Socio-Mathematical Norms In Mathematical Reasoning-And-Proving Process: Case Study Of Preservice Mathematics Teachers

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Current research findings show that the nature of mathematics teaching significantly affects the nature and results of student's learning (Anthony & Walshaw, 2009a). On the other hand, teachers affect their students in ways of their respective values, their futures, the way they participate in society and how they shape their lives. Even though this may be seen as a heady responsibility for teachers, this is actually the real reward for being a teacher (Schoenfeld, 2009). In another aspect, this situation reveals the importance and requirements of a good mathematics teacher regarding the effective teaching process. Anthony & Walshaw (2009a, 2009b) describe the characteristics of effective mathematics teaching, including these importances and requirements within the contexts of class community, class discourse, mathematical tasks, teacher learning, and knowledge. If we were to examine some of these characteristics, we would get the following information:

- Effective teachers can provide students with opportunities to work both independently and collaboratively to express their ideas.
- Effective teachers can facilitate intraclass dialogues focused on mathematical discussion.
- Effective teachers can develop and use solid knowledge to begin learning and respond to the mathematical needs of all their students.

Recognizing the characteristics of effective mathematics teaching is an increasingly important issue of today. This is because both the rapid changes in the world and the characteristics shaped with the current needs of the dynamic society have directly affected the students' interests and needs and expectations from education (Ministry of National Education [MEB], 2018). This situation shows that there is a need for individuals that have the qualifications of overcoming problems, critical thinking, skills of communicating, feeling empathy and etc. Teachers are the ones to raise individuals that have those qualifications. In this respect, when the mathematics

teacher's special field competencies of MEB (2017) are examined; It is seen that the development of the qualifications indicated with competency indicators such as being able to organize suitable environments for teaching, improves students' reasoning, association and communication skills. In mathematics teaching-learning environments, the importance is given to concepts such as accepting and not accepting, reasoning, and communicating a thought gains meaning with the concept of the socio-mathematical norm. With socio-mathematical norms, the students are able to understand situations that are considered as mathematical explanations. By understanding socio-mathematic norms, it becomes possible to interpret classroom interaction, students' mathematical activities, and teachers' actions to create teaching and learning opportunities (European Mathematical Society [EMS], 2013; Yackel & Cobb, 1996) . For mathematics educators and mathematicians, the subject area that requires understanding, sense-making, interpretation, and reasoning is called mathematical proof (Yackel & Hanna, 2003). The effect of mathematical proofs when explaining and communicating for mathematics education is commonly seen. But in the past students made use of proofs generally as a final verification method. Therefore, many students have the misconception of thinking that a few examples of proofs are sufficient enough to prove the reality of mathematical generalizations. In addition to this, there are few application-based research studies addressing the teaching and learning of proof (Stylinides & Stylianides, 2017).

It is important for the students to make individual and group studies about the proofs in order to determine the deficiencies and limitations in their knowledge regarding their proving skills and to improve them (Uğurel & Moralı, 2010). Fukawa-Connelly (2012), who gave this opportunity to his students, conducted a research on proof-writing, understanding, and comprehension in an abstract algebra degree at the undergraduate level, and concluded that positive situations occurred in students who undertook individual and social responsibility. He also observed the emergence of classroom norms such as taking responsibility, reading carefully, persuading himself, asking questions, answering questions, and using information approved by his peers. Fukawa-Connelly (2012) stated that these norms lead students to cognitive processes that are useful when they are making proof and understanding proof.

In this study, it is aimed to investigate the mathematical reasoning -and-proving (R-P) processes of prospective mathematics teachers from a social perspective. The study was designed as a case study from qualitative research patterns because it requires an in-depth investigation of a limited system based on extensive data collection (Creswell, 2012). The participants consisted of three mathematics teachers and were selected with purposive sampling method supported by qualitative research methods in order to obtain the data suitable for the purpose of the study. A communication environment is one of the most important factors for revealing the norms considered important for the purpose of research. The second necessary factor is the existence of tasks that give socio-mathematical meaning to norms. They also give an explanation mathematically value, understand the situations that are accepted in the mathematical context and what constitutes the mathematical difference. For these purposes; multiple data collection tools were used to provide diversity of data and to obtain complete and in-depth answers to research questions. These; (a) proof tasks in different categories (b) video-audio recordings of all communications that occur during the performing of proof tasks (c) interviews and (d) investigative observation notes.

The data obtained in the scope of the research has been through content analysis with the support of video and audio recording transcription. In the analysis of the data; The socio-mathematical norm observation tool developed by Durfee (2018) and the Interpretive Framework developed by Yackel & Cobb (1996) were used. In this context, it was tried to determine the socio-mathematical norms of mathematics teacher candidates in the process of R-P and their emergence process. In this process, socio- mathematical norms exhibited in the literature (Yackel & Cobb, 1996; McClain & Cobb, 2000; Lopez & Allal 2007; Tatsis & Koleza, 2008) and socio-mathematical norms exhibited during the R-P process are correlated.

As a result of the research, during the R-P process the following socio-mathematical norms have emerged; (a) comparison of constraints based on mathematical reasoning, explanation and justification processes (b) providing and specifying the necessary conditions based on acceptable mathematical explanation (c) making explanations based on mathematical differences in the R-P making process and (e) the clarity of mathematical expressions. In addition, it is determined that socio-mathematical norms have emerged from (a) understanding the question (b) trying to understand the solution of others (c) developing common solutions (d) specifying the validity of the solution and (e) explaining the solution based processes. The findings of the study revealed that mathematics teacher candidates have improved positively in terms of socio-mathematical norms and mathematical proofs that emerged during the R-P process. As a result, it is thought that this study will contribute to the literature due to the interpretation of the socio-mathematical norms that emerge during the R-P process and the contribution of the preservice teachers to the professional development of the reasoning-and-proving process.

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