CHAPTER I
INTRODUCTION

This chapter presents several sub-themes. The first section is the background of the study, which primarily describes the fundamental issues related to the limitation of Teacher Professional Development (TPD) in Indonesia focusing on Students' Mathematical Reasoning. The second part is eliciting the problems into the research question. The third part provides the aims of the study. The fourth part is the details of the benefits of the study. The fifth section shows the depiction of the limitation of the study. The last section presents the structure of the dissertation.

1.1 Background of The Study

One of the abilities that a student must possess is reasoning. According to the Principles and Standards for Schools Mathematics, reasoning becomes one of mathematical content goals essential for students' development process in mathematics (The National Council of Teachers of Mathematics, 2000). Many researchers consider students should master reasoning as the foundation of mathematical competence (Alexander et al., 2013; English, 2004; Goswami, 2004; Gultom et al., 2022; Vale et al., 2016; Wheatley, 2013). However, previous studies have indicated that mathematical reasoning abilities of Indonesian students were still low (Basra & Fauzi, 2017; Darta & Saputra, 2018; Febriandi et al., 2022).

Furthermore, in The National Council of Teachers of Mathematics (2000) stated that teachers play an important role in promoting students' mathematical reasoning. They should be able to assume that students possess ability through their mathematics instruction. Nevertheless, attention to developing teachers' abilities to promote students' mathematical reasoning remains limited.

In mathematics, a teacher professional development program is believed to support the teachers to conceive the mathematical concept that would be taught to their students, namely *Pendidikan Matematika Realistik Indonesia* (PMRI) in-service training. PMRI was adapted from Realistic Mathematics Education (RME), a theory of mathematics education developed by Hans Freudenthal at the end of 1960's, that focused on mathematics as a human activity (Van den Heuvel-Panhuizen, 2020a).

According to Van den Heuvel-Panhuizen & Drijvers (2014), there are six principles that teachers should master when implementing RME. Those principles are: 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 first principle, the activity principle, highlights the active participation of students in the learning process. Second, the reality principle emphasizes the purpose of mathematics education, which involves the ability to use mathematics in real-life situation with a meaningful context. Furthermore, the level principle concerns how mathematization progresses from informal to formal learning levels. The intertwinement principle emphasizes on the integration of different areas of mathematical knowledge, so students will be able to use a variety of models and strategies. Next, the interactivity principle emphasizes that learning mathematics is not an individual activity but a group activity involving discussion and group work. This principle will enable students to share their strategies and develop them to get a better understanding. Finally, the guidance principle refers to Freudenthal's idea of "guided re-invention" of mathematics that mentioned how through realistic contextual problems, students are given the opportunities to construct and reinvent mathematical ideas and concepts.

In addition, according to Putri et al. (2015), professional development of RME/PMRI can make teachers more confident in applying socio-mathematical norms in their classes. In line with this, Fauziah et al. (2018) showed that the teachers, who were being their target research, agreed that RME/PMRI approach can support their mathematical understanding in certain topics. It means that as a domain-specific instruction theory, RME was successful in helping teachers in teaching mathematics. PMRI training facilitates teachers in designing and implementing PMRI lesson using their products (Ekawati & Kohar, 2016).

However, there are some challenges in the implementation of PMRI. Previous research indicated the gap between teacher education program's actual condition and expected outcomes. For example, Revina & Leung (2019) discovered a misalignment between the implementation of Realistic Mathematics Education (RME) by Indonesian Primary School Teachers (PMRI) and the RME principles suggested by Dutch educators due to cultural and contextual factors. Ekawati & Lin

(2013) also found that teachers moved back to teach algorithms after they were introduced to a contextualized mathematics approach. These findings suggest a need for teachers to learn how to understand the students' difficulties and apply challenging tasks to students, so they can explore their mathematical reasoning. Nevertheless, when we interviewed some Indonesian teachers, they preferred to teach sequentially, starting from easy to complex, as commonly outlined in textbooks. One of the reasons why some Indonesian teachers do not implement more active teaching-learning practices is due to their heavy workload (Revina & Leung, 2019).

The unwillingness of teachers to use more active teaching and learning practices must be addressed because they must adapt to the 21st-century learning era by implementing constructivist/active-based learning, particularly in the teaching of mathematics. They must be brave to provide challenging tasks to students, to support their mathematical reasoning. Nonetheless, previous research has highlighted a gap between educational research findings and teachers' classroom practices in Indonesia, particularly regarding the traditional perspective of teachers' responsibilities as simply teaching and implementing provided content from textbooks (Ekawati & Lin, 2013; Purnomo et al., 2020; Revina & Leung, 2019). The study of Revina & Leung (2019) shows that some Indonesian teachers often focus on achieving the curriculum objectives. Moreover, most current teacher education programs in Indonesia prioritize students' academic achievements (Bank, 2015). As a consequence, there is little emphasis on developing specific abilities such as mathematical reasoning.

As this research is specifically focused on teacher professional development in mathematics, the researchers conducted a study in the Netherlands and Indonesia to understand how RME was conducted in both countries and how the impacts of the teacher education program on their mathematical teaching. As a result, the implementation of Realistic Mathematics Education (RME) / *Pendidikan Matematika Realistik Indonesia* (PMRI) has posed significant challenges (Pramudiani et al., 2023). The reason of why the study was conducted in both countries is because of the historical background of RME. It was initially found and developed in the Netherlands (Freudenthal, 1991; Gravemeijer, 1994b; Van den

Heuvel-Panhuizen, 2020a, 2020b), and it was adapted and used in Indonesia since 2000 and continuing to the present (Prahmana et al., 2020; Sembiring et al., 2000; Zulkardi et al., 2020). In this research, RME becomes the underlying context and activities in the implementation of TPD Program. Therefore, it is expected by conducting the research in both countries would enrich the framework towards the design principles and prototype developed.

To elaborate deeper into the teacher education program in the Netherlands and Indonesia, particularly in mathematics, the researcher interviewed some Dutch educators and PMRI experts with experience providing mathematics training for teacher professional development in each country. According to one of the Dutch RME educators, the teacher education program in the Netherlands that she conducted emphasizes two important aspects: strengthening teachers' consciousness and teachers' reflection regarding mathematical teaching. Based on her experiences, these aspects help teachers improve their understanding of students' thinking in mathematics. Whereas, based on the interview with some PMRI teacher trainers, most in-service teacher training for PMRI focused on RME principles. These principles are the main focus of PMRI training, which has been conducted from the year 2000 to present.

Achieving RME can significantly change an individual's perspective on mathematics and make mathematical teaching more comprehensible for teachers and students (Zolkower in Van den Heuvel-Panhuizen, 2020a). Therefore, the creativity of teachers in applying appropriate mathematical contexts is crucial. Creative teachers can promote the learning process, particularly in mathematics, which is often considered a challenging subject requiring various cognitive skills (Salihu et al., 2018). Creativity is not only crucial in mathematics but also it becomes a necessity in the 21st century learning (Ardiansyah & Asikin, 2020). However, according to Bakker (2018), teachers prefer staying within their comfort zones as implementers rather than acting as researchers or (co)designers. Astari et al. (2021) confirmed that traditional learning approaches lead to passive student engagement, and lower mathematical proficiency. Therefore, teachers' creativity can be stimulated through problem-solving approaches and structured tasks using

meaningful contexts (Jupri & Hidayat, 2022; Murtafiah et al., 2021). The improvement of teacher professionalism aligned with educational needs is crucial.

In the context of teachers' willingness to self-development through joining Professional Development in Indonesia, an interesting issues were identified by Wijaya & Sumarno (2017). The issue was that only a few teachers voluntarily participated in the training. Furthermore, this lack of participation was attributed to the teachers' feelings of inadequacy or less of confidence.

Moreover, PMRI which is believed to be the only Teacher Professional Development (TPD) program focused on mathematics, has not been evenly distributed for all schools in Indonesia. Starting from 2000, PMRI has involved more than 20 provinces in Indonesia (Zulkardi et al., 2020) and continues until this year to intensively expand the program in partnership with several Indonesian primary school teachers. They receive coaching from PMRI experts through the series of professional development program. However, Syahril (2018) indicated that PMRI training lacked effectiveness in coherence and alignment between professional development, curriculum, and assessment. In addition, Wijaya & Sumarno (2017) found that mathematics teachers often lack innovative ideas to creatively craft lesson plans due to time constraints, lack of confidence, and insufficient materials. Hence, strengthening teachers' noticing and reflective ability of the importance of students' development in learning mathematics is crucial. This can be achieved through a teacher education program oriented to promote students' mathematical reasoning.

According to the preliminary study conducted by the researchers, formal or traditional procedures were found in teaching mathematics, especially in teaching fractions. In terms of students, it was indicated that there were several students' struggles in understanding fractions namely making references to the whole, making references to the complete partition, and making sense of the incomplete partition (Pramudiani et al., 2022). Therefore, the task design context developed in this research is focused on fractions.

1.2 Research Question

While students' mathematical reasoning is very important for mathematical content goal, teachers' foundational abilities in implementing constructivist/ active-

based learning must be addressed in line with the RME approach. Thus, the research question for this study is: "What are the characteristics of effective in-service Professional Development program in promoting students' mathematical reasoning within the realistic context?" This research question is elaborated on several sub-research questions, namely:

a. What constitutes primary school teachers in promoting students' mathematical reasoning?
b. What is the level of teachers' ability to promote students' mathematical reasoning?
c. How tasks with mathematical reasoning orientation be used in the teacher professional development program?
d. What activities/ learning pathways and conditions of success are required to implement Primary School Teacher Professional Development in Promoting Students' Mathematical Reasoning?

This research provides detailed insights into how Teacher Professional Development (TPD) in mathematics can be implemented effectively.

1.3 Aims of This Study

The study aims to fill the research gap concerning the limitations of TPD oriented to Students' Mathematical Reasoning (SMR). Specifically, the focus is on fostering Teachers' Noticing and Reflective Ability (*NARA*), inspired by the teacher education program conducted by some educators in the Netherlands. To achieve this goal, a task design characterized by its challenging nature while still incorporating the Realistic Mathematics Education (RME) approach that underpins its contextual development. This task is named as *CHANTIC* (Challenging Realistic) task design. This study aims to analyse the characteristics of an effective TPD program, including the role and level of teachers' abilities in promoting SMR. The main objective of this research is to investigate whether *CHANTIC* task design is eligible in eliciting Teachers' NARA and to what extent they contribute to promote SMR.

1.4 Significance of The Study

This study holds significancy in theoretical, practical, and policy aspects. From theoretical aspect, this study will give benefit for educators in primary school mathematics education and can become a reference for primary school teachers and students both in Indonesia and The Netherlands who were involved in this study. Moreover, for educators worldwide especially who are interested to apply RME approach in mathematical teaching. Through this study, the teachers will get benefit from applying the knowledge through the series of the design context and activities.

From the practical aspect, this study can help educators in mathematics education to develop teaching material related to mathematical concepts. In addition, information and knowledge about the task design will be helpful for teaching strategy to have more effective instructional processes in mathematical teaching. The products of this study comprise an international publication journal describing the task design series are eligible to promote students' mathematical reasoning. In addition, the study about how RME was implemented in both countries was also published in a national accredited journal. The results of this study can be an alternative solution of providing new insight into TPD in mathematics including what characteristics are necessary to make an effective teacher education program by eliciting the teachers' foundational abilities through the task design developed using the RME approach.

In terms of policy aspect, this research fits the current Indonesian curriculum, *Kurikulum Merdeka*, in which literacy and numeracy skills are the main components for the students who are taught more contextually. The task design developed in this research contains the mathematical contexts intended to strengthen students' literacy and numeracy skills through their own mathematical reasoning, in terms of strengthening Pancasila's student profile (*Profil Pelajar Pancasila*) which is following the Vision and Mission of the Ministry of Education, Culture, Research and Technology of the Republic of Indonesia, this research supports students' noble character, global diversity, collaboration, critical thinking, and creativity. Moreover, in this research, the students are allowed to explore their reasoning through the classroom settings and the role of teachers' noticing and reflective ability which can become the best practices for mathematical teaching. In

addition, building a learning community can become an alternative solution for teacher professional development.

1.5 Limitation of The Study

However, there is a limitation to this study. Since this study only involved several Dutch and Indonesian teachers, it could not be generalized. Due to the limited number of participants in this research, further research is needed to elaborate the effective design of Teacher Professional Development for students' mathematical reasoning in a broader area. Regardless of the limitation of the research, this finding can become a recommendation for designing teachers' professional development and fostering students' mathematical reasoning, especially in developing teachers' noticing and teachers' reflective ability for those interested in studying Realistic Mathematics Education.

1.6 Structure of the Dissertation

This dissertation is written in five chapters. In Chapter I, there is an introduction which discusses the background of the study including the research problems, research questions, research aims, significance of the study, and limitation of the study. Literature Review in Chapter II includes Students' Mathematical Reasoning, Teachers' Ability, Realistic Mathematics Education, Task Design, The Use of Task Design for Teacher Professional Development, Terminology, and Research Roadmap. Chapter III discusses the Research Method as follows: Research Design, Participants, Data Collection, Data Analysis, and Ethical Issues. Results and Discussion in Chapter IV includes Phase 1: Problem Identification and Needs Analysis, Phase 2: Design Development and Implementation, and Phase Evaluation. Conclusions, Implications and Recommendations are presented in Chapter V.