Korean Primary School Teachers’ Conceptions of Foundations and Creativity in Mathematics

Mangoo Park (Seoul National University of Education)

I. Introduction

Mathematics is unique in that mathematical concepts require learners to understand their abstractness. Even though teachers use concrete manipulatives for introducing mathematical concepts, they eventually need to ‘teach’ intangible mathematical concepts to students. Thus, the teaching methods vary from teacher to teacher and teachers’ teaching practices are also affected by their conceptions of mathematics (Andrews & Hatch 1999, 2000; Beswick, 2004; Diakidoy & Kanari, 1999; Hong & Kang, 2010; Hoz & Weizman, 2009).

Foundations of mathematics have long been the subject of debate in the history of mathematics (e.g., Chaitin, 2000; Marek & Mycielski, 2001). Foundations of mathematics have been recognized in various manners (Shapiro, 2004). The detailed philosophical definition of foundations of mathematics is beyond the scope of this study and the definition of it is added in the next section. In this study, I regarded the foundations of mathematics as essential and important mathematical components—concepts and skills—that students should learn. Foundations of mathematics are emphasized in the Principles and Standards for School Mathematics (National Council of Teachers of Mathematics, 2000) as content standards such as number and operations, algebra, measurement, and data analysis, and as process standards such as problem solving, reasoning and proof, communication, connections, and representation. The recently revised Korean mathematics curriculum (Ministry of Education & Human Resources Development [MOE & HRD], 2011b) also emphasizes foundations of mathematics as basic skills, concepts, principles, and patterns (p.3).

Contrasting to the long-debated issue of foundations of mathematics, researchers recently drew attention to creativity in mathematics. Regardless of slight differences, creativity has been emphasized in every field of contemporary society. We often use the terms like ‘creative thinking,’ ‘creative management,’ ‘creative man or woman,’ ‘creative problem solving,’ and so forth. Creativity in mathematics is also appreciated in most mathematics curricula (e.g., National Council of Teachers of Mathematics [NCTM], 1989, 2000) and the revised Korean mathematics curriculum Ministry of Education & Human Resources Development [MOE & HRD], 2011b). The Curriculum and Evaluation Standards for School Mathematics (NCTM, 1989) recommends teachers include “open-ended problems with no right answer” (p.6). The Learning Principle in the book (NCTM, 2000) emphasizes the need to go beyond rote memorization and basics saying, “students need to learn a new set of mathematics basics that enable them to compute fluently and to solve problems creatively and resourcefully” (p.1) and “students must learn mathematics with understanding, actively
building new knowledge from experience and prior knowledge" (p.20).

The Korean mathematics curriculum (MOE & HRD, 2011b) emphasizes creativity in mathematics as "producing new ideas and challenges" (p.1) to make an ideal human. It also includes "creative problem solving" (p.3) as a goal, and "creative thinking ability based on mathematical knowledge and skills" (p.131) in the teaching, learning, and evaluation requirements. International studies, including Trends in International Mathematics and Science (TIMSS) (National Center for Educational Statistics, 2011) and the Program in International Student Assessment (PISA) (OECD, 2010) also include creative ideas in their test items.

Mathematics has been considered as a subject with which students can foster logical thinking (Whitehead & Russell, 1910) which has different brain functions compared to creative thinking (Carter, 2009). With this view, foundation building and fostering creativity are the main interests for mathematics educators although both topics are not given much attention at the same time. There have been several studies on conceptions of mathematics and creativity related to mathematics, respectively (e.g., Hox & Weizman, 2008; Laborde, 2007; Marek & Mycielski, 2001). Hox and Weizman (2009) investigated official conceptions of mathematics concerning the nature of mathematics. They assembled the ideas about mathematics and about its teaching mathematics. Concerning creativity in mathematics, there have been several studies (e.g., Alughaiman & Mowrer-Reynolds, 2005; Bolden, Harris, & Newton, 2010; Silver, 1997). Bolden, Harris, and Newton (2010) analyzed pre-service primary teachers' conceptions of creativity in mathematics in the United Kingdom. Silver (1997) suggested fostering creativity strategies through instruction enrich mathematical problem solving and problem posing. He argued that mathematics educators should view creativity not as the domain of only a few exceptional individuals but rather as an orientation or disposition toward mathematical activity that can be fostered broadly in the general school students.

Korean students have routinely scored high at the TIMSS (National Center for Educational Statistics, 2011) and PISA (OECD, 2011). However, Korean students spend almost double the amount of time studying compared to the time spent by other OECD students. In addition, their attitude toward mathematics is quite negative among participating students (National Center for Educational Statistics, 2011). Being aware of this problem, the Korean government emphasizes creativity in the mathematics curriculum and in the process of teaching and learning mathematics (MOE & HRD, 2011b).

Recently, the Korean government suggested that teachers should encourage students to use the STEAM (Science, Technology, Engineering, Arts, and Mathematics) model as an integrated approach to enhance students' creativity in instruction (MOE & HRD, 2011a). Teachers' conceptions of foundations and creativity in mathematics can significantly affect their teaching methods when they help students foster the foundations and creativity of mathematics (Brunkalla, 2009). However, few related research has investigated in subject areas and teachers have limited understanding of creativity. For instance, Hong and Kang (2009) argued that Korean science teachers had narrow conceptions of creativity.

Some found that there could be a closer relationship between conceptions and teaching (e.g., Beswick, 2004; Strauss, 1999), and teachers' beliefs about the nature of knowledge would impact their teaching plans and practices (Hofer & Pintrich, 1997; Lerman, 1990; Thompson, 1984). Studies on foundations and creativity in mathematics have been conducted in many countries (e.g., Alughaiman & Mowrer-Reynolds, 2005; Andrews & Hatch, 1999; Fryer & Collings, 1991; Kampylis, Berki, &