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The Study of Knowledge Exchange on Sociomathematical Norms: Dialogue Writing and Dramatization

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Abstract
Sociomathematical norms are the explicit or implicit arrangements that affect participation in mathematics classes and the emerging interactive structure of mathematical practice. For effective instruction, the teacher should guide the creation and development of acceptable sociomathematical norms. Thus, pre-service teachers should be given experiences in teacher education programs that demonstrate how the nature of sociomathematical norms influences critical abilities such as mathematical understanding and problem solving. This study aims to look at how pre-service teachers' knowledge of sociomathematical norms changes over time. This knowledge exchange is investigated throughout the pre-service training process, which involves dialogue writing and dramatization activities based on sociomathematical norms and psychological principles. Sixty-eight pre-service teachers took part in this study, which used the case study method. A semi-structured interview, the pretest and posttest containing the sociomathematical norm-framed dialogue analysis, video recordings of class discussions, and the researchers' observation notes in the lectures where the applications were carried out were all employed as data collection tools. This study would contribute to the literature with its components, positive outputs and suggestions for future studies.

Key Words: Mathematics education, sociomathematical norms, social norms, dialogue writing, dramatization, teacher education

Introduction

Learning and socio-cultural processes are inextricably linked, and scholars agree that social and cultural factors should be considered when understanding pupils' mathematical growth (Cobb & Bauersfeld, 1995; Mottier Lopez & Allal, 2007). Students' mathematical activities are entirely social, and they cannot be fully comprehended until they are understood in the context of the social and cultural milieu in which they occur (Cobb, Jaworski, & Presmeg, 1996). Learning takes place in two crucial processes in this context: 1) students adopt and own the rules, beliefs, practices, tools, and goods, and 2) students participate in the creation of these rules, beliefs, practices, tools, and products (Mottier Lopez & Allal, 2007). As a result, the information is constructed by the interactions between teachers and students, as well as the negotiation of the meaning ascribed to these members' activities.

Norms are established by the interaction of teachers and students in the classroom, which creates expectations and obligations (Stephan, 2020; Yackel, Rasmussen, &

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King, 2000). Norm is a sociological construct that encompasses a group's shared understandings and interpretations, as well as the responsibilities that they give to one another (Yackel, 2000). Social norms should be viewed as a form of social interaction grammar (Bicchieri, 2006). The standards system, like grammar, governs what is acceptable and undesirable in a group. Any study of social norms in the classroom tries to expose the nature of group activities or social interaction in the classroom. Social norms are a distinguishing element of a classroom community, and they help to keep order in activities that the teacher and students produce together. While social norms can be used to teach any idea, sociomathematical norms are focused on students' mathematics-related activities (Yackel & Cobb, 1996; Cobb, Stephan, McClain, & Gravemeijer, 2001).

Explicit or implicit arrangements affecting participation in mathematics classes and the increasing interaction structure of mathematical practice are referred to as sociomathematical norms (Gorgorió & Planas, 2005; Hofmann & Ruthven, 2018; Stephan, 2020). The necessary requirements for a different mathematical solution, a complex solution, an effective solution, and an appropriate mathematical explanation can be evaluated under sociomathematical norms (Yackel & Cobb, 1996). Yackel, Rasmussen, and King (2000) explained the subtle distinction between social norms and sociomathematical norms as follows: Waiting for a student to give an explanation in the classroom is part of "social norm analysis", but the conditions for an acceptable mathematical explanation are within the scope of "analysis of sociomathematical norms". Negotiating sociomathematical norms provides students and teachers with opportunity to learn (Yackel & Cobb, 1996; Cobb, Yackel & Wood, 1991; McClain & Cobb, 2001; Yackel, 2001). As students try to understand their peers' explanations, compare their solutions to other solutions, and make judgements about similarities and differences, additional learning opportunities occur. The process of negotiating sociomathematical norms has a direct impact on teachers' learning possibilities. Students will continue to present a wide variety of explanations as long as various answers are expected, cared for, and good solutions are embraced in the classroom. These will inform the teacher about their students' present conceptual grasp and limitations. Simultaneously, the teacher's perspective on what is effective for his students shifts (Cobb, Yackel, & Wood, 1991; Wood, Cobb, & Yackel, 1991; Yackel & Cobb, 1996; Yackel, Cobb, & Wood, 1998).

One of the major turning points in mathematics education was the introduction of the idea of sociomathematical norm (Levenson, Tirosh, & Tsamir, 2009). Different sociomathematical norms provide a variety of learning opportunities and access to mathematical concepts (Erath, Ingram, Moschkovich, & Prediger, 2021; Lopez & Allal, 2007; Sullivan, Mousley & Zevenbergen, 2006). The Mathematics Curriculum (MEB [MoNE], 2018) places a strong emphasis on the development of important abilities like reasoning and problem solving, as well as meaningful learning. It is vital to

apply sociomathematical norms successfully in the classroom for a mathematics education that focuses on meaningful learning and strives to develop high-level thinking skills. Social and sociomathematical norms are the social aspects of the classroom that the teacher can control, such as teaching materials and course content (Yackel, Rasmussen & King, 2000). In order to achieve success, teachers must consider these social factors and guide the emergence and development of acceptable sociomathematical norms. This introduces additional elements and responsibilities that must be addressed in teacher training, both in-service and pre-service. Pre-service teachers should be given experiences in teacher training that demonstrate how the nature of sociomathematical norms influences critical abilities like mathematical understanding and problem solving (Toluk Uçar, 2016). The study's aim is to look at how pre-service teachers' knowledge of sociomathematical norms evolves as a result of this determination. The pre-service training process examines this exchange of knowledge, which involves dialogue writing and dramatization based on sociomathematical norms and psychological principles. Communication between students and between students and teachers is critical in the establishment of norms, and psychological science cannot be overlooked in this process. Psychology has made a significant contribution to the development of teaching and learning processes. This contribution will go under the heading of psychological principles.

Theoretical Framework

The theoretical framework of the study and information about the previous research is given below.

Psychology Principles

This study's theoretical framework is likewise founded on psychological principles. Psychology has made a significant contribution to the development of teaching and learning processes. Cognition, motivation, social contact, and communication are all social and behavioral aspects in human development that influence teaching and learning. Furthermore, the study of psychology can provide crucial insights into successful teaching, classroom conditions that facilitate learning, and the proper use of measuring and assessment procedures as well as research methodologies that can be employed in practice. A report describing and transmitting psychological principles for use by K-12 teachers is discussed in this context. The most essential 20 psychological principles that can be employed from preschool through high school, as well as classroom practice recommendations, are offered in this paper. Each principle has been identified and described, as well as the supporting literature and how these ideas apply in the classroom. The American Psychological Association (APA) commissioned the Schools and Educational Psychology Unit to write this paper (APA, 2015). In this work, twenty basic principles are put in five areas of psychology study.

The first eight principles are related to cognition and learning and address the question "How do students think and learn?" The next four principles (9–12) discuss the question "What motivates students?". The three principles (13–15) that follow are related to social context and emotional dimensions and focus on the question "Why are social context, interpersonal relationships and emotional well-being important for students' learning?". The next two principles (16–17) relate to how context affects learning and address the question "How best to manage the classroom?". Finally, the last three principles (18-20) examine the question "How is student progress measured?".

Conversations between students and teachers are one of the most basic tools for classroom involvement. As a result, in the processes of negotiating, structuring, and internalizing knowledge, classroom conversations should be carefully structured.

Writing Dialogue

The main source of communication is dialogue based on interpersonal conversations (Smith, 2005). Multiple dialogues take place in the classroom, with teachers and students as participants. Students will be asked to interact with and create new things using the information they have learnt, and creative writing tasks will be valuable (Firek, 2006). As students begin the writing process, they go through several steps in order to transform and reproduce their information.

Grenwille (2001) listed the stages of writing as follows: getting ideas, choosing the most appropriate idea, making a plan to write the idea found (outlanding), drafting, revising the draft and to finalize it in terms of form (editing). The stages of Ruurs (2007) to write a dialogue are as follows: a- Finding a problem or a topic to be discussed, b- Developing at least two characters with different characteristics (age, level of knowledge, tone of voice, appearance, and personality, etc.), c- To write a dialogue draft on the determined topic / problem with the questions asked by the characters and their answers, c- Reading aloud the text of the dialogue, removing unnatural words and making the necessary arrangements to make the text natural, d- To revive the final form of the dialogue text in the classroom in a way to show the emotional states of the characters (curiosity, sadness, and joy, etc.). As a result, pre-service teachers identified a critical math problem that middle school children might struggle to comprehend.

One of the most fundamental criteria in dialogue writing is authenticity, which means that the character's speech should seem real. When writing a speech, the writer should avoid imitating speech patterns and instead develop a unique style for the character he or she is creating (Kempton, 2004). They used a teacher and a student model as characters in a dialogue text to explain the topic. They also used class norms. They read the draft of the dialogue aloud after finishing it. They made the necessary changes to ensure that all of the text's speeches sounded natural. They used the dramatization method to enact the dialogue in a way that other students could see in the classroom.

Smith (2005) recommended various stages for dialogue and dialogue authoring.

Interrupting or changing a conversation alters people's perceptions of one another. What matters most when creating dialogue is that it sounds natural. This is accomplished by reading it out loud. Dialogue necessitates the occurrence of an event or dispute between at least two characters. When composing a dialogue, an "initial sentence" should be prepared, along with alternative responses. Regardless of which of these options is picked, a suitable reaction should be considered. Each inquiry elicits a response. The fact that there are so many sentences to say in opposition to a single line demonstrates how diverse the number of points of view can be. The level of agreement between the two participants in the dialogue can be low, medium, or high. Dialogue can take place in a variety of settings: a- more conceptual, implicit, and so on as content (Example: A: Will you accompany me? B: We can't always be where we want to be.), b- It can represent power clashes, positive and negative emotions, and a very simple transaction. While not answering the question or asking a new one is a form of avoidance, returning the question to the original asker is also a form of bullying. (A: Will you accompany me? B: What are your thoughts?), c- Participants in the discourse may be of equal status, greater status, or lower status. (A: Will you accompany me? B: When I'm finished, I'll come.)

In the classroom, dialogues over reasoning content stimulate creativity (Weigerif, 2005). He claims that such discussions are beneficial in resolving issues. Hofmann and Ruthven (2018), on the other hand, claim that meaningful debate is possible in small groups in mathematics and science, but not in classrooms. The diyalogic pedagogy method was developed in response to previous studies that found that attempting to overcome learning difficulties through extended student responses and reason-based discussions did not yield the desired results (to listen to others when they speak, to treat other people and their ideas respectfully, to elaborate on one's answers, and to try to reach consensus). They discovered, however, that these standards did not match the previous class norms, generating issues. They contended that the dialogue pedagogue could not be achieved as envisioned without introducing new norms. It should be noted that the aforementioned norms are prevalent not only in mathematics classes but also in all educational settings, and they should be viewed as the most significant barrier to the adoption of new standards.

Dramatization

For the sake of information, coordination, and perlocution, humans have the ability, and often the requirement, to perform their stories, self-presentations, and even abstract notions through acts of dramatization (Pascarelle, Vicigrado, Tateo & Marsico, 2021). Since the 1960s, a new field of research has focused on the role of dramatization in the learning process (Heathcote, 1984; Johnson & O'Neill, 1991; O'Neill, 1995; Pascarelle, Vicigrado, Tateo & Marsico, 2021; Slade, 1955; Wagner, 1976; Way, 1967), with a particular focus on student motivation and creativity (Heathcote, 1984; Johnson

& O'Neill, 1991; O'Neill, 1995; Pascarelle, Vicigrado, Tateo & Marsico, 2021; Slade, 1955; Wagner, 1976; Way, 1967). The drama in education approach (Wagner, 1976; Johnson & O'Neill, 1991; Xu & Tateo, 2020) and the process drama approach (Haseman, 1991; Heathcote, 1984; O'Neill, 1995; Pascarelle, Vicigrado, Tateo & Marsico, 2021) were developed as a result of this interest. Dramatization as a teaching/learning technique, effective for improving social, emotional, and creative skills, as well as acquiring knowledge on subjects like history, is now a well-established field of research and practice (Pascarelle, Vicigrado, Tateo & Marsico, 2021). Pascarelle, Vicigrado, Tateo and Marsico (2021) claim that improvised dramatization practices are already overflowing in school environments, in the teaching of teachers to their students, in the creation of interpersonal relationships and collective identity, or in the acquisition of behaviors that aim to provide moral orientation.

Many notable educational scientists such as John Dewey, Herbert Read, and Louis Arnaud Reid (O'Toole & Stinson, 2009) have developed strong ties between education and visual arts such as dramatization, music, and dance during the first half of the twenty-first century. Dramatization helps students develop their perception and emotions (O'Toole and Stinson 2009b). One of the learning-teaching techniques is dramatization, which is the portrayal of a scenario or event in front of a group of people using movement and speech. With the dramatization technique, students improve their communication abilities while also having the opportunity to explore the subject from many perspectives (Çelik, 2018; Sever, Yalçınkaya, & Mazman, 2009; Özyürek, 1983). Students gain knowledge of a concept, event, or other topic. To ensure that the dramatization he created and animated within the visual and auditory processes can be used effectively in educational and training processes, teachers should receive the requisite in-service training (Toy, 2015).

The term dramatization refers to the human activity of staging in narrative and ritualistic form, executed through the full person and numerous channels, communicative and self-presentation meanings, as we use it in this study. Furthermore, human-built places, such as schools, are frequently set up as dramatic stages that frame the behaviors that guide the meaning-making process (Valsiner, 2020). In the first stage of the dramatization technique, group members think about the formation of an event or thought they have determined, the stages of the subject, and find words and speeches according to these. In the second stage, they internalize their roles by assuming another identity and trying to understand what others feel and think and find qualities that they can add from their personalities suitable for the role they will play. Thus, they learn to feel as well as to grasp information using their creativity. In the third stage, there is the display of the event or situation through the specified words and behaviors. With the dramatization technique, both the actors and the audience learn to prepare for real situations they will face in the future and what they can use to deal with them, and to be cool when under pressure or when things go wrong. For the implementation of

the dramatization method, a layout that every student in the class can see, hear and participate in should be created. Observers should be able to take notes on what they see and hear. Some parts of each dramatization activity, which should be at most 5-10 minutes, can be repeated if necessary, student views on the whole activity are included, everyone can express their free opinions about what they watch and participate in the discussion (Özyürek, 1983; Sönmez, 2009; Valsiner, 2020). Dramatization is not a one-sided technique. It is performed for both actor and audience. In addition to being fun, this technique serves gains for many educational purposes. Dramatization contributes students to express their feelings and thoughts through concrete experiences. The key points of the dramatization technique are to find topics suitable for the interests and needs of the students, to make an effective planning and preparation, to give the audience the task of observing, and to discuss the situation played, not the role-playing performance of the students with the whole class at the end of the activity (Sönmez, 2009; Valsiner, 2020).

Methodology

The case study was used in this study. Case studies aim a holistic interpretation of the environment or events of a study (Creswell, 2009) and allow one aspect of the research problem to be studied in depth and in a short time. Case studies give researchers the opportunity to concentrate on a specific case of a problem (Wellington, 2000). Different data collection techniques can be used together in case studies (Cohen & Manion, 1994).

Participants

The participants of the study consist of 68 pre-service teachers studying in the 3rd year of Elementary Mathematics Education program of a state university in Central Anatolia. In the study, due to the limitations in terms of time and labor conditions, appropriate sampling method was preferred in determining the sample. In accordance with participants' background within the scope of pedagogical content knowledge, the components which are: multiple representations of concept, student difficulties regarding concepts and misconceptions, concept assessment-evaluation, and teaching concepts in the curriculum were handled in the elective Mathematics Curriculum course. Pre-service teachers participating in the study were coded as PT1, PT2, ..., PT68 within the framework of research ethics.

Data Collection and Application Stages

A semi-structured interview, a pre-test and post-test containing questions based on the analysis of dialogue on sociomathematical norms, video recordings of class discussions, and observation notes of the researchers in the lectures where the applications were carried out were used as data collection tools in the research.

Pre-Application Trainings

Basic psychological concepts and social norms - sociomathematical norms were theoretically discussed for a total of 16 lesson hours (1 lesson hour was 50 minutes) throughout the first four weeks of the pre-service education process. Pre-service teachers were given training in composing dialogue and dramatization as part of this process. Pre-service teachers received training in areas such as breathing, pronunciation, posture, use of body language, role-playing, and basic dramatization competencies. The required literature information was provided to the pre-service teachers during the dialogue writing training, as well as sample dialogue writing activities.

This study promotes literary interaction using socio-mathematical norm content that can be found in mathematics classes. Grenwille (2001), Ruurs (2007), Kempton (2004), Weigerif (2005), and Smith (2005) used the following stages:

a-To enable pre- service teachers to identify mathematics questions that can start between teacher and student and to choose one among them.

b-To decide the behavior and word patterns of the teacher character that will be the subject of the dialogue text, which can be deemed positive or negative, according to sociomathematical norms and psychological principles.

c- To decide on the behavior and word patterns of the student characters that will be the subject of the dialogue text, which can be deemed positive or negative, according to sociomathematical norms and psychological principles.

d- Based on the question decided at the beginning; to write dialogues suitable for the determined teacher and student characters and to determine the behaviors that will guide those who will act during the role-play.

e- Reading the dialogues aloud and arranging them naturally.

Each group was able to write four dialogue texts, two positive and two negative, in terms of sociomathematical standards by following the processes outlined. During their dialogue writing tasks, pre-service teachers might define teacher and student identities, needs, competencies, and so on. They considered it. Then, using the dramatization technique, they practiced how their dialogues would appear in real life and how they would teach students class standards through similar dialogues in their teaching careers.

In the dramatization training, the pre-service teachers were given basic dramatization information such as acting, using body language, and adjusting the tone of voice (Özyürek, 1983; Sönmez, 2009; Valsiner, 2020). Accordingly, the following stages were followed:

a- Distributing the roles that best suit the personality of the pre-service teachers for the characters in the text of the dialogue,

b- Determining appropriate behaviors for each role,

c- Memorizing the words in the text of the dialogue,

d- To rehearse the words written in the text of the dialogue and the behaviors determined,
e- To create a classroom order so that everyone can watch the dramatization activity,
f- Reminding the audience to note the right or wrong things they see in the play they watch,
g- To stage the game,
h- At the end of the game, to receive opinions and evaluations from the audience regarding the application of the educational and psychological principles in the game,
i- To open a discussion on the content of the game rather than the students' role-playing ability.

After that, an eight-question pre-test was used, which included sociomathematical norm-framed dialogue analysis. The questions in this pre-test were adapted from Yackel and Cobb's (1996) book section and translated into Turkish by Toluk Uçar (2016). These questions were chosen by two specialist math educators, and the results of their pilot study were applied to 53 pre-service teachers in the third year of an elementary mathematics education program at another public university. In the pilot study, ten questions were used, and two of them were deleted from the main study since there were issues with interpreting the dialogue in two of them. The following are two samples of the study's questions.

Sample Question 1:
The class working on the operation which is "78 - 53 =?".
Derya: I said, ummm, subtract 70 and 50, which is equal to 20.
Teacher: Okay.
Derya: And then, then I got 3 out of 8, I got it and then 5 left.
Teacher: Okay. What did you get?
Derya: 25
…
Teacher: Ela, what do you think?
Ela: I said 7, 70, I said 70 - 50… .20 and I said 8 plus 3… Ooo, I added it, I said 8 minus 3, it makes 5.
Teacher: Okay. What did she do?
Ela: And I meant it 75… 25.
Derya: [Objection to Teacher] this is the same as what I said.

What could be the common rule, expectation or obligation shared by every individual in the classroom that started to occur in the classroom with teacher-student or student-student communication in the dialogue above?

Sample Question 2:

The class is working on the problem of how many stamps are in ten cards with 4 red stamps in one and 6 green stamps in the other.

Taner: I can take one of these [green] stamps, um, I have 6 here, and put it on the card with the red scales.

Teacher: Listen to your friend!

Taner: And I would have 5 plus 5.

Teacher: All right! Do you understand what he said? I like it! When we put one of the green scales on the card with red scales, he said, what do we get with these 4 stamps?

Class: Five.

Teacher: Five. Here too [showing the card with green stamps] there are 5 of them and we could say 5 plus 5.

Beautiful.

…….

Can: This is, we can put these four [red stamps] on it and make 10.

Teacher: Yeah! I liked it.

Teacher: [addressing the class] Can says let's take these 4 stamps [showing the red stamps], put them here [showing the spaces on the other card]. How many are there in total?

Class: 10.

Teacher: 10. Okay, good. Yes?

Gözde: 2 plus 2, 4 [showing red checkers] and 2 plus 2, 4 [showing 4 green checkers] and they all make 8 and 2 more are 10.

Teacher: Right. Do you understand what he said? [The teacher repeats the student's solution to the class.]

Metin: We could say 7 plus 3 and we get 10.

Teacher: I like that too.

What could be the common rule, expectation or obligation shared by every individual in the classroom that the teacher is trying to create in the classroom in the dialogues above?

Application Process

Following the pre-test, dialogue writing and dramatization practices took place for 10 weeks. In these applications, groups of four pre-service teachers were asked to revise these texts by writing 2 positive and 2 negative dialogue texts containing basic psychological principles and sociomathematical norms. In each dramatization, a different person from the group members took the role of a teacher, while the other group members took part in the student role. After each dramatization, positive -negative

principles and norms in that dialogue text were discussed with all pre-service teachers under the leadership of the group member who carried out the practice. As a result, each group member was capable of performing the role of group leader. Video recordings of the dramatizations and discussions were taken.

The groups submitted their reports containing the dialogue texts and analysis to the researchers before implementation. At the end of the applications, semi-structured interviews were conducted with the pre-service teachers. The focus of the interview questions consists of evaluating the benefits and limitations of social and sociomathematical norms in the classroom in terms of mathematics learning and teaching, and evaluations on how they can affect students' mathematical understanding and skills.

Sample interview questions are as follows: "Evaluate the benefits and limitations of social and sociomathematical norms in the classroom in terms of mathematics learning and teaching? Do you think that social and sociomathematical norms in the classroom affect students' mathematical understanding? Explain in detail." Simultaneously, the 8-question test, which included sociomathematical norm-framed dialogue analysis and was used as a pretest, was used as a post-test.

Data Analysis

Miles-Huberman model, which includes three basic stages designed as organizing or reducing the data, displaying the data, depicting and verifying the results, was used in terms of application and interpretation. In this study, semi-structured interview transcripts, pre-test and post-test data including sociomathematical norm-framed dialogue analysis, class discussions, video recording transcripts, and the researcher's observation notes in the lectures where the practices were carried out were analyzed in accordance with this model (Miles & Huberman, 1994). The stages of creating a framework for analysis, processing the data according to the thematic framework, defining and interpreting the findings were taken into consideration. After the research data were coded separately by two researchers, the code and theme list that emerged was finalized. After the code and theme list was finalized, the data were evaluated by two researchers according to the code and theme list. The consistency of the codes used by the researchers independently from each other was determined by marking "consensus" or "disagreement". The cases where the researchers used the same code for the statements of the students were accepted as consensus, and the cases where they used different codes were accepted as dissent. In the sections where there was a contradiction by one researcher, coding was made by taking the opinion of the other researcher. Reliability of data analysis done was calculated using the formula [Agreement / (Agreement + Disagreement) x 100] (Miles & Huberman, 1994). The average reliability among coders was found to be 84% since the reliability calculations above 70% are accepted as reliable for the research, this result is accepted as reliable for the related research.

Findings

Table 1 shows the percentages of pre-service teachers' right responses for each question in this study on pre-service teachers' knowledge changes on socio-mathematical norms when pre-test and post-test answers were compared. The difference in average right answer percentages between pre-test and post-test was increased from 17 percent to 88 percent. This situation demonstrates a favorable shift in pre-service teachers' understanding of how to determine sociomathematical norms as a result of dialogue analysis.

Table 1.

Percentage of Pre-Service Teachers' Correct Answers to the Questions Asked in the Pre-Test and Post-Test

Tests	Correct Answer Percentages of Questions								Average Percent
	1st	2nd	3rd	4th	5th	6th	7th	8th	
Pre-Test	13%	21%	19%	18%	15%	22%	13%	12%	17%
Post-Test	84%	97%	94%	88%	86%	97%	80%	77%	88%

Following the pretest, ten weeks of dialogue writing and dramatization practice took place. These applications required groups of four pre-service teachers to animate the texts by authoring two positive and two negative dialogue texts containing core psychological principles and sociomathematical norms. A different pre-service teacher from the group played the role of a teacher in each dramatization, while the others acted as students. Following each dramatization, all pre-service teachers reviewed the positive and negative principles and norms in the dialogue text with the group member who led the practice. As a result, each group member was capable of performing the role of group leader. The dramatizations and discussions were recorded on video. When these video transcripts and observation notes were analyzed, effective discussions took place. In these discussions and dramatizations, pre-service teachers were able to play an important role in supporting students' mathematics learning. With the reactions of the teachers, possible reactions that may occur in the students could be reflected. The sociomathematical norms to be created were correctly expressed by the teachers. The sociomathematical norms to be created could be addressed within the framework of the psychological principles given theoretically with correct expressions and word determinations. Below is a sample dramatization with positive elements and discussion transcripts made after this dramatization.

The pre-service teacher in the role of teacher projects the question (Figure 1) to be discussed on the board before beginning the dramatization.

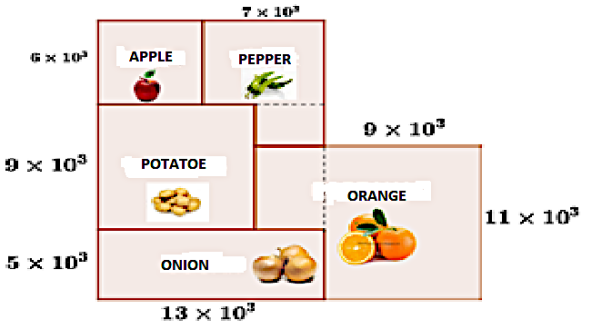

Figure 1: The Question used in the Dramatization

Ahmet has a field where he grows apples, peppers, potatoes, onions and oranges. Ahmet decides to surround his field with a wire fence to prevent the animals in the vicinity from harming it.

• Fields where apple and potato are grown are square.

• The area where onion grows is rectangular.

Ahmet wants to find out how many meters of wire are needed. According to the information given above, would you help to Ahmet?

-Teacher Zehra: Kids, we saw exponential numbers last week. Now let's solve questions to reinforce it a little bit in this lesson. Let's read the question on the board.

-Teacher Zehra: What did you understand from the problem you read? What does he want from us? Merve?

-Merve: He wants the length of the wire needed in the field.

-Teacher Zehra: Yes, what is it given to us? Meryem?

-Meryem: We have been informed that some of the edges of the field are square, the areas where apples and potatoes are grown are square, and the area where onions are grown is rectangular.

-Teacher Zehra: Yes, Meryem, you explained what was given to us well. Let's try to solve the question now.

(Students are given time.)

(Merve tries to solve the question.)

-Teacher Zehra: Merve, Is there a place where you hang out while solving?

-Merve: It's like, I can't.

-Teacher Zehra: No, don't think so, Merve, if you try a little more, you can do it.

-Kübra: Teacher, I found 2520.

-Teacher Zehra: Kübra, can you explain to us how you found it?

(Kübra goes on the board and begins to explain the solution, showing it in the figure)

-Kübra: I collected the side lengths one by one.

- Teacher Zehra: Yes, your way to go is nice, Kübra, go ahead.

-Kübra: $6.10^3 + 6.10^3 + 9.10^3 + 5.10^3 + 13.10^3 + 9.10^3 + 11.10^3 + 9.10^3 + 9.10^3 + 7.10^3$

$= 84.10.3 = 2520$

-Kübra: Well, but wait, it's like we weren't writing 103 like that?

I should have written $103 = 10.10.10$ so is it 84 000?

(Shy and replaces, class laughs.)

- Teacher Zehra: Okay, Kübra. Kids, there is no reason to laugh at your friend, we can make mistakes. I am saying for all of you, even if your answer is not correct, your thoughts are important to me. I am interested in these. We may not always find the correct answer to the questions. But we must do our best to find it.

……

Following the dramatization, a discussion with other pre-service teachers is initiated, led by the pre-service teacher playing the role of a teacher.

Group Member 1: First of all, this dialogue text contained positive or negative elements?

The majority said loudly as "positive".

Group Member 1: What are the psychological principles considered here?

PT1: "Well explained" in the dialogue "You can do it if you try a little harder." Flexible intelligence is used, which emphasizes performance-oriented intelligence that rejects fixed intelligence by saying "your way is beautiful".

PT14: The teacher did not use words emphasizing intelligence such as "Well done", "You are very clever", "My smart children".

Group Member 1: As you have seen, a path was tried to emphasize flexible intelligence. If there is nothing you want to add, we can discuss sociomathematical norms.

The answers came from the classroom that there was no other psychological principle in general.

Group Member 1: So which sociomathematical norms got your attention?

PT21: Teacher "Can you explain how you found it?" With the question, he tried to process the norm that the justifications for solutions and explanations should be presented.

PT35: He also used the norm of making efforts to solve the problem, even if it was a wrong answer, by making the student realize his/her mistake and saying that your thoughts are important to me even if your answer is not correct.

Group Member 1: To summarize in general

PT62: Providing solutions and reasons for explanations.

PT29: Don't try to solve problems even if the answer is wrong.

PT14: Making the student realize his / her mistake

Group Member 1: Yes, we tried to address these sociomathematical norms. Thank you all

……

When the discussion sections and the dramatized dialogues discussed were examined, they could correctly address sociomathematical norms and reflect the formation of a correct norm with possible student interaction. On the other hand, they were able to show the wrong discourses with the dramatizations containing negative elements, and the reason why these discourses were wrong could be discussed with effective discussions. Below is a sample dramatization with negative elements and discussion transcripts made after this dramatization.

The pre-service teacher in the role of teacher projects the question (Figure 2) to be discussed on the board before beginning the dramatization.

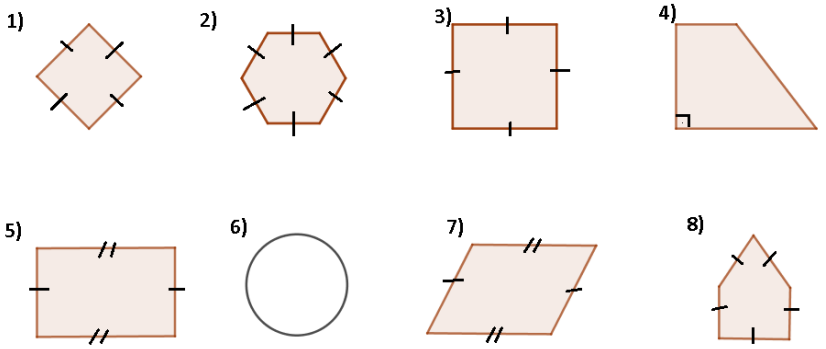

Figure 2: The Question used in the Dramatization

Usain Bolt is preparing for the Rio 2016 Olympic Games. For this, he trains 4 hours a day.

Since the tracks, he trained, are parallelograms, would you like to help Usain Bolt choose the tracks he will choose from the above figures?

-Teacher Dursun: Yes, kids we learned about polygons last week, let's reinforce this lesson by solving some questions. Let's read the question on the board. What is required of us in the problem?

-Zehra: It wants us to find the parallelogram tracks among the running tracks given.

-Teacher Dursun: Well done, Zehra. Well, do we remember, guys, what was the parallelogram? Meryem?

- Meryem: It is a quadrilateral whose parallelogram interior angles add up to 360o.

-Teacher Dursun: Well done, does anyone remember another feature? Merve?

-Merve: Parallelogram was a quadrilateral whose sides are equal.

-Teacher Dursun: It is that, you are smart. Did you solve the question?

-Kübra: Emine, you figured it out, why don't you tell the teacher?

-Emine: Certainly my solution is wrong. Because I'm not smart!

-Merve/Meryem: We figured it out, teacher, the answer is 1-3-5-7.

-Teacher Dursun: Here are my smart kids. (They make a high five with Merve and Meryem) Ooo Merve and Meryem's pluses are gradually increasing. Kids, take your friends as an example.

-Emine: (returns to Kübra) Did you see?

-Zehra: Teacher, I solved the question too.

-Teacher Dursun: Okay, Zehra have already said the correct answer. Let's move on to the other question.

……

Following the dramatization, a discussion with other pre-service teachers is initiated, led by the pre-service teacher playing the role of a teacher.

Group Member 2: Do you think this dialogue text contains positive or negative aspects?

The majority gave answer as "negative" loudly.

Group Member 2: What are the psychological principles considered here?

PT5: The teacher emphasized fixed intelligence by saying "Well done", "You are smart", "My smart kids".

Group Member 2: What's wrong with that?

PT18: If it exemplifies intelligence, it causes some students in the classroom to think that they do not smart. As in your reenactment here.

Group Member 2: So, what should the teacher do?

PT25: What the teacher has to do here is to give students performance-oriented feedback instead of praising their intelligence.

Group Member 1: We wanted to address the emphasis on fixed intelligence that should not be, as you mentioned, and we wanted to talk to you about the performance-oriented feedback that should be. Is there a different psychological principle you would like to add?

The answers came from the classroom that there was no other psychological principle in general.

Group Member 1: So, which can be considered negative sociomathematical norms caught your attention.

PT53: The teacher focused only on the right solution, ignored different solutions, and should follow a path that supports different solutions.

Group Member 1: Did you notice anything else?

PT44: Presenting justifications for solutions and explanations did not apply the sociomathematical norm in the classroom.

Group Member 1: So what should the teacher do?

PT49: What the teacher had to do was create the norm to give every student the opportunity to express his opinion and justify their solutions.

……

The sociomathematical norms determined and addressed by the groups in the dramatizations and discussions are presented below.

- To explain mathematical thoughts with their reasons.
- Supporting mathematical explanations with different representations and mathematical relationships.
- When disagreeing with a mathematical explanation, presenting the reasons why they disagree.
- To participate actively in mathematical discussions.
- Listening to each other in mathematical discussions, asking questions to friends and teachers in incomprehensible situations.
- To produce different mathematical solutions and explain why they are different with reasons.
- Explain the solutions made and defend them in detail when necessary.

At the end of the applications, semi-structured interviews were conducted with the pre-service teachers. The focus of the interview questions consists of evaluating

the benefits and limitations of social and sociomathematical norms in the classroom in terms of mathematics learning and teaching, and evaluations on how they can affect students' mathematical understanding and skills. The dominating codes will be shown below, with a frequency of the codes acquired from the analysis of these opinions exceeding 20. Table 2 lists the themes, codes, and frequency of these codes, as well as the opinions of a sample of pre-service teachers. A pre-service teacher's views might be classified under multiple codes.

Table 2.

Codes Obtained from Pre-Service Teachers' Opinions, Frequency of Codes, Themes and Sample Pre-Service Teachers Opinion

Themes	Code	f	Sample Pre-Service Teachers Opinion
Importance in Mathematics Education	The element of the learning environment that needs to be controlled	23	"… If you do not know how to control the norms, you cannot train in the right and desired direction." PT38
	The element affecting mathematical qualities	36	"The established norms are very important factors that affect everything in our class ... affect our activities, question solutions, discussions, and increase in quality if the right norms are established ..." PT11
Supporting Mathematics Education	Supporting the applied method	26	"Which teaching method you want to apply is definitely about the norms you create in your classrooms. If you cannot establish the right norms, you cannot apply the correct teaching methods. Or vice versa. For example, if you want to use the problem-solving method and have norms based on explaining and encouraging different solutions, this supports your method." PT57
	Supporting meaningful teaching	35	"… Sociomathematical norms provide the basis for understandable teaching …" PT2
	Supporting mathematical applications	31	"I think as a teacher, we can actually support the practices we do in our whole classroom with sociomathematical norms. Ultimately, by establishing these norms, we can provide them with good guidance. In this way, we can manage problem solving practices and mathematical discussions more comfortably."PT64
Supporting Student Learning	Supporting thinking skills	38	"Norms provide an interaction that supports mathematical thinking and reasoning. …" PT45
	Developing problem solving skills	41	"... if a teacher asks for the justification of mathematical thoughts and provides them to think of different solutions with the norms she creates, of course students' problem solving will improve." PT8
	Promoting mathematical insights	29	"When the teacher engages the sociomathematical norms, he actually achieves the goal. It provides students with meaningful and conceptual learning ..." PT32

Based on the codes and themes obtained from the opinions of the pre-service teachers, the following inferences can be summarized. The pre-service teachers presented and described the importance of sociomathematical norms in mathematics education as the element of the learning environment that should be controlled and the element that affects mathematical qualities. They presented supporting mathematics education by positively affecting the application method, meaningful teaching, and mathematical applications. It improves student learning positively by developing thinking skills, problem solving skills, and supporting mathematical comprehension.

Discussion

Teachers are representatives of the discipline of mathematics in the classroom and have an important role in influencing, even determining, the mathematical qualities of classroom activities. The nature of the sociomathematical norms that the teacher initiates in the classroom and supports its re-formation significantly affects the level of mathematical knowledge that students create. There are important differences between the teacher allowing only a learned solution to be repeated and the result said as an explanation in the classroom, and constantly asking for different solutions and arguing why it is different, in terms of affecting the level of mathematical discourse in the classroom. In classrooms where explanations consist of enumerating operative steps or simply saying the answers, it will be very difficult for students to understand how the narrator reasons (Rasmussen, 1998) and the development of deeper mathematical discussions in the classroom will be prevented. But such an environment assigns new roles to teachers. Pre-service teachers' familiarity with these new roles is essential. Based on these determinations, the study's aim is to look at how pre-service teachers' knowledge of sociomathematical norms evolves. This exchange of knowledge was examined in the pre-service teacher training process, which includes the practices of dialogue writing and dramatization based on sociomathematical norms and psychology principles.

Creative writing activities are a good way to enable students to find creative solutions (Firek, 2006). In this study, pre-service teachers had the opportunity to think about the content and form of dialogues that could pass between teacher and student by doing dialogue writing activities. There are constantly developing natural dialogues and dramatizations between teacher and student in the natural classroom environment (Pascarelle, Vicigrado, Tateo, & Marsico, 2021). In this study, many dialogue texts and their dramatizations were prepared within the scope of preparation for the natural classroom environment. These are examined in terms of psychological principles and sociomathematical norms. Thus, the pre-service teachers reviewed both their sociomathematical norms and their knowledge through the dialogue texts and dramatizations they designed.

When the pre-test and post-test answers were compared, there was a considerable

rise in the percentage of accurate answers in this study, which looked at pre-service teachers' knowledge changes on sociomathematical norms. This situation demonstrates a favorable shift in pre-service teachers' understanding of how to determine sociomathematical norms as a result of dialogue analysis.

When the video transcripts and observation notes of the applications were analyzed, effective discussions took place. In these discussions and dramatizations, pre-service teachers were able to play an important role in supporting students' mathematics learning. Potential student reactions could be reflected in the teacher's reactions. The teachers correctly explained the sociomathematical norms to be formed. The creation of sociomathematical norms could be addressed within the context of psychological principles provided theoretically with accurate terminology and word determinations. On the other hand, they were able to demonstrate incorrect discourses through dramatizations with negative aspects, and the reasons for these errors could be examined through effective discussions. Class discussions are a challenging process for the teacher because the teacher must understand the wide range of student solutions presented in the discussions. The teacher has to both turn the student explanations he listens into a learning opportunity and choose rich and complex tasks that provide an environment for this. This both requires and supports the teacher's understanding of the students' thoughts and conceptual development. In summary, teachers' learning opportunities are directly affected by the process of negotiating sociomathematical norms. As long as different solutions are requested, cared, and effective solutions are adopted in the classroom, students will continue to give a wide variety of explanations. These will inform the teacher about their students' present conceptual grasp and limitations. It also strengthens the teacher's perceptions of what is effective and sufficient for his students (Cobb, Yackel, & Wood, 1991; Wood, Cobb, & Yackel, 1991; Yackel & Cobb, 1996; Yackel, Cobb, & Wood, 1998). When the findings are compared to the literature, the study's application procedure creates an appropriate learning environment for these possibilities.

The sociomathematical norms determined and discussed by the groups in the dramatizations and discussions are as follows: "Explaining mathematical thoughts with their reasons. Supporting mathematical explanations with different representations and mathematical relationships. If a mathematical explanation is not included, presenting the reasons why they disagree. To participate actively in mathematical discussions. Listening to each other in mathematical discussions, asking questions to friends and teachers in incomprehensible situations. To produce different mathematical solutions and explain why they are different with their reasons". Similar norms are presented as important norms for meaningful and conceptual learning in different studies in the literature (Güven & Dede, 2017; Özmantar, Bingölbali, Demir, Sağlam, & Keser, 2009; Partanen & Kaasila, 2015; Toluk Uçar, 2016; Yackel & Cobb, 1996). Pre-service teachers gained awareness of sociomathematical norms, and they were

able to reflect this in practice.

Based on the codes and themes derived from the pre-service teachers' viewpoints, the following conclusions can be drawn. The pre-service teachers discussed and demonstrated the importance of sociomathematical norms in mathematics education as a controllable element of the learning environment that influences mathematical characteristics. Social and sociomathematical norms are defined as the social aspects of the classroom that the teacher has control over, such as instructional materials, technological use, and course content (Yackel, Rasmussen, & King (2000). They claimed that it benefits mathematics education by influencing the application method, meaningful instruction, and mathematical applications in a good way. Teachers should also successfully direct the establishment and evolution of acceptable sociomathematical norms for a mathematics education that aims to comprehend. (Toluk Uçar, 2016). The pre-service teachers stated that they improve student's learning positively by improving their thinking skills, problem solving skills, and supporting mathematical comprehension. In the literature, there are many various approaches to support student learning. In order to suggest diverse ideas, students must listen to the explanations and draw comparisons with their own solutions. At the same time, students must be able to defend their solutions by understanding their own and others' reasoning processes. In other words, students who try different answers, defend their ideas, review others' solutions, try to find more effective methods, and encourage other students to engage in this process help to create a classroom environment where mathematical understanding is the goal (Yackel, Rasmussen, & King, 2000).

Conclusion

Dialogue writing and dramatization practices will improve pre-service teachers' ability to empathize with their possible students, their ability to verbally express themselves correctly in front of students, and their ability to gradually develop an event or situation. Dialogue writing and dramatization methods applied in this study offered the opportunity to predict and design how sociomathematical norms in mathematics lesson may emerge in the real world. Through the dialogue writing training, pre-service teachers were able to learn to empathize with teachers and students and to transfer their way of thinking to dialogue. Using the dramatization method, the pre-service teachers brought their discussion texts to life. As a result, they were able to observe positive and negative examples of the implementation of sociomathematical norms in the classroom and discuss which ones were appropriate. They considered ways to address sociomathematical norms in teacher-student interactions, which they observed through dialogue and dramatization. They had the opportunity to discuss the dramatizations with other pre-service teachers, which they began as a beginning point for the construction of sociomathematical norms. The pre-service teachers had the opportunity to discuss with their instructors about how the language in the conversations reflected

psychological principles. Every phrase in the dialogues has a psychological principle that corresponds to it. As a result, dialogue writing served as both a creative writing exercise and a means of concretizing the violation or reproduction of educational psychology principles.

Sociomathematical norms assign new roles to teachers and teacher trainers. Teachers need to be equipped with the knowledge and skills that make it easier to perform such roles. In this sense, pre-service teachers should be provided with experiences showing how the nature of sociomathematical norms affects their mathematical understanding, argumentation, and problem-solving skills in teacher training programs (Toluk Uçar, 2016). In this respect, pre-service training addressed in this study would contribute to the literature with the components it offers and its positive outputs. The sociomathematical norms covered in the dialogue literature must, of course, be addressed with the appropriate words and actions in a practical class by giving continuity. Although the beneficial changes may not be mirrored in all pre-service teachers' classes, they can raise awareness, which can lead to action over time. The lack of observation and implementation in a real-world classroom setting can be regarded a weakness of this study. The determination of current standards in the practical classroom setting, as well as their application regions, might be included in future research as part of the pre-service training components to be addressed.

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