CHAPTER I

INTRODUCTION

1.1. Background of the Study

Constructivist view on mathematics education has brought a great change in teaching and learning approaches. The change put the emphasis on the notion that student is the developer of their own knowledge. Instead of delivering learning material to the students, teachers' role today is guiding and supporting students' invention of viable mathematical ideas. Even though the learning activity is situated in a less directive way, the guidance given by the teacher will lead the students to reach the expected learning outcome. This is the feature that distinguishes constructivism from unguided discovery (Clements and Battista, 2009).

Even though constructivism has provided useful thinking framework for teacher to understand their student and the way they learn mathematics in a more meaningful way, it does not provide practical instruction of how to teach mathematics. It does not stipulate any particular model for teaching. It means that teachers have to create the didactical design by themselves. This makes sense since the didactical designs made by teachers may vary due to the characteristic differences of students, environments, and teachers' experiences. However, the task of making a didactical design on the basis of constructivist view is considered challenging for teachers. This is an issue that the mathematics education community has just started to handle (Simon, 1995).

The success of learning relies heavily on the preparation that teachers have. As professional, teachers are expected to make their own preparation of learning. But in fact, according to Suryadi and Turmudi (2011), teachers' preparations for mathematics instruction in general are only based on presentation model provided in the text book. They adopt it without making some re-contextualization and re-personalization. This is understandable since the text-book centered pedagogy has been culture of teaching for a long period of time.

Making their own constructivist didactical design for teachers is not easy. It requires a lot of preparation that combines their understanding of mathematics, their knowledge about the nature of mathematics and their experiences in pedagogical techniques. This initiative will replace the text-book centered pedagogy that dulls the teachers' mathematics activities (NCERT, 2006).

In doing their professional job, teachers should be able to overcome problems they encounter in the class. The major problem teachers typically find in their daily activities at the classroom is students' learning obstacles. These learning obstacles arise considerably when the material is getting more and more abstract. One of the materials considered to create learning obstacles among the students at high school level is the topic of absolute value. Teaching absolute value has its own difficulties. This is shown by the number and the variety of researches about it that have been published (*Wilhelmi, Godino, & Lacasta, 2007).*

Absolute value is a concept in mathematics which is defined only by several lines with very simple mathematical words. However, the concept of absolute value has become a terrifying monster for students. This bad image is created not only at the level this topic first introduced, but also at the higher level that requires absolute value as preliminary knowledge (Duroux 1983, 44).

The existing learning designs presented in many handbooks generally introduce the concept of absolute value using piece-wise function defining that $|x| = \begin{cases} x & \text{if } x \geq 0 \\ -x & \text{if } x < 0 \end{cases}$ (Neill & Quadling, 2002, p.18; Zandy & White, 2004, p.4; Purcell &Varberg, 1997, p.18). This is the basic definition that builds fundamental idea of absolute value and provides reliable means to solve absolute value problems algebraically. However, the piece-wise function of absolute value definition has posed learning obstacles for students. The obstacles have to do with the use of more than one formula in the definition (Brumfiel, 1980 p.24).

Many studies revealed more learning obstacles on absolute value. Duroux (1983) also Glorian & Jeanne (1995) identified that many students think of absolute value as number without sign. While Chiarugi, Fracassina & Furinghetti

(1990) found that the use of absolute value on variables posed more obstacles for the students than the use of it only on numbers. In its relation with other topics, further use of absolute value on equations and inequalities has posed the students to a more complicated and serious obstacles (Chiarugi, Fracassina, & Furinghetti, 1990 ; Pantsidis, Zoulinaki, Spyrou, Gagatsis and Elia, 2004 ; Ciltas and Tatar, 2011 ; Almog and Ilany, 2012).

The similar learning obstacles were also found among students in Indonesia. A diagnostic test on absolute value toward 87 students of SMA Krida Nusantara found that students participating on the test revealed some learning obstacles that are: (1) students believed absolute value as a means to change negative into positive, (2) students believed that solution for any problem of absolute value will always be positive, (3) students had difficulty dealing with absolute value equations and inequalities, (4) students were dependent upon the use of formula when solving absolute value problem and (5) students worked on integer when they are supposed to work on real number.

Learning obstacles shown by errors students made on their mathematics tasks are not erratic and fleeting. They don't arise by chance. They are caused by their existing knowledge adapted from their previous learning experiences. The obstacles are more likely to be persistent and reproducible when the students dealing with the same situation. It is essential for the teacher to identify and characterize the arising learning obstacles and the source that caused them in order to get empirical information in the process of analyzing and constructing the learning design for the students (Brousseau, 2002).

An ideal didactical design is a result of teacher's effort creating learning design that is developed continuously. In order to have a valid design that effectively build the expected learning outcome, it is required a research-based development of the design. Based on that reason, the researcher is motivated to conduct a didactical design research on the topic of absolute value to build students' strategic competence, adaptive reasoning, and productive disposition. The didactical design developed through this research activity is expected to be

solution for overcoming students' learning obstacles and building their mathematical proficiencies.

1.2. Statement of Problems

This research will study qualitatively several things namely:

1. How is the didactical design on the topic of absolute value developed to build students' strategic competence, adaptive reasoning and productive disposition?
2. How does the learning situation happen during the implementation of the developed didactical design in the classroom?
3. How are students' strategic competence, adaptive reasoning, and productive disposition built through the implementation of the developed didactical design in the classroom?

1.3. Research Objective

The aim of this research is to develop a didactical design on the topic of absolute value to build students' strategic competence, adaptive reasoning, and productive disposition. The didactical design will contain (1) learning material, and (2) learning scenario and the Didactical and Pedagogical Anticipation (DPA)

1.4. Expected Product Specification

The didactical design developed through this research is expected to create supportive learning environment that enable students to construct their own understanding on the topic of absolute value. The expected learning outcome as the results of implementing the didactical design are the strong emergence of mathematics proficiencies introduced by Kilpatrick, Swafford and Findell (2001) namely (1) conceptual understanding, (2) procedural fluency, (3) strategic competence, (4) adaptive reasoning and (5) productive disposition. As all of the proficiences emerge simultaneously for they are intertwined, learning all of the

proficiencies would be a very wide range of study. Therefore, to have deeper understanding on some specific concerns, this research will be focused on studying the emergence of the last three proficiencies.

1.5. The Importance of the Research

If this research were successful, the product of this resarch will give contribution in overcoming students' learning obstacle on the topic of absolute value. Teachers can either adopt or adapt the design to be used in their class. Furthermore, some findings from this research can be used by teachers as reference to develop their own didactical design on other topics. The more didactical design on various topic produced through didactical design research, the more students' learning obstacles will be overcome. Gradually, this will bring quality improvement for mathematics education in general.

1.6. Assumption and Limitation of the Research

This research focuses only on the topic of absolute value which belongs to obligatory and optional material of mathematics for the 10th grader in the 2013 curriculum. The subject of this research is students of Krida Nusantara Intergrated Senior High School in Bandung. Therefore, several limitation concerning this study that need to be considered are :

1. The characteristic of students in Krida Nusantara Integrated Senior High School might be different from students in other schools. Therefore, teachers who want to adopt the design to be used in their school need to consider the compatibility with the characteristic of students in their school. Re-contextualization and re-personalization towards the design and the learning scenario are strongly suggested for teachers before using them in the classroom.
2. The design produced by this research is only on the topic of absolute value with all typical characteristic on the topic.

1.7. Definition of Terminologies

Several terminologies need to be clearly defined to avoid different interpretation are:

1. Didactical Design: Learning plan that contains learning material, tasks, instructional activity for students that create an appropriate learning situation to construct students' knowledge and comprehension about certain topic.
2. Strategic Competence: Ability to formulate, represent, and solve mathematical problems
3. Adaptive Reasoning: capacity for logical thought, reflection, explanation, and justification.
4. Productive Disposition: Habitual inclination to see mathematics as sensible, useful, and worthwhile, coupled with a belief in diligence and one's own efficacy