

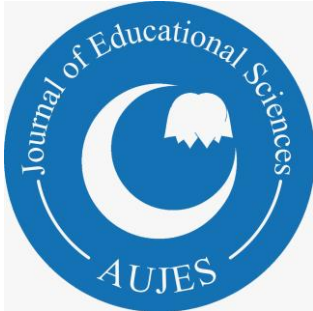
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**Examining the Opinions of Prospective
Mathematics Teachers on
Sociomathematical Norms**

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Examining the Opinions of Prospective Mathematics Teachers on Sociomathematical Norms

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Abstract

The aim of the study is to examine prospective mathematics teachers' opinions regarding the definition of sociomathematical norms, the factors (variables) that are effective in the establishment of sociomathematical norms, and the negotiation of sociomathematical norms. This study was conducted with 10 prospective teachers in the primary school mathematics teaching undergraduate program of a state university located in the Mediterranean Region of Türkiye. The participants of the study, in which the special case approach was adopted, were prospective mathematics teachers in the course on "Sociomathematical Norms in Mathematics Teaching". The data were collected through semi-structured interviews and classified under certain categories with content analysis. The results showed that prospective mathematics teachers defined sociomathematical norms according to individual (such as attitudes and beliefs) and social (such as rules, obligations, and expectations) perspectives. In addition, prospective mathematics teachers stated that sociomathematical norms are directly affected by factors such as students, teachers and classroom atmosphere, and indirectly by factors such as family and school. Finally, prospective mathematics teachers emphasized that the negotiation of sociomathematical norms can provide opportunities in terms of learning (skills and autonomy), teaching (participation and intervention) and management (communication and control). In this context, taking into consideration the opinions of prospective mathematics teachers regarding sociomathematical norms is valuable in terms of increasing the efficiency of mathematics applications.

Keywords: Primary school mathematics teaching, Prospective mathematics teachers, Sociomathematical norms, Opinions

Introduction

Norms regulate patterns of interaction in the classroom microculture. In other words, it is a grammatical system that governs the actions and discourse of class members. In this context, the normatives of class members' discussions specific to mathematical applications can be expressed as sociomathematical norms (such as what is mathematically different, efficient or sophisticated). The discovery of sociomathematical norms has been an important turning point in mathematics teaching (Levenson et al., 2009). As a matter of fact, the European Mathematics Committee has claimed sociomathematical norms as one of the seminal findings in mathematics teaching. It also stated that sociomathematical norms can provide effective and valid understandings in structuring learning/teaching in the mathematics classroom (Partanen, 2011). Therefore, examining how sociomathematical norms, which are an important component of the mathematics classroom microculture, are defined by class members is valuable in terms of the efficiency of mathematics teaching.

With sociomathematical norms beginning to become the focal point (Toscano et al., 2019), the number of researches increased. While some of the studies examine how sociomathematical norms are established (Güven & Dede, 2017; Dixon et al., 2009), others focus on the role of the teacher in establishing them (Kang & Kim, 2016; Tatsis & Koleza, 2008). Similarly, while some studies have focused on the conservation of sociomathematical norms (Sekiguchi, 2005), some others have examined the relationship between the negotiation of sociomathematical norms and conversations (Gorgorio & Planas, 2005). Negotiation of sociomathematical norms is an endeavor to reach a common point. In other words, it means establishing mathematical validity criteria in classroom discussions (Author). By negotiating sociomathematical norms, class members can compare proposed ideas and gain insight into which is valid. In this context, negotiation of sociomathematical norms can be used as an effective tool to disclose mathematical opportunities. However, almost all of the above studies assessed sociomathematical norms using didactic approaches (for how to teach mathematics better rather than how to learn mathematics better). This situation can be considered a limiting factor in our understanding of how the negotiation of sociomathematical norms is perceived by class members. Therefore, it is important to analyze

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what class members consider regarding the negotiation of sociomathematical norms in order to better understand the impact of actions/discourses on the classroom microculture.

Those responsible for learning/teaching based on the interaction between class members have an active role in the establishment and development of norms in the classroom (Partanen & Kaasila, 2015). However, Levenson et al. (2009) mentioned that the sociomathematical norms in endorse in the classroom may be different from the sociomathematical norms that are tried to be put into enact. This brings new responsibilities to teachers, prospective teachers and educators. Pedagogical knowledge and skills that promote the realization of these responsibilities have an important place in undergraduate education. In this context, opinions about what affects sociomathematical norms are also valuable in terms of testing the validity of existing pedagogical knowledge and allowing us to understand its working principles. Therefore, considering that the perspectives of prospective teachers throughout their undergraduate education represent their professional development and practices, it can be said that their views on norms will also be effective in structuring the classroom microculture. In this context, the opinions of prospective mathematics teachers at the beginning of their teaching careers regarding sociomathematical norms are valuable for the teaching that will take place in mathematics courses. According to the phenomenological perspective claims those experiences modify human behavior and that behavior is modified according to desires, beliefs and/or perceptions. The perspective also advocates people who experience similar phenomena establish different meaning. In this context, individuals' past experiences are as significant as their current experiences. Therefore, it may be important to consider characteristics such as gender, grade and field of graduation when evaluating the opinions of prospective primary school mathematics teacher regarding sociomathematical norms. In addition, there is a need for exhaustive information about each classroom microculture, starting from the basic steps in the mathematics teaching (Yackel & Cobb, 1996). This could be achieved by understanding the views on the norms of microcultures, especially in primary school mathematics classes. Therefore, analyzing the perspectives on what may affect the sociomathematical norms of primary school mathematics classes that focus on understanding and try to develop higher-order thinking skills will support the field in new ways.

In line with the explanations above, the problem of this study is to investigate the opinions of prospective primary school mathematics teacher regarding sociomathematical norms. Although sociomathematical norms demonstrate themselves in discussions conducted in classrooms, opinions of teachers or prospective teachers who lead these discussions will contribute to the understanding of sociomathematical norms. In this context, purpose of the study is to clear the thoughts of prospective primary school mathematics teachers considering the nature of sociomathematical norms, the factors affecting sociomathematical norms, and the effects of negotiating sociomathematical norms.

Method

In this study, since the opinions of prospective primary school mathematics teachers considering sociomathematical norms were analyzed in detail, a special case study was preferred among the qualitative research approaches. In addition, the study was designed as an internal case study (Yıldırım & Simsek, 2011) in order to understand more comprehensively the opinions of prospective mathematics teacher regarding the definition of sociomathematical norms, the factors influencing sociomathematical norms, and the effects of negotiating sociomathematical norms. The purpose of the internal case study is to analyze a specific group in a multifaceted, systematic and comprehensive way, rather than developing general theories or making generalizations to a larger sample (Baxter & Jack, 2008).

Participants

The study was conducted with 10 prospective teacher in the primary school mathematics teaching. T1, T2, T3... T10 were used to designate participants in order to keep their identities confidential. 7 of the participants were female and 3 male, 1 was a senior student, 4 were 3rd graders, and the remaining were 2nd graders. In addition, 7 of the participants graduated from high school in the field of mathematics-science and 3 of them graduated from the field of literature-mathematics (see Table 1). In the field of mathematics-science, individuals engaged in higher-level mathematical skills (algebra, proof, etc.), while in the field of literature-mathematics, they focused on basic skills (arithmetic, etc.).

Table 1. Characteristics of participants

Participants	Gender	Grade	High school graduation
T1	Female	4	Mathematics-Science
T2	Female	2	Mathematics-Science
T3	Male	2	Mathematics-Science
T4	Female	2	Mathematics-Science
T5	Female	3	Mathematics-Science

T6	Male	2	Mathematics-Science
T7	Male	3	Literature-Mathematics
T8	Female	3	Literature-Mathematics
T9	Female	3	Literature-Mathematics
T10	Female	2	Mathematics-Science

In the study where the purposeful sampling method was preferred, the participants consisted of prospective teachers in the course on “Sociomathematical Norms in Mathematics Teaching (SNMT)”. The content of SNMT incorporated theoretical foundations of sociocultural approaches, components of mathematics classroom microculture, establish/negotiation of sociomathematical norms, and characteristics of sociomathematical norms according to grades. Detailed information about the week, duration and content of the course are presented in Table 2. The instructor of the course conducted longitudinal studies on sociomathematical norms and experienced in teaching the course.

Table 2. Week, duration and content information of SNMT

Week	Duration	Content
1-4	(8x40 minutes)	<ul style="list-style-type: none"> •Explains the significance, arguments and historical development of sociocultural approaches in mathematics education. •Explains the reflections of symbolic interactionism on mathematics education. •Explains the reflections of ethnomethodology on mathematics education. • Explains the reflections of phenomenology on mathematics education. • Explains the reflections of constructivism on mathematics education.
5-8	(8x40 minutes)	<ul style="list-style-type: none"> • Explain the interpretive framework • Explains the significance of social norms in terms of classroom microculture •Explains the significance and negotiation of sociomathematical norms • Explains the significance of mathematical practices in classrooms regarding teaching mathematics.
9-12	(8x40 minutes)	<ul style="list-style-type: none"> •Explains the establishment of sociomathematical norms • Explains the factors affecting the establishment of sociomathematical norms • Explains the negotiation process of sociomathematical norms • Explains the relationship of negotiations to learning opportunities
13-14	(4x40 minutes)	<ul style="list-style-type: none"> • Explains the normatives adopted in primary school mathematics teaching. • Explains the characteristics and negotiation of sociomathematical norms in secondary school

Data Collection

In the study, a semi-structured interview form consisting of five open-ended questions was used to determine the opinions of prospective mathematics teachers regarding sociomathematical norms. The questions in the interview form were analyzed and their convenience was assessed by two experts in the field. Initially, seven open-ended questions were created, but two questions were removed from the interview form in line with the suggestions of experts. Some questions were corrected to reflect a complete meaning. Later, interviews were conducted with three prospective mathematics teachers who were not included in the study to test whether the prepared questions were understandable.

The first question targets understanding how the prospective mathematics teachers perceive and define sociomathematical norms, the second question targets understanding how the factors affecting sociomathematical norms are assessed, and the last three questions target understanding the participants' evaluations of the negotiation of sociomathematical norms. Questions in the interview form;

1. What is the sociomathematical norm according to you (How would you define the sociomathematical norm)? Explain
2. Which factors affect sociomathematical norms? Explain.
3. What effects does negotiation of sociomathematical norms have for the teacher, students, classroom microculture, and mathematics learning/teaching? Explain.
4. Do you think sociomathematical norms are/will be effective in your own professional development? Explain.

5. What kind of pedagogical additions the course(s) you took in undergraduate studies make to sociomathematical norms?

At the end of the 14-week course, face-to-face interviews were held with each student. Before the main interview, preliminary interviews were organized with prospective primary mathematics teachers, they were informed about the purposes of the study, and the appropriate day and time were decided. Each interview lasted 25-35 minutes and was conducted in person. The interviews were also recorded with a voice recorder and notes were taken.

Data analysis

The data collected in the study was analyzed using the content analysis method. In this process, first the data must be encoded. Then, categories that best explain these codes are created and the data must be organized and interpreted according to these categories (Yıldırım & Simsek, 2011). The answers to each question asked to the participants were examined comprehensively. Each response was reviewed and inductive analysis was applied during the analysis process. This method offers an important advantage and convenience for organizing qualitative data. During the coding process, certain words or sentences were used to describe and separate the data into meaningful sections. Categories were formed based on the common features of the obtained codes. This can be used to separate codes into categories that can describe them at a general level. An expert mathematics educator accompanied the coding of the data. In order to resolve disagreements in the codes and achieve consensus, differences between the codes were discussed and the approved codes were included in the study. The formula (reliability=consensus/(consensus+disagreement)) developed by Miles and Huberman (1994) guarantees the reliability of coding. The coding reliability made by the coders independent of each other was 0.92. Since it is recommended to quote data directly in qualitative research for the reliability of the study (Yin, 2011), some opinions of the participants were directly reflected in the study.

Ethics approval

The ethics committee approval of this study was granted by Mersin University Social and Human Sciences Ethics Committee with the decision dated 31.12.2023 and numbered 323.

Results

The results are presented as opinions on the definition/nature of sociomathematical norms, opinions on the factors affecting sociomathematical norms and opinions on the negotiation of sociomathematical norms.

Opinions on the Definition/Nature of Sociomathematical Norms

This section includes the opinions of prospective primary school mathematics teachers regarding what sociomathematical norms are. The codes and categories resulting from the analyses are presented in Table 3.

Table 3. Codes and categories related to the definition/nature of sociomathematical norms

Participants	Codes	Subcategories	Categories
T9, T7, T8	Reactions related to mathematics	Attitudes	Individual perspective
T7	Beliefs about mathematics	Beliefs	
T1, T2, T3, T10	Mathematical procedures	Rules	Social perspective
T4	Things to do about mathematics	Obligations	
T6, T2	Things to do not about mathematics		
T5, T9	Requests from each other about mathematics	Expectations	

The opinions of prospective mathematics teacher regarding the nature of sociomathematical norms and what they are were separated into two categories: individual and social perspectives. In the individual perspective category, two subcategories were determined as attitudes and beliefs. In the attitudes subcategory, participants defined sociomathematical norms as the reactions of the person regarding mathematics. Sample statements are presented below;

T9; “I think mathematics has a unique structure, for example, when solving a problem, I first model it by visualizing... Sociomathematical norms like these are our reactions to mathematics...”

T8; “They are the reactions that occur when a person does mathematics.”

The other subcategory that comes forward in the individual perspective category is belief. In this subcategory, it was observed that the participants assessed sociomathematical norms as beliefs that individuals have about mathematics. Sample statements of the participants were presented below;

T7; “Sociomathematical norms are the beliefs that individuals have about the nature of mathematics, such as associating mathematical concepts with real life... Because, in fact, mathematics emerged from real life.”

It was determined that the statements in the subcategories of attitude and belief were made by prospective teachers who graduated from literature-mathematics in high school. This demonstrated that prospective teachers' perspectives on the sociomathematical norms of the high school field they graduated from are decisive. As a matter of fact, prospective teachers who graduated from literature-mathematics in high school mostly assessed sociomathematical norms from the individual perspective.

Another category that emerged regarding what sociomathematical norms are is the social perspective. This category includes three subcategories: rules, obligations and expectations. In the rules subcategory, participants represented sociomathematical norms as jointly established procedures within the classroom. Sample statements of the participants are presented below;

T1; “They are mathematical rules that are applied in the classroom with or without the influence of the teacher. When finding the percentage of a number, it's like dividing by the denominator and then multiplying by the numerator...”

T3; “When I think of sociomathematical norms, I think of the procedures accepted by everyone regarding mathematics. Everyone knows that the operations with parentheses should be done first in the operation priority...”

T10; “...are unwritten common rules in mathematics teaching.”

Prospective mathematics teachers who expressed their opinions in this category graduated from mathematics-science in high school and interpreted the norms as rules related to mathematics, in other words, actions.

In the obligation subcategory, prospective mathematics teachers described sociomathematical norms as obligatory situations that class members establish together and that everyone must or must not comply with. Additionally, the participants stated that these obligatory situations should be taken into consideration. Sample statements of the participants are presented below;

T4; “When we say sociomathematical norms, what comes to my mind is obligations that we have developed during mathematics activities in the classroom and that we must (not) comply with... Everyone should pay attention to these obligations to make mathematics more understandable. Because everyone is in this class for the same purpose.”

T6; “Sociomathematical norms are obligations established by the teacher and the students, without realizing it, through mathematics...”

The prospective mathematics teachers who expressed their opinions in this subcategory were studying in the lower grades. This situation demonstrated that prospective primary school mathematics teachers perceive sociomathematical norms as a requirement in the early stages of their pedagogical education.

In the expectations subcategory, participants generally defined sociomathematical norms as the mutual wishes or expectations of class members. The statements of the participants who expressed their opinions in this category are presented below;

T5; “I can define it as something that the teacher expects from the students in the classroom. In other words, they are requests related to mathematics... Such as the teacher asking the students to explain the solution or provide a justification...”

T9; “...are mutual expectations about mathematics. What do students actually expect from teacher? The teacher can think about this. Do I teach mathematics in accordance with the students' wishes? Am I providing the classroom environment they want? Likewise, what do teacher expect us to do for students? They can think about it. Of course, as a result of this, if everyone clearly understands each other's expectations, this will have a positive impact on doing mathematics, and a better classroom environment will be provided as everyone knows each other's expectations.”

Prospective mathematics teachers who expressed their opinions in this subcategory described sociomathematical norms as expectations. They noted that mutual expectations of class members also affect mathematics learning/teaching in the classroom. Participants with this view were predominantly women. This brings to mind the idea that gender may have an effect on opinions about what sociomathematical norms are.

Opinions on the Factors Affecting Sociomathematical Norms

This section includes the opinions of prospective primary school mathematics teachers regarding the factors affecting sociomathematical norms. The codes and categories obtained as a result of the analyzes are shown in Table 4.

Table 4. Codes and categories related to the factors affecting sociomathematical norms

Participants	Codes	Subcategories	Categories
T7, T10	Mathematics learning style	Student	Direct
T6, T7, T8	Mathematics readiness		
T1, T9	Teaching method	Teacher	
T5	Perspective on mathematics		
T5, T9	Professional development/undergraduate education		
T1, T7	Physical facilities of the classroom	Classroom atmosphere	
T3, T5	Interaction in the classroom		
T2	Socioeconomic status	Family	
T4	Cultural structure at school	School	

When the opinions of prospective mathematics teachers regarding the factors affecting sociomathematical norms were analyzed, two categories were named: direct and indirect effects. In the direct category, three subcategories were observed: student, teacher and classroom atmosphere. In the student subcategory, participants emphasized learning style and readiness. Sample statements are presented below;

T6; “Student's mathematical experiences affect the norms; for example, students whose learning style is operational may adopt more behavioral/symbolic norms than conceptual ones...”

T7; “...students with good readiness contribute more to the formation of norms...”

Participants noted that teacher was another factor affecting sociomathematical norms. They mentioned that the teacher's understanding of teaching, his perspective on mathematics, and his professional pedagogical education directly affect sociomathematical norms. Sample statements of the participants are presented below;

T1; “The teacher's perspective on mathematics, for example, mathematical conversations in classrooms where teacher-centered teaching and student-centered teaching is carried out, will be different, which will affect sociomathematical norms...”

T5; “I think pedagogical education is very effective... For example, algebra is a subject that students have difficulty with. In general, they have difficulties, but we had seen the sociomathematical norms that came to the fore in undergraduate education and affected students' learning, so we had the opportunity to see in the course why and how students do something in teaching algebra. Seeing these in undergraduate education will affect the sociomathematical norms in our own classrooms. In this context, I think that courses on sociomathematical norms should be compulsory rather than elective in undergraduate education.”

T9; “Each teacher may care about different things. For example, some may care about the strategies and solutions developed for the problem, while others may only care about whether the answer to the question is correct or not; such understandings can pave the way for the development of different sociomathematical norms in the classroom...”

The statements in this subcategory were expressed by prospective teachers in upper grades. This demonstrated that prospective primary mathematics teachers in the upper grades assessed the factors affecting sociomathematical norms in the context of teachers and teaching, and that they had the opinion that pedagogical (undergraduate) education was more effective on sociomathematical norms.

Another subcategory within the direct category was classroom atmosphere. Participants generally stated that the interaction design in the classroom, class size, or physical equipment such as materials were effective on sociomathematical norms. Sample statements of the participants are presented below;

T1; “sometimes class size or lack of materials can limit the mathematical proficiency of class members, which can affect the use of mathematical skills and the nature of sociomathematical norms in the classroom...”

T3; “The way students interact with each other or with the teacher has an impact on sociomathematical norms.”

T5; “The impact students have on their peers can be significant. For example, if someone expresses his mathematical ideas easily, others can also emulate him and express their own mathematical ideas. That's why I think the classroom atmosphere is important.”

T7; “Even the decoration of the classroom can be effective, anything you see in the classroom can affect the discovery of mathematical structure in terms of increasing the student's motivation.”

According to the analysis of the data obtained, another category that affected sociomathematical norms was indirect effects. This category included two subcategories. Sample statements of participants in the family subcategory are presented below;

T2; “I think the family the student lives in can also have an impact on sociomathematical norms. In other words, the family's interest and socioeconomic status are effective on the student's mathematical experience, knowledge, fear, prejudice and understanding...”

In the school subcategory, participants stated that the school's facilities and cultural environment were especially effective on sociomathematical norms. Sample statements are presented below;

T4; "...albeit limited, the sociocultural structure of the school and the relationship between its administrator and teachers indirectly affect sociomathematical norms because the school is a small culture...”

It was determined that the expressions in this category were mostly made by prospective mathematics teachers who were in lower grades. This demonstrates that lower grade prospective primary school mathematics teachers also take into account conditions such as family and school when assessing the factors affecting sociomathematical norms.

Opinions on Negotiation of Sociomathematical Norms

This section includes the opinions of prospective primary school mathematics teachers regarding the effects of negotiating sociomathematical norms. The codes and categories obtained as a result of the analysis are shown in Table 5.

Table 5. Codes and categories related to the negotiation of sociomathematical norms

Participants	Codes	Subcategories	Categories
T8, T9	Meaningful learning through reasoning	Skills	Opportunities for learning
T7	Permanent learning through association		
T7, T9	Mathematical autonomy	Autonomy	
T3, T5, T6	Promotion of alternative teaching methods Role playing in teacher intervention	Intervention	Opportunities for teaching
T2, T10	Taking responsibility in learning	Participation	
T4, T6	Mathematical communication	Communication	
T1, T5	Simplifying classroom management through collaboration	Control	Opportunities for management

When the opinions of prospective mathematics teachers regarding negotiating sociomathematical norms were analyzed, three categories were identified: opportunities in terms of learning, teaching and management. In the category of opportunities for learning, two subcategories were formed: skills and autonomy. In the skills subcategory, participants noted that negotiations of sociomathematical norms could ensure students achieve meaningful and permanent learning by using skills such as reasoning, verification and association. Sample statements of the participants are presented below;

T7; “Negotiations also have a positive impact on learning. It mostly affects the cognitive level. I think justification improves reasoning further. It makes you think more. It encourages questioning...”

T8; “Thanks to negotiations, verifying or searching for different solutions in mathematics makes learning more permanent...”

T9; “...association and communication skills are especially active in the negotiation process, of course, these skills also improve students' problem-solving skills...”

Another subcategory was autonomy. Sample statements of the participants are presented below;

T9; "Negotiation of sociomathematical norms can provide students with the possibility to present their own mathematics... This also allows them to enjoy mathematics."

The prospective mathematics teachers who expressed their opinions in this category graduated from literature-mathematics in high school and they were in the upper grades. In particular, they pointed out that mathematical skills can emerge through the negotiation of sociomathematical norms.

When the opinions of prospective mathematics teachers regarding the effects of negotiating sociomathematical norms were analyzed, two subcategories were identified in the opportunities for teaching category: intervention and participation. In the intervention subcategory, participants underlined that intervention methods that would support conceptual learning could be put forward through negotiations. Sample statements of the participants are presented below;

T3; "It can give teachers the opportunity to highlight students' ideas that they consider valuable in class discussions. Most of the time, students' valuable mathematical ideas have little chance of being revealed in the classroom, or even if they do, they may not be reciprocated in the classroom. In this context, negotiations of sociomathematical norms provide opportunities for teachers to make interventions that enable conceptual learning..."

T6; "Although different teaching methods are used in mathematics teaching, the teacher may sometimes be inadequate or ineffective in intervention. Therefore, negotiation of sociomathematical norms may give the teacher a chance to detect and intervene in misconceptions. It may provide opportunities during intervention transitions..."

The last subcategory determined in this category was participation. Prospective mathematics teachers stated that negotiating sociomathematics norms would encourage students to assume responsibility for their own learning. Sample statements are presented below;

T2; "In the process of negotiation, students are responsible for their own learning, they listen to their peers, approve or disapprove... Thus, they regulate their own mathematics learning..."

According to the opinions of prospective mathematics teachers, two subcategories were identified in the opportunities of management category: communication and control. In the communication subcategory, participants emphasized the correct use of mathematical symbols. Sample statements of the participants are presented below;

T4; "Sometimes during the negotiation process, class members may attribute features of their own language structures to mathematical symbols, that is, they may not be able to use formal language when expressing mathematics. In this case, the negotiation process may also offer opportunities to transform informal language structures into a more formal structure..."

T6; "For example; Regarding inverse proportion, the expression *parallel multiplication* is a linguistic structure that indicates the inverse proportion between variables. Negotiations may offer opportunities to understand the mathematical relationship between variables (the multiplication of inversely proportional variables are constants)..."

According to the analysis of the data obtained, the last subcategory determined in this category was control. Sample statements are presented below;

T1; "negotiations can contribute to classroom management by increasing cooperation between students..."

T5; "Teachers can gain from better classroom control during the negotiation process."

Prospective mathematics teachers who expressed their opinions in this subcategory noted that negotiations could provide opportunities for classroom management by increasing cooperation between class members.

Discussion, Conclusion and Recommendations

The opinions of prospective primary school mathematics teachers regarding the definition/nature of sociomathematical norms are classified as individual and social perspectives. While the individual perspective represents the values of class members, such as attitudes and beliefs in their participation in mathematics applications, the social perspective represents the collective understandings of what class members agree on, such as rules, obligations, or expectations regarding mathematics applications. In other words, while the individual perspective focuses on the psychological dimension of the classroom microculture, the social perspective focuses on the social dimension. Although sociomathematical norms are common structures of classroom microculture (Partanen & Kaasila, 2015), the results of the current study point to the importance of considering these two

perspectives together in evaluating sociomathematical norms. As a matter of fact, evaluating sociomathematical norms only from an individual perspective or only from a social perspective may limit understanding its nature. According to Bauersfeld et al. (1988), the process of adapting to individual logic in mathematics classrooms cannot be separated from social processes. Yackel and Cobb (1996) pointed out that psychological processes may be inadequate in evaluating the thoughts held or defended by class members and that the assumption that social and psychological factors in the classroom are mutually reflexive. Prospective mathematics teachers' views on sociomathematical norms also showed that individual structures such as attitudes and beliefs can be associated with social structures such as rules, obligations or expectations. Similarly, Cho's (2001) research showed that teachers' beliefs about mathematics affected the negotiation of norms in the classroom. In their study, Kang and Kim (2016) noted that when the teacher selects interactive activities based on his mathematical beliefs in the classroom, it can influence the participation structure of the class.

The prospective mathematics teachers who express their views on what sociomathematical norms are from their individual perspective are mostly those who graduated from literature-mathematics field in high school. The fact that these candidates had little experience with mathematics before undergraduate education may have been effective in their evaluation of sociomathematical norms in this way. Therefore, giving these candidates a theoretical structure regarding the nature of sociomathematical norms, starting from the early stages of their undergraduate education, may be effective for a more comprehensive perspective. In addition, prospective primary school mathematics teachers evaluated sociomathematical norms more from a social perspective. In this category, it was determined that prospective mathematics teachers who graduated from mathematics-science field in high school expressed sociomathematical norms as rules and obligations. In the expectations subcategory, the opinions of female candidates came to the fore. No research was found in the literature on the definition/nature of sociomathematical norms related to variables such as graduation from high school or gender. In this context, investigating these variables related to the definition/nature of sociomathematical norms may be effective in revealing the differences in the thoughts of prospective mathematics teachers.

When the opinions of prospective mathematics teachers regarding the factors affecting sociomathematical norms were examined, three subcategories emerged in the direct category: student, teacher and classroom atmosphere. Prospective mathematics teachers emphasized that the students' readiness and learning style, the teacher's understanding of teaching, his perspective on mathematics and the pedagogical education he has acquired professionally have an impact on sociomathematical norms. The fact that prospective teachers, especially in the upper grades, have such views may be due to the fact that they attach importance to learning and teaching in evaluating the factors affecting sociomathematical norms. As a matter of fact, the literature states that sociomathematical norms should be seen as regulatory elements of teaching (McNeal & Simon, 2000; Pang, 2001). However, lower grade candidates stated that indirect variables such as family and school mostly affect sociomathematical norms. In terms of factors affecting sociomathematical norms, the fact that prospective mathematics teachers who expressed their opinions in the indirect effects category give more value to variables that had indirect effects outside the classroom more showed that they were more anxious and therefore more sensitive to the external factors of the education system. Therefore, this should be taken into consideration in the pedagogical education offered to prospective mathematics teachers regarding sociomathematical norms.

When the opinions of prospective primary school mathematics teachers regarding negotiating sociomathematical norms were examined, categories for opportunities in terms of learning, teaching and management were determined. As a matter of fact, according to Sekiguchi (2005), different norms can offer effective ways to both obtain different learning opportunities and access mathematical concepts. Similarly, Sánchez and García (2014) stated that class members can also affect their own understanding during the process of negotiating norms. In the category of opportunities for learning, two subcategories emerged: skills and autonomy. In the skill subcategory, participants mentioned that negotiations of sociomathematical norms could ensure students achieve meaningful and permanent learning by encouraging them to use skills such as reasoning, verification and association. As a matter of fact, stated that negotiation of norms is effective in shaping class members' beliefs and feelings about mathematics, producing creative solutions, and obtaining learning opportunities to find the similarities/differences of mathematical expressions. In addition, the candidates who expressed their opinions in this category were in the upper grades and graduated from literature-mathematics field in high school. These candidates interpreted negotiations in the context of learning and pointed out that mathematical skills can be revealed especially through the negotiation process. In the opportunities for teaching category, two subcategories were identified: intervention and participation. The candidates who expressed their opinions in this category graduated from mathematics-science field in high school and evaluated the effects of negotiations in the context of teaching. They emphasized that the negotiations would provide intervention opportunities, especially for teachers, that would support conceptual learning (Partanen, 2011) in mathematics teaching. Additionally, prospective teachers stated that negotiating sociomathematical norms would encourage students to assume responsibility of their own learning. In the category of opportunities for management, two subcategories were identified: communication and control. In the communication subcategory, participants stated

that negotiation of sociomathematical norms could support mathematical communication, albeit implicitly. In the control subcategory, they stated that negotiations could provide opportunities for classroom management by increasing cooperation among class members. In this context, designing the structures that constitute the classroom microculture considering the effects of the negotiations of sociomathematical norms specific to mathematics classes and carrying out mathematical applications accordingly can provide productive outcomes in terms of mathematics teaching.

References

- Baxter, P., & Jack, S. (2008). Qualitative case study methodology: Study design and implementation for novice researchers. *The Qualitative Report*, 13(4), 544–559. <http://www.nova.edu/ssss/QR/QR13-4/baxter.pdf>
- Bauersfeld, H., Krummheuer, G., & Voigt, J. (1988). Interactional theory of learning and teaching mathematics and related microethnographical studies. *Foundations and methodology of the discipline of mathematics education*, 174–188.
- Cho, J. (2001). Ethnography for research of mathematics teacher's belief and classroom norm. *Journal of Korea Society of Mathematics Education Series E: Communications of Mathematical Education*, 12, 349–361.
- Dixon, J. K., Andreasen, J. B., & Stephan, M. (2009). Establishing social and sociomathematical norms in an undergraduate mathematics content course for prospective teachers: The role of the instructor. In Denise S. Mewborn (Eds.), *Scholarly practices and inquiry in the preparation of mathematics teachers* (pp. 43–66). Association of Mathematics Teacher Educators.
- Gorgorio, N., & Planas, N. (2005). Norms, social representations and discourse. In M. Bosch (Eds.), *Proceedings of the 4th Congress of European Society for Research in Mathematics Education (CERME 4)* (pp. 1176–1181).
- Güven, N. D., & Dede, Y. (2017). Examining social and sociomathematical norms in different classroom microcultures: Mathematics teacher education perspective. *Educational Sciences: Theory and Practice*, 17(1), 265–292. <https://eric.ed.gov/?id=EJ1130899>
- Kang, S. M., & Kim, M. K. (2016). Sociomathematical norms and the teacher's mathematical belief: A case study from a Korean in-service elementary teacher. *EURASIA Journal of Mathematics, Science and Technology Education*, 12(10), 2733–2751. <https://doi.org/10.12973/eurasia.2016.1308a>
- Levenson, E., Tirosh, D., & Tsamir, P. (2009). Students' perceived sociomathematical norms: The missing paradigm. *The Journal of Mathematical Behavior*, 28(2–3), 171–187. <https://doi.org/10.1016/j.jmathb.2009.09.001>
- McNeal, B., & Simon, M. A. (2000). Mathematics culture clash: Negotiating new classroom norms with prospective teachers. *The Journal of Mathematical Behavior*, 18(4), 475–509. [https://doi.org/10.1016/S0732-3123\(00\)00027-4](https://doi.org/10.1016/S0732-3123(00)00027-4)
- Miles, M. B., & Huberman, A. M. (1994). *Qualitative data analysis: An expanded sourcebook*. Sage.
- Pang, J. (2001). Challenges of Reform: Utility of Sociomathematical norms, in *Annual Meeting of The American Educational Research Association*, Seattle, (pp. 143–150).
- Partanen, A. M. (2011). *Challenging the school mathematics culture: An investigative small-group approach. Ethnographic teacher research on social and sociomathematical norms* [Unpublished master's thesis]. University of Lapland. <https://core.ac.uk/download/pdf/30083851.pdf>
- Partanen, A. M., & Kaasila, R. (2015). Sociomathematical norms negotiated in the discussions of two small groups investigating calculus. *International Journal of Science and Mathematics Education*, 13(4), 927–946. <https://doi.org/10.1007/s10763-014-9521-5>
- Sánchez, V., & García, M. (2014). Sociomathematical and mathematical norms related to definition in pre-service primary teachers' discourse. *Educational Studies in Mathematics*, 85, 305–320. <https://doi.org/10.1007/s10649-013-9516-0>
- Sekiguchi, Y. (2005). Development of mathematical norms in an eighth-grade Japanese classroom. *International Group for the Psychology of Mathematics Education*, 4, 153–160. <https://eric.ed.gov/?id=ED496958>
- Tatsis, K., & Koleza, E. (2008). Social and socio-mathematical norms in collaborative problem-solving. *European Journal of Teacher Education*, 31(1), 89–100. <https://doi.org/10.1080/02619760701845057>

- Toscano, R., Sanchez, V., & García, M. (2019). Combining theoretical approaches: socio-didactic-mathematical norms and perspectives in pre-service secondary mathematics teachers' discourse. *International Electronic Journal of Mathematics Education*, 14(3), 455–466.
- Yackel, E., & Cobb, P. (1996). Sociomathematical norms, argumentation, and autonomy in mathematics. *Journal for Research in Mathematics Education*, 27(4), 458–477. <https://doi.org/10.5951/jresmethed-uc.27.4.0458>
- Yıldırım, A., & Simsek, H. (2011). *Qualitative research methods in social sciences* (11 Eds.: 1999-2018). Seçkin Publishing.
- Yin, R. K. (2011). *Applications of case study research*. Sage.