in posing the questions of the problem to the children compared to the last year. It means the coaching in RME for DB works well. The children proposed the topics because the question was posing to them and they were invited to propose their own lesson. The way of teacher's acting was very good. Sometimes she made a note, sometimes made a question, sometimes made a sentence, and guided the children.

The interactivity also was going well because the children could present and communicate the mathematical idea as well. The children could make the connection with themselves, and the story used from *de grote rekendag book* (Boswinkel et al., 2006) really worked to them. They were very intuitive and then they could make the connection with the numbers related to the story. Even though the teacher could conduct the teaching and learning process well, she admitted that the most difficult thing in implementing RME is a guidance principle, which is how to guide the children to re-invent the mathematical concept by themselves. Furthermore, the researcher asked to DB about her perspective of RME and how she would recommend it to her colleagues:

R : How would you recommend the school to implement RME either in students at early age or in higher grades?

DB: I would recommend to do it in the whole classes in primary school because now they experienced a little bit and then when you have the progress into the years they get to know how they can ask things, how they can do their own researches, and there would be more critical of the things and the topics that you give them, so if you started at (students) at an early age, they were already engaged in the program and then when you were in the higher classes, there would be very engage to discuss the topics with you.

DB also shared that in her school, there were several teachers that really want to do RME approach, and they have already followed some coaching but the problem was they got difficulties doing it in a big group due to the time constraints.

R : How do you cope the time-constraints because when we applied RME, you said that it needed more time, right?

DB: Then you have to practice and then you know that our experience is getting better every time. And of course, you may make the mistake, and that is good if you can watch a lesson together like today, when you were watching me and give me some advices then I can try to improve myself next time.

According to DB, it was difficult to get all the children to talk about the things in large group, and also to make the setting of class. So, for now, they set to the lower grades first and they would seek for organization point of view, which hopefully could bring the higher grades to do the same approach by sharing the experiences of what they have already known. In order to cope the time constraint, DB suggested to do practice more in order to improve the skill so the teacher can notice how the teaching and learning run well. DB stated that reflecting the lessons together could help her to improve her knowledge in applying RME approach.

In another occasion, the researchers sought the information from the primary school teachers in Zwolle. The researchers asked about their experiences in mathematical teaching and asked about the example of context they used in classroom. Below is the example of the context used by Dutch teacher C (DC). DC is a mathematics specialist who teach 9- and 10-year old children. She shared her experience in teaching fractions as follows:

Zelf neem ik bij de breuken altijd de breukstokken erbij uit de rekenmaterialenkast. Ik hoop dat je daarmee bekend bent? Het werkt niet alleen verduidelijkend maar geeft ook overzicht in welke breuken er "bij elkaar horen".

Translated:

Personally, I always take the fraction sticks from the calculation materials cabinet for the fractions. I hope you are familiar with that? It is not only clarifying, but also provides an overview of which fractions "belong together".

The stage in more detail was described by DD. DD is a mathematics specialist teacher. She has been working in primary school for many years. Most of the time she taught children at ages of 10, 11, 12. Currently she teaches children from 6 to 9 years of age. Therefore, she could describe the learning stages (in fractions) starting from lower grades to higher grades as follows:

Recognizing a half	*Grade 3.4*
Recognizing a quarter	*Grade 4.5*
Dividing a figure into equal parts	*Grade 5*
Introducing to fractions	*Grade 6*
Recognizing and writing fractions	*Grade 6*

Reading off a fraction	*Grade 6*
Displaying a fraction	*Grade 6*
Displaying a fraction in a simple figure	*Grade 6*
Drawing a whole of a fraction via measurement	*Grade 6*
Determining the break in an image, Recognizing in image	*Grade 6*
Split and supplement the number 1 with fractions	*Grade 6.7*
Displaying a fraction in a figure	*Grade 6.7*
Comparing simple dissimilar fractions, comparing easily	*Grade 7*
Comparing unlike fractions	*Grade 7.8*

Another mathematics specialist teacher (DE) shared her experiences using context. Currently DE teaches 8-9-year old children. Herewith is the example of context described by DE:

> *Wij starten eerst met concreet mteriaal (stroken, rondjes, chocoladerepen). Daarnaast breukenstokken en breukentorens. Kinderen zijn dan echt betrokken. Ze zijn handelend bezig en hebben daardoor meer inzicht.*
>
> Translated:
>
> *We first start with concrete material (strips, circles, chocolate bars). In addition, (we use) fraction sticks and fraction towers. Children are really involved. They are active and therefore have more insight.*

According to the teacher trainer in Zwolle, when the in-service training was conducted, the teachers were encouraged to be more curious toward mathematics, and they must have the ability for giving the space to all children to solve mathematical problem by themselves using their own thinking. Furthermore, based on their experiences, it was much more fun to do mathematics when the students could think for themselves and they were allowed to make mistakes and learn from their mistakes. Those also can make them become more creative and more curious about mathematics. Therefore, in the Netherlands, especially in Zwolle, referring to Terlouw (2010), two important things that have to be mastered by the teachers were teachers' consciousness and teachers' reflection toward mathematical teaching that enable them to improve their ability in understanding students' thinking in mathematics.

Regarding the research question, which is "What are the challenges faced by Indonesian and Dutch teachers in implementing RME/PMRI?", this research showed that even though RME has been implemented for more than fifty years in the Netherlands and more than twenty years in Indonesia as PMRI, there were still certain challenges in accordance with the dynamics that occurred in each country. To elaborate what kind of challenges they encountered, the researchers investigated the teachers' perceptions of and teachers' experiences in implementing RME/ PMRI.

To answer the first sub-question about what teachers' perceptions toward RME/PMRI are, both Dutch and Indonesian teachers have their own perceptions toward the principle and characteristic of RME/PMRI. The Dutch teachers considered the construction of interesting mathematical problems and the use of the guided-reinvention principle as the difficulties but it motivated them to do more practices. Through meaningful RME context, children were given the opportunity to build and reinvent mathematical ideas and concepts (Van den Heuvel Panhuizen et al., 2014).

Indonesian teachers described that they have struggles in intertwinement principle. Referring to the characteristics of RME by Treffers (in Bakker, 2004), the intertwinement means the integration of mathematical content domains or the connection between one topic and another topic in mathematics. However, interestingly, based on the Indonesian teachers' answers, intertwinement here was defined as making connection between mathematics using PMRI context and other subjects since in Indonesian 2013 curriculum, Mathematics, Cultural Arts and Crafts, Pancasila and Civic Education, Sports Physical Education and Health, and Indonesian language were integrated in one theme (*Tematik Terpadu*). However, even though they admitted it as their constraints, but it was also a challenge for them to be more creative. In fact, eventually some teachers could propose some mathematical contexts although they had to integrate it in one theme together with other subjects. In other words, it does not matter what curriculum is, the important thing is that when teachers have consciousness to be innovative in facing the challenges, then they can apply the good approach for the students and can reflect the teaching and learning process for the better.

For the second sub-question, since both groups were the teachers who have experiences in joining the in-service training in RME/PMRI, they shared their difficulties and also proposed the solution for their obstacles. The participants of this research were the teachers who have commitment to do RME approach, whom in Indonesia we called PMRI teachers. Even though they admitted that they encountered some difficulties but they presumed it as a challenge and motivation to become more creative and to do practice more. According to Terlouw (2010), it is believed and experienced that when the teachers were curious, then they were willing to reflect upon it.

As the final remark for the last sub-question, in this research, we found similarities and differences between Indonesian and Dutch teachers. The differences could be identified from their perceptions as mentioned previously. In terms of similarities, both groups of teachers have already applied the meaningful context as a starting point for students to construct mathematical understanding. They realized that they have to master the mathematical concept through applying the good context that is meaningful for students. A good context plays an important role for students' mathematical understanding (Aziiza et al., 2022; Putri & Zulkardi, 2019; Zulkardi & Putri, 2006). In addition, there are similar goal among Indonesia and the Netherlands in which teachers are agents of change for education (Iskandar & Zulela, 2021; Vandeyar, 2017). Therefore, as educators we have to learn every time in the whole of our life.

CONCLUSION

According to the research result, the implementation of RME/PMRI has proven to be challenging. There were similarities and differences between Indonesian and Dutch teachers in implementing RME/PMRI. Both groups of teachers understand the use of context as a starting point for students to construct mathematical understanding. The Dutch teachers considered the construction of interesting mathematical problems and the use of the guided-reinvention principle as the difficulties but it motivated them to do more practice. Indonesian teachers mentioned that for them, the integration of mathematics with other subject areas for integrated thematic learning in the 2013 curriculum was a constraint but it was also a challenge for them to be more creative. Even though both group of teachers admitted that they have struggles in implementing RME/PMRI, they still have commitment to use its approach because based on their experiences, it enabled them to develop their creativity by exploring the meaningful contexts suitable for students' thinking. Specifically, for Indonesian teachers' case, whatever the curriculum used, the important thing is that when the teachers have consciousness to be innovative in facing the challenges, then they could apply the good approach for the students and could reflect upon their own teaching and learning process. Since the participants of this research were limited, the research results could not be generalized, but these findings can become a reference for the development of a localized implementation of learning trajectory in classroom practices.

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