CHAPTER V
CONCLUSION

In the following sections, each of these sub-questions is addressed respectively with their corresponding answers, leading to the organisation of the fourth sub-questions dedicated to exploring the main research question. Subsequently, the implications and recommendations for prospective research are discussed.

5.1 Conclusion

According to the research findings, the professional development design prototype has an interesting outcome. The study aimed to use task design using challenging and realistic context as a starting point for teachers to promote students' mathematical reasoning. As a result of the objective, a main research question emerged "What are the characteristics of an effective in-service Professional Development program in promoting students' mathematical reasoning within the Realistic context?" This was 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 are tasks with mathematical reasoning orientation used in the teacher professional development program?
d. What are the activities/ learning pathways and conditions of success required to implement Primary School Teacher Professional Development in Promoting Students' Mathematical Reasoning?

5.1.1 What constitutes primary school teachers in promoting students' mathematical reasoning?

According to the research results, the interviewed Dutch teachers who implemented the mathematical problems and found the guided-reinvention principle difficult. However, it motivated them to do more practice. Like Indonesian

teachers who were the participants of this research, they also acknowledged that trying to be patient and not judging or directing students towards right or wrong answers is difficult. Despite the adversity, they still committed to use the RME approach because their experience showed that it enabled them to develop their creativity by exploring meaningful contexts suitable to students' mathematical reasoning.

Based on the findings about teachers' noticing and reflective ability, the teachers: 1) must possess the knowledge of learning flow; 2) must understand how students learn mathematics; 3) must observe and interpret students' behaviour accurately during mathematics learning; 4) must develop goal-oriented and diagnostic learning methods; and 5) must understand the different students' characteristics.

5.1.2 What is the level of teachers' ability to promote students' mathematical reasoning?

In the context of promoting students' mathematical reasoning, teachers should possess fundamental abilities such as teachers' noticing and reflection. Based on the findings, various levels of teacher's ability ranged from lack, limited, substantial, to robust were discovered. The result indicated that Task Design using the RME approach provokes teachers' noticing and reflective ability in various conditions. For teachers' noticing, the ability to attend has been mastered by almost all the teachers at the level of substantial and robust. However, the ability in interpreting students' responses was in the range of substantial and limited. Additionally, the teachers' ability of deciding was still varied from substantial, limited, and lack.

5.1.3 How tasks with mathematical reasoning orientation be used in the teacher professional development program?

The implementation of Professional Development using NARA (Noticing and Reflecting Ability) among teachers and integrated with CHANTIC task design in a realistic context demonstrated the opportunity to support students' mathematical reasoning. Those teachers' abilities could promote students' mathematical reasoning. Specifically, the indicator of "defining" is the one that students are most likely to achieve. And other indicators such as analysing, making

and investigating conjectures, determining, constructing arguments, and making conclusions could also be reached by the students.

5.1.4 What activities/ learning pathways and conditions of success are required to implement Primary School Teacher Professional Development in Promoting Students' Mathematical Reasoning?

The Teacher's Professional Development in promoting students' mathematical reasoning within the framework of Realistic Mathematics Education (RME) include: 1) Cultivating teachers' expertise in implementing the CHANTIC task design; 2) Reinforcing teachers' abilities in attending, interpreting, and deciding mathematical instructions; 3) Examining the different characteristics of SMR; and 4) Developing goal-oriented based on reflective and diagnostic classroom practices.

From the details of the sub-research questions and their corresponding answers, it can be concluded that the prototype of Design Principles of Primary School Teacher Professional Development has demonstrated its efficacy in promoting Students' Mathematical Reasoning. The following fact characterises the efficacy: 1) the foundational abilities, such as teachers' noticing and reflective ability possessed by the teachers should be addressed well; 2) the level of teacher proficiency should be at substantial or robust mastery in advanced category; 3) the task design that has features as challenging and realistic (CHANTIC) can be presented as mathematical reasoning orientation in the classroom practices as the part of TPD, and 4) the series of activities in TPD and classroom practices are focused to students' mathematical reasoning. In addition, the cooperation between teachers and the researcher as the developer should be built and maintained as a learning community. This community will contribute to supporting mathematical ideas, particularly in crafting lessons based on students' mathematical reasoning orientation.

To sum up, the design principles of Teacher Professional Development (TPD) with Students' Mathematical Reasoning (SMR) orientation encompass: 1) eliciting and advancing teachers' foundational ability level (Noticing and Reflective Ability/ NARA); 2) using challenging and realistic (CHANTIC) task design; 3) applying

the series of activities based on SMR; 4) building learning community (among teachers and researcher/ designer).

5.2 Implication

The development of this prototype is expected to significantly contribute to researchers, teachers, and lecturers interested in the mathematics field. This study is supposed to fill the research gap concerning the limitations of TPD to support students' mathematical reasoning.

The study is expected can serve as a reference, showing the significance of students' mathematical reasoning in achieving educational goals. Encouraging students to give their reasons can support their critical and creative thinking skills. In the 21st-century learning, there are some competencies students must master, such as effective communication, critical thinking, creativity, and collaborative ability. By promoting students' reasoning, especially in mathematics, which is known as a difficult subject, students will be better prepared to encounter many challenges in this era. This study also supports four key competencies necessitated of teachers namely pedagogical, personal, professional, and social competency.

Furthermore, since this study was conducted in Indonesia and The Netherlands, perhaps it could become a guideline for all educators in both countries on how to conduct an effective Teacher Professional Development. Since Indonesia's vast archipelago and numerous local wisdoms, we hope the collaboration between the two countries can benefit mathematical knowledge. Moreover, the collaboration also can open broader opportunities for other educators interested in developing Teacher Professional Development using Realistic Mathematics Education.

5.3 Recommendation

This research has resulted in many valuable findings. However, due to the limited number of participants in this research, further research is recommended to be conducted to understand better designing effective Teacher Professional Development programs for students' mathematical reasoning on a broader scale. This is especially for those who are concerned about conducting TPD in mathematics, such as the PMRI team, which has partnered with several schools in

13 provinces in Indonesia. It is also expected that more stakeholders can be involved in collaborative research to reach a mutual multidisciplinary such as *The Southeast Asian Ministers of Education Organization (SEAMEO) Regional Centre for QITEP in Mathematics* under the Indonesian Ministry of Education, Culture, Research and Technology (MoECRT). In addition, the research finding is expected to support the government of Indonesia, which has conducted numerous efforts to improve teachers' competence in education. These efforts coincided with realizing the national education goal based on *Undang-Undang Nomor 14 Tahun 2005 Tentang Guru Dan Dosen.*