



## OPINIONS OF MATHEMATICS TEACHERS AND PRE-SERVICE TEACHERS ABOUT THE RELATIONSHIP BETWEEN MATHEMATICS AND CULTURE<sup>i</sup>

Özge Özcan<sup>1iii</sup>,

Elif Bahadır<sup>2</sup>

<sup>1</sup>Elementary Mathematics Teacher,  
National Education,  
Istanbul, Turkey

[orcid.org/0000-0001-7197-9680](https://orcid.org/0000-0001-7197-9680)

<sup>2</sup>Assoc. Prof. Dr.,  
Department of Mathematics Education,  
Faculty of Education,  
Yildiz Technical University,  
Istanbul, Turkey

[orcid.org/0000-0002-1154-5853](https://orcid.org/0000-0002-1154-5853)

### Abstract:

When the studies aimed at determining the relationship between 'mathematics' and 'culture' are scanned, although there are many researches carried out worldwide, the researches carried out in our country are quite few. The research aims to determine the perspectives of mathematics teachers and teacher candidates on the relationship between 'Mathematics' and 'Culture' and is important in terms of making a contribution to the field literature on ethnomathematics and cultural mathematics. The participants are 34 mathematics teacher candidates who have taken the "Mathematics and Culture" course and 32 mathematics teachers who are actively working at various. A form consisting of 4 open-ended questions was used. The qualitative data obtained from the answers to these questions were evaluated through content analysis. At the end of the application, it shows that teachers and teacher candidates know the ways to recognize culture and intercultural situations and that the teacher candidates who are not aware of these situations are more than the teachers. Both teachers and teacher candidates see cultural diversity as a privilege that is positive, useful and can develop people both socially and individually. When asked about the contributions of cultural diversity to mathematics education, they agreed that both teachers and teacher candidates will develop students socially, increase course efficiency and provide permanent and meaningful learning, and

<sup>i</sup> This article was presented at the VIII Yıldız International Social Sciences Congress in the 23-24 December 2021. The abstract was included in the conference abstract book, but the full text was not included in print. In addition, this study was made from the Master's thesis.

<sup>ii</sup> Correspondence: email [ozgeaksoyozcan@gmail.com](mailto:ozgeaksoyozcan@gmail.com)

develop the mind individually and create a rich perspective. However, teachers had more negative ideas about the reflection of cultural diversity in their classrooms on mathematics education than teacher candidates and stated that students would have problems with adaptation, disagreements, and communication problems would increase.

**Keywords:** mathematics and culture, ethnomathematics, culture, cultural diversity, mathematics education

## 1. Introduction

This study is designed to determine the perspectives of mathematics teachers and mathematics teacher candidates on the relationship between mathematics and culture. Whether the existing relationship between mathematics and culture will be integrated into the lessons, what kind of problems will be encountered in the integration and how the positive or negative effects of the lessons will change were evaluated in line with the opinions of teachers and teacher candidates.

## 2. Literature Review

Since culture is a concept that different disciplines evaluate from different perspectives, it is impossible to make a definition of culture that will satisfy everyone (Koçel, 2003: 30). According to Göçer (2012: 50), the definition of culture, which has different definitions in this context, is a heritage that will be passed on from one generation to the next, including the lifestyles, interests, attitudes, perceptions, behaviors, material and spiritual values that a society has created over the centuries. D'Ambrosio (2007: 30), on the other hand, states that culture in its broadest form is a system of knowledge that includes art, literature, music, history, language, language, medicine, technology, science, and religion and that these concepts are shared by people.

Güvenç (2002: 97) uses the word culture in four senses: scientific, biological, aesthetic, and humanitarian. When it is used in the field of science, it refers to civilizations; when it is used in the field of aesthetics, it refers to fine arts such as mosaics, sculptures, paintings and the like; when it is used in the biological field, it refers to agriculture and the cultivation of crops; and when it is used in the human field, it refers to the product of the education process. It is clear from this definition that when culture is used in the human sphere, it produces an educational product. In fact, when this product has a mathematical characteristic, it creates the concept of ethnomathematics (Ascher, 2005: 5).

D'Ambrosio (2007: 30), in his definition of the concept of culture, divided culture into its elements and mentioned that it is a system of knowledge. Similarly, Ascher (2005: 5) stated that these parts of culture are related to separate mathematical elements and built a bridge between culture and mathematics. For this study, D'Ambrosio's (2007: 30) and Ascher's (2005: 5) definitions of culture were taken as a basis, since the participants

will be guided as to whether intercultural situations and cultural elements are related to mathematical concepts and definitions, and if so, to what extent this relationship exists and which dimensions are addressed in the lessons.

D'Ambrosio (1985: 45), who first used the word ethnomathematics to express the relationship between culture and mathematics, defined ethnomathematics as "*mathematics practiced by cultural groups or communities*". D'Ambrosio (2007: 26) also evaluated the problems faced by people with different cultures in their lives, people's efforts to survive, and the techniques they have developed to make sense of and understand the world within the framework of ethnomathematics.

Ethnomathematics is both intercultural and interdisciplinary. It establishes connections between mathematics and every element of culture such as religion, science, traditions, games, history, art, literature, medicine, and music. On the contrary, mathematics, which is considered one of the most important subjects in international studies (Aikpitanyi & Eraikhuemen, 2017: 34), has for centuries been regarded as an independent and neutral discipline, far from socialization. Curricula in schools aim to teach universally accepted mathematical content, ideas, and concepts (Aktekin, 2017: 29). As a result, mathematics becomes a subject that is independent of the social environment, prejudiced, feared, and failed by the majority (Yenilmez, 2011: 80). One of the most important reasons for this is that the teaching process of mathematics aims to teach mathematical knowledge instead of teaching mathematical thinking. For this reason, students have convinced themselves that mathematics is a challenging subject by using only the memorization method without engaging in thinking activities (Owens, 2012: 587). Therefore, mathematics, which is detached from the social environment, can be difficult for students when it is conveyed as in textbooks.

In the literature, it is argued that one of the biggest obstacles to raising individuals with high mathematics achievement is that mathematics is taught as a boring and isolated subject, disconnected from daily life, not associated with any course, situation or phenomenon (Moyer, 2001: 186; Achor et al., 2009: 386). On the contrary, mathematics has been used for centuries in different geographies to meet the same or different social needs. In addition, mathematics, which is needed to understand many other disciplines, has a very important place for other disciplines (Weaver, 2004: 382). However, students cannot be expected to have positive attitudes towards the course when they are required to learn academic knowledge and this background does not show association. Therefore, teachers need to enrich the course content in order to overcome this negative perception of mathematics by students (Carter & Dean, 2006: 127). Taking steps to this end, the Ministry of National Education has included associations with history in the mathematics curriculum and has included the history of mathematics in the textbooks, albeit to a limited extent (MoNE, 2022: 6).

Although ethnomathematics encompasses the history of mathematics, it is a much larger term. The connection of mathematics with culture, mathematical operations, concepts, and phenomena in cultural activities, how mathematics changes according to cultural changes, or how culture is affected by the development of mathematics are some

of the points that ethnomathematics is based on. Therefore, no matter how progressive the changes in the history of mathematics in curricula are, they are not considered sufficient (Presmeg, 1998: 320).

However, a mathematics curriculum designed with a sociocultural dimension in mind will improve students' mathematical thinking skills, increase their interest in their own culture and history, and show students that learning mathematics is a unique process (Arismendi Pardi, 1999: 14). A mathematics course that integrates ethnomathematics will also show students that their ancestors were interested in mathematical operations before them and will positively affect their attitudes towards mathematics (Strutchens, 1995: 4).

D'Ambrosio (1999b: 52) mentioned the benefits of using an ethnomathematics program in terms of strengthening people's self-esteem, developing their creativity, becoming aware of cultural dignity and honor by getting to know their own culture or different cultures, and gaining a world view. According to Ascher (2005: 8-9), a mathematics program supported by ethnomathematics is important in terms of presenting the history of mathematics more accurately to students, incorporating the ideas of different cultures into mathematical ideas, and using different perspectives that come with cultural diversity in mathematical problems and examples.

Although there are many studies on ethnomathematics, culture and mathematics in the international literature (Aikpitanyi & Eraikhuemen, 2017: 34-38; D'Ambrosio & Borba, 2010: 271-279; Jankvist, 2009: 235-261; Owens, 2012: 586-593; Arismendi Pardi, 1999: 2-18; Presmeg, 1998: 317-339; Strutchens, 1995: 1-8), the importance of the relationship between mathematics and culture has not yet been recognized in the national literature.

When the literature is reviewed, it is seen that as teachers enrich the education and training process with various historical, cultural, and daily life elements while adhering to the curriculum, students' motivation, positive attitudes, and academic achievement increase (Kotluk & Kocakaya, 2019: 306-307). Considering that teachers and pre-service teachers are an important part of the education and training process and that they guide students, the starting point of this research will be drawn. Since teachers' and pre-service teachers' perspectives on culture, whether they make connections between mathematical elements and cultural elements, which connections they make, whether they include cultural elements in the course curriculum, and which elements they include will be important factors that diversify the teaching process, teachers and pre-service teachers were selected as the participant group in this study.

Therefore, this study will contribute to the literature on the perspectives of mathematics teachers and prospective elementary mathematics teachers on the relationship between culture and mathematics and shed light on ethnomathematics research.

The aim of this study is to examine the perspectives of pre-service elementary mathematics teachers and mathematics teachers on the relationship between culture and

mathematics teaching. In this direction, answers to the following sub-problems were sought.

- 1) Do mathematics teachers and pre-service elementary mathematics teachers know how to recognize culture and intercultural situations?
- 2) How do mathematics teachers and pre-service elementary mathematics teachers define cultural diversity?
- 3) According to mathematics teachers and pre-service elementary mathematics teachers, which aspects of cultural diversity are particularly important for mathematics education?
- 4) Which aspects of cultural diversity do mathematics teachers and pre-service elementary mathematics teachers encounter or think they will encounter in their classrooms?

### 3. Material and Methods

#### 3.1. Research Design

In this study, phenomenology design, which is one of the qualitative research methods, was used. Phenomenology studies are used in cases where the researcher is aware but does not have detailed information (Tekindal & Uğuz Arsu, 2020: 157). Phenomenology design, which is one of the foundations of qualitative studies, focuses on explaining and describing phenomena (Yıldırım & Şimşek, 2016: 71). The most important feature of phenomenology is that it makes us realize that common experiences have an essence. Based on this assumption, phenomenology describes the basic meanings and essence of understandings formed through a phenomenon, concept, or phenomenon that has been experienced in common (Tekindal & Uğuz Arsu, 2020: 157). Since experiences about phenomena are very important, an environment based on direct interaction should be created through interviews (Kıral, 2021: 98). The reason for choosing this method is that interviews were conducted to obtain in-depth information about the thoughts and experiences of two different groups, namely elementary mathematics pre-service teachers who have not yet had active teaching experience but have taken the "Culture and Mathematics" course in the teaching process, and mathematics teachers who have actively gained experience on the job.

#### 3.2. Participants

In phenomenology studies, the source of the data should be individuals who experience the phenomenon or who can reflect on this phenomenon (Yıldırım & Şimşek, 2016: 71; Creswell, 2020: 83). The participants of this study consisted of 32 active mathematics teachers selected based on the random sampling method, in which every item in the universe is equally likely to be included in the sample (Özen & Gül, 2007: 399), and 34 pre-service elementary mathematics teachers selected by the purposeful sampling method which consists of including the items that will serve the purpose of the research (Özen & Gül, 2007: 399). Among the 32 selected teachers, the one with the least experience

was a newly appointed teacher and the one with the most experience was another teacher who had been working for 25 years. The reason for the random selection of the teachers was to examine the views and experiences of teachers at various levels of primary and secondary education in private and public institutions of National Education in Turkey, regardless of whether they had previously had an idea about the link between culture and mathematics. As diversity in experience is important, it is also important to ensure diversity in the institutions and levels at which teachers work. This is because many factors affect teachers' perspectives on the relationship between mathematics and culture. The other group of the study consisted of 34 pre-service elementary mathematics teachers who had taken the "Culture and Mathematics" course and were in their second year at the university. The reason for this selection is to determine the perspectives of pre-service elementary mathematics teachers who are still in their academic life and have not yet started to work actively on the relationship between mathematics and various different cultures, to determine their perspectives on the relationship between culture and mathematics after taking the "Culture and Mathematics" course, which has a content that touches on the relationship between mathematics and various different cultures, asks them to design activities for this relationship and discusses the efficiency of these activities, and to examine their skills on how they will transfer this idea to their professional life in the future.

### **3.3. Data Collection Tools**

Since it is aimed at understanding the thoughts and experiences of the participants in-depth in phenomenology designs, which is the research design, it is very important to establish one-to-one contact with the participants and to establish an interaction environment based on trust and empathy, so phenomenology studies are more suitable for interviews (Kıral, 2021: 98). In interviews, the researcher conducts face-to-face or telephone interviews with the participants. Interviews are generally unstructured and consist of open-ended questions with the aim of revealing the views of the participants. The interviewer can record handwritten notes about the interview or take audio recordings (Creswell, 2013: 190). In this study, data were collected through interviews with teachers and pre-service teachers. During the research, the interviews were conducted unstructured as the participant spoke freely and was not guided through 4 open-ended questions. The researcher recorded the answers from the participants in writing without any changes. The questions in the interview form prepared with expert opinion are as follows:

- 1) How would you describe ways of recognizing culture and intercultural situations?
- 2) How would you define cultural diversity?
- 3) Which aspects of cultural diversity are important for mathematics education? Why is this important?
- 4) Which aspects of cultural diversity do you encounter or think you will encounter in your classes?

### **3.4. Implementation Process**

Before the study was conducted, the necessary permissions were obtained and then the participants who voluntarily participated in the study were informed about the study. The interview form consisting of open-ended questions was distributed and the researcher recorded the answers given by the participants in writing without making any changes. While the interview form was being applied, there had no negative feedback from the participants regarding the questions in the form. In order not to bias the interview, the researcher did not intervene in the answers given by the participants and did not direct the interview process.

### **3.5. Data Analysis**

The content analysis method was used to analyze the qualitative data obtained from the interview forms. The content analysis method, which is frequently used in social sciences research, is a systematic and repeatable summarization method in which some words in a text are reduced to small content categories through coding (Büyüköztürk et al., 2020: 259-260). Similar data were associated and coded by combining them within the framework of certain themes, and then the frequency of each code was determined. In order to ensure the reliability of the codes used in the content analysis, the data were coded by the same researcher at two different time intervals and there was no difference between the results. Microsoft Excel program was used to analyze the data by creating themes and codes and determining frequencies. While analyzing qualitative research, including direct quotations from individuals increases the validity of the research (Yıldırım & Şimşek, 2011: 279). For this reason, a few of the data obtained from the participants were directly quoted. In addition, if a participant referred to different codes in his/her response to the same problem, the same participant was counted again in different codes. Therefore, there had cases where the sum of frequencies was higher than the number of participant groups.

### **3.6. Validity and Reliability of the Study**

The following studies were conducted to ensure validity and reliability during this study:

- Since long-term interaction would increase the validity of the research, participants were also met at times other than interviews.
- Direct quotations were frequently used in the research process.
- The method, process, and results of the research were explained in a clear and detailed manner.
- An in-depth examination and research approach was adopted in the processes of collecting, analyzing, and evaluating the data.
- Throughout the research process, an interconnected process was followed step by step from data collection to analysis and evaluation to avoid inconsistencies.
- Research data and results were shared with the participants and verified (Göçer, 2013: 29).

## 4. Findings and Interpretation

In this phenomenological research, which aims to investigate in depth the perspectives of pre-service elementary mathematics teachers and mathematics teachers on the relationship between "Culture" and "Mathematics", the findings of the 4 open-ended questions asked to the participants are listed under separate headings and in separate tables. If a participant's answer was included in different codes or categories, the participant was rewritten for each code and category.

In addition, while creating categories and codes, codes that were close to each other were coded by paying attention to the purposes, ways, and methods. For example, although the Erasmus/Farabi answer in the first sub-problem is similar to the answer of traveling, it is included in the education category because it is an education-oriented activity in terms of its purpose. Although the answer "Embodying mathematics" in the third sub-problem is suitable for the course category, it is included in the category "Mathematically" because it is more related to mathematics, especially the change of mathematics. While direct quotations are included, teachers are expressed with the letter "T" and pre-service teachers are expressed with the letters "PsT".

### 4.1. Findings and Interpretation of the First Sub-problem

The answers from the teachers to the sub-problem "How would you describe ways of recognizing culture and intercultural situations?", which determines the knowledge of mathematics teachers and pre-service elementary mathematics teachers to recognize cultural and intercultural situations, are shown in Table 1 and the answers from teacher candidates are shown in Table 2.

**Table 1:** Mathematics Teachers' Views on Culture and Intercultural Ways of Recognition

Categories	Subcategories	Frequency
Social Ways	Meeting and interacting with people from different cultures.	5
	Using social media/internet.	3
	Travelling.	3
	Communicating with language.	3
	Learning from family elders.	1
	To live that culture/to be included in that culture.	1
	Immigrate.	1
Educational Ways	Spending time with classes of different cultures	4
	Participate in international games or events.	3
	Learning different cultures through education/training.	2
	To participate in programs such as Erasmus/Farabi.	1
Individual Ways	To investigate, to question.	2
	Spending labor.	1
	Being a good observer.	1
	Being a versatile person.	1
Others	I do not know.	3



When the 32 mathematics teachers who were interviewed were asked the question " How would you describe ways of recognizing culture and intercultural situations?", answers that could be divided into 3 categories as social, individual, and educational ways were obtained. According to the ideas of teachers, although there are multiple ways to recognize cultural and intercultural situations, interacting with people from different cultures, spending time in classes with different cultures, traveling, learning languages, using social media, watching international games, events, documentaries are more preferred ways to get to know cultures. When the answers are divided into themes and codes, it is seen that the least preferred theme is the ways of recognizing cultures individually. Teachers want to be in an environment of interaction rather than an individual breakthrough to get to know new cultures or to be aware of intercultural situations.

Social ways are to meet and interact with people from different cultures (n = 5), to transfer through language (n = 3), to transfer through social media/internet (n = 3), to learn through travel (n = 3), to transfer by grandparents (n = 1), to live that culture (n = 1), and to migrations (n = 1).

When the educational aspect of intercultural situations is examined, it is understood that spending time with classes of different cultures (n = 4), participating in international games and activities (n = 3), learning about other cultures through education and training (n = 2), and learning through student exchange programs such as Erasmus and Farabi (n = 1).

There have also been teachers who have stated that the individual can learn in individual ways through his own effort. These teachers emphasized investigating and questioning (n = 2), spending effort (n = 1), being a good observer (n = 1), being a well-rounded person (n = 1). There are also teachers (n=3) who state that they do not know intercultural situations.

When teachers are asked whether they know the ways of cultural and cross-cultural recognition, the answers can be listed as follows:

*"... In fact, when we watch a series and movies in international production, while browsing social media, intercultural interaction is ensured..." (T1)*

*"... Culture is an important element that affects people's perspectives on life and lifestyle. I can recognize the culture and intercultural situations from the behavior of the students and their answers to the question I ask..." (T2)*

*"... Ways of getting to know the culture; socialization, education, owning and valuing national values, technological or printed sources, documentaries and films, grandparents, family tree, etc. But the most basic way of recognizing and transmitting culture is language. Because all the cultural elements formed in society are transmitted to later generations through oral or written language..." (T13)*

It can be seen from the answers of the teachers that; The first way to recognize cultural and cross-cultural situations is through socialization and interaction. There are also teachers who say that they cannot recognize intercultural situations, and that they do not know how to recognize them. These participants did not make any comments because they said they did not know. However, one participant stated that he thought he would learn this throughout his teaching life.

**Table 2:** Pre-service Elementary Mathematics Teachers' Views on Culture and Intercultural Ways of Recognition

Categories	Subcategories	Frequency
Social Ways	Meeting and interacting with people from different cultures.	8
	To live that culture/to be included in that culture.	7
	Travelling.	5
	Communicating with language.	3
	Immigrate.	2
	Learning from family elders.	1
	Using social media/internet.	1
Educational Ways	Learning their language/dialect/English, which is the universal language.	4
	Learning different cultures through education/training.	2
	To participate in programs such as Erasmus/Farabi.	2
	To get to know the geographical regions where the students live.	2
Individual Ways	Being a good observer.	7
	To investigate, to question.	4
	Watching movies and TV shows that involve different cultures.	3
Others	I do not know.	6

When the 34 pre-service elementary mathematics teachers who were interviewed were asked the question " How would you describe ways of recognizing culture and intercultural situations?", answers that could be divided into 3 categories as social, individual, and educational ways were obtained, as in the answers of the teachers. When the opinions of pre-service teachers are taken into consideration, it is seen that social interaction is the first choice for learning about culture and intercultural situations, as in teachers. Prospective teachers have also frequently expressed their views on interacting with people from different cultures, traveling, learning languages, being a good observer. Differently, pre-service teachers thought that living that culture, being involved in the culture in a way, were part of the process of recognizing cultures. Both groups of participants who say that cultures will be recognized through sociality and interaction agree that after sociality comes education. In addition, pre-service teachers also gave importance to individuality and thought that being a good observer as an individual and conducting research would make it easier to notice cross-cultural situations.

Social paths are to meet and interact with people from different cultures (n = 8), to live or be involved in that culture (n = 7), to learn through travel (n = 5), to transfer through language (n = 3), to migrate or to move to a different place (n = 2), to learn by grandparents (n = 1), to transfer via social media/internet (n = 1).

When the educational aspect of intercultural situations is examined, there are pre-service teachers who think that they will learn in teaching life (n = 2) as well as pre-service teachers who think that they will learn in teaching life (n = 2) who state that it is necessary to master languages, dialects, especially English, which is the universal language (n = 4), that different cultures can be learned through education (n = 2) or through student exchange programs such as Erasmus and Farabi (n = 2), that it is necessary to know the geographical regions and characteristics where students live (n = 2).

Pre-service teachers who said that they could learn in individual ways also emphasized the importance of being a good observer (n = 7), reading and researching (n = 4), watching different cultures in series, films, and documentaries or reading in books (n = 3).

When pre-service teachers are asked about ways to recognize cultural and intercultural situations, the answers are as follows:

*"... The best way to get to know a culture is to experience that culture. It's going to where the culture is. In this way, we get to know and see our own culture and the intercultural situations of that culture. If we can't do that, the best way to get to know a culture is to communicate with someone who lives in that culture. Because every piece of information we get first-hand can often be more useful than the information we research and find..."* (PsT1)

*"... I don't think I'm at a level of knowledge enough about it. Before I start my profession, I plan to improve myself both as a teacher and as a person..."* (PsT 6)

*"... If we were to say my own ideas here, the best way to get to know a culture is actually to live or be in that culture. Only if this is done can a culture be recognized. Well, if we don't have the culture to live in, we can get to know them by watching who lived at that time. We should read movies, TV shows, and books..."* (PsT 9)

*"... If we think about ways to recognize cultural and intercultural situations in the context of the classroom, I think that being in contact with students, parents and people in the region where we teach is the best way to ensure this. It is necessary to be a "good observer" to be able to recognize these two concepts..."* (PsT 25)

Pre-service teachers, as in the case of teachers, thought that social ways were the basic step in recognizing a culture. They also stated that it would be more efficient to carry out the process with education and that it was important for the individual to educate himself. Although the pre-service teachers think that interaction is very important to transfer cultures, they also added that it is possible for individuals who cannot reach this opportunity to improve themselves through social media, internet, film, series of documentaries. Pre-service teachers who stated that they did not know about intercultural situations (n = 6) were also more numerous than teachers (n = 3). The reason

for this can be explained by many factors such as age, experience, educational life. The presence of pre-service teachers who think that they will learn while teaching from teacher candidates who express that they do not know is also important in terms of education and thinking that contact with individuals from other cultures will teach this situation.

#### 4.2. Findings and Interpretation of the Second Sub-problem

The answers from the teachers to the second sub-problem "How do you define cultural diversity?", which determines how mathematics teachers and primary school mathematics teacher candidates define cultural diversity, are shown in Table 3 and the answers from teacher candidates are shown in Table 4.

**Table 3:** Mathematics Teachers' Views on the Definition of Cultural Diversity

Categories	Subcategories	Frequency
Differences Diversity	It is to have different cultural elements.	11
	It is the coexistence of different cultures freely, without assimilation, living together in interaction.	8
	It is the coexistence of people with different life experiences, traditions, language, religion, social and economic opportunities.	8
	It is the intertwining/intersection of two or more cultures/many cultures.	7
Simile	It is a lifestyle.	2
	It is a dining table.	1
	It is the aggregation of discrete sets under the universal set.	1
Benefits	Enriches the environment.	8
	It affects people's visions/perspectives on life.	6
	It provides socialization.	5
	It increases imagination.	3

When mathematics teachers were asked the question "How would you define cultural diversity?", the answers received were divided into 3 categories. The definitions in this regard generally came within the same framework and it was seen that there was intensity in several points. Teachers have placed particular emphasis on the issue of differences and variations. The point that is seen as important is that; it has been that differences interact while living together, but continue to exist without assimilating each other. Since there are also quite a lot of teachers who define cultural diversity by expressing its benefits, a separate category has been opened as the benefits of cultural diversity. In this category, teachers who said that cultural diversity is wealth, affects their perspective on life, and contributes to socialization also touched upon their individual and social contributions.

Teachers who define difference as diversity, having different cultural elements (n = 11), interacting with different cultures without assimilating (n = 8), each different understanding or behavior (differences such as language, perspective, flexibility, belief, lifestyles, social structure, ethnic structure, differences in thought structures) constitutes

cultural diversity in itself (n = 8), two or more cultures intertwine, they focused on the points of intersection (n = 7).

Teachers who explained cultural diversity through simulation compared it to lifestyle (n = 2), a dining table where different images and tastes adapt to each other (n = 1), and discrete clusters gathered under a homogeneous mixture of different cultures or a universal cluster (n = 1).

Referring to the benefits of cultural diversity while defining it, the teachers stated that it enriched the environment (n = 8), affected people's vision (n = 6), increased socialization (n = 5) and imagination (n = 3).

When mathematics teachers are asked about the definition of cultural diversity, the opinions they receive can be listed as follows:

*"... Cultural diversity is the material and spiritual values that vary from region to region and even from country to country. I think every different understanding, every different behavior is a culture..." (T3)*

*"... We can say that it is the fusion of the cultures of people who come together from different places for different reasons..." (T17)*

*"... Cultural diversity is the homogeneous mixing of different cultures or the aggregation of discrete clusters under the universal cluster..." (T20)*

*"... Cultural diversity; it's like a dining table. Each one is a different flavor, each one is a different image beauty. When they all come together, it becomes the perfect dining table..." (T30)*

When the direct quotations of the teachers are examined, the analogies they make about cultural diversity have added a different color to the study. The parable of discrete clusters grouping under universal clusters should be seen as a metaphor for communities that are in the same place with each other, in the same environment, but live together respectfully without changing each other. Another parable of the dining table is that dishes of different flavors and each of which is valuable in its own right become more beautiful as they take place at the same table, and this is interpreted by the teacher as the different cultures that are beautiful when they are apart become more beautiful together.

**Table 4:** Opinions of Pre-Service Elementary Mathematics Teachers on the Definition of Cultural Diversity

Categories	Subcategories	Frequency
Differences Diversity	It is the intertwining/intersection of two or more cultures/many cultures.	17
	It is wealth.	11
	It is the coexistence of people with different life experiences, traditions, language, religion, social and economic opportunities.	9
	It is the coexistence of different cultures freely, without assimilation, living together in interaction.	8
	It's a change of thinking.	1
Simile	It is treasure.	3
	It is a rainbow.	1
Benefits	It affects people's visions/perspectives on life.	6
	It breaks prejudices.	4
	It gives a magic touch.	3

When the question "How would you define cultural diversity?" was asked to pre-service elementary mathematics teachers, the answers received were divided into 3 categories. However, there are fewer teacher candidates who express the definition by making simulations and voicing their benefits. 50% of the teacher candidates answered that different cultures live together and interact. In addition, in this interaction, the candidates expressed a few points to be considered. According to pre-service teachers it is important to point out that different cultures can coexist freely, without assimilating each other. Thanks to this contact and interaction, it is thought by the participants that people's perspectives on life will change, prejudices against different cultures will be broken, and the social skills of individuals will increase.

Pre-service teachers who define difference as diversity, intertwining, intersecting, interacting with two or more cultures (n = 17), cultural diversity being an indicator of richness (n = 11), the coexistence of people with different life experiences, traditions, language, religion, social and economic opportunities (n = 9), the coexistence of different cultures in interaction without assimilation (n = 8), they focused on the moments of thought change (n = 1).

Teacher candidates who explained cultural diversity through simulation made the analogies of treasure (n = 3) and rainbow (n = 1).

Referring to the benefits of cultural diversity while defining it, the teacher candidates stated that it affects people's visions (n = 6), breaks prejudices and increases socialization (n = 4), and adds color to life (n = 3).

When teacher candidates are asked to define cultural diversity, the answers received can be listed as follows:

*"... Culture is the religious, social, ethnic values of people. Man is greatly influenced by culture in his life. There are fragments of culture in man's daily life. People know their culture from birth to when they grow up. When he observes the behavior of his family and the region (environment) where he grew up, he begins to know his culture. Cultural*

*diversity is a concept that means having many cultures in a field, country or organization...” (PsT 2)*

*“... Cultural diversity; It is formed by the coming together of people who have different life experiences and therefore different rules, traditions and perspectives. The best way to notice these cultural differences is to be included in these differences, to travel, read and observe a lot...” (PsT 3)*

*“... Cultural diversity is like a rainbow. If different colors can create a beautiful image together, different cultures can come together and create a beautiful cultural diversity...” (PsT 23)*

For cultural diversity, the general range of pre-service teachers first defined the culture. According to the candidates, language, religion, ethnic values, social and economic life, thoughts and behaviors constitute people's cultures. It has been said that the coming together of individuals from whom these cultures differ provides cultural diversity. Cultural diversity increases the interaction of individuals from different cultures, and if wealth is to be achieved as a result, it must be ensured that they support each other rather than blunt each other.

### 4.3. Findings and Interpretation of the Third Sub-problem

Researching the thoughts of mathematics teachers and pre-service elementary mathematics teachers on which aspects of cultural diversity are important for mathematics education, "Which aspects of cultural diversity are important for mathematics education? Why?" answers from teachers to the third sub-problem are shown in Table 5, and answers from teacher candidates are shown in Table 6.

**Table 5:** Opinions of Mathematics Teachers on Which Aspects of Cultural Diversity is Important for Mathematics Education

Categories	Subcategories	Frequency
Socially	It adds different solutions.	7
	It helps the student to discover his/her self-culture.	4
	It gives students a 'worldview/independence'.	4
	It improves communication skills.	3
	It develops tolerance, understanding and empathy.	2
	It helps the student to explore different cultures.	2
	There may be disagreements between students.	1
In Terms of the Course	Students' interest/course activity increases.	4
	Permanent, meaningful learning takes place.	4
	It contributes to the proliferation and diversification of examples in the course.	3
	It decreases the prejudice of the students to the course.	1
	It adds intimacy to the classroom environment.	1
	Cultural diversity facilitates the teaching of mathematics.	5

In Terms of Mathematics	As cultures diversify, the universality of mathematics is better understood.	4
	As cultural diversity increases, the acceptance, understanding and progress of mathematics in society increases.	2
Individual Perspective	It gives a rich/multifaceted perspective.	7
	It improves the mind and increases comprehension capacity.	5
	It improves reasoning ability.	1

The 32 math teachers were asked, "What aspects of cultural diversity are particularly important for math education? Why?" which can be divided into 4 categories to be evaluated socially, structurally, mathematically, and individually. According to other sub-problems, the answers can be divided into a large number of themes and codes, but the most common answer is that cultural diversity adds different solutions and provides a multifaceted perspective. It has been expressed by teachers that mathematics and culture are very similar in structure as they consist of the merger of many sub-branches and that this similarity will facilitate the teaching of mathematics. From this point of view, some of the teachers actually predicted that the use of cultural diversity in mathematics teaching would have many benefits. The response that there may be disagreements among students, voiced by only 1 teacher, is also worth noting. Considering this opinion of the teacher, it has become an important issue to take measures to prevent this situation in the lesson.

When the importance of cultural diversity is examined from a social point of view, it is also stated by the teachers that it adds different solutions ( $n = 7$ ), gives students a "world view and an understanding of independence" ( $n = 4$ ), helps the student discover both himself and his culture ( $n = 4$ ) and different cultures ( $n = 2$ ), develops communication skills ( $n = 3$ ) and tolerance, understanding and empathy ( $n = 2$ ), as well as negative effects that there will be disagreements between students ( $n = 1$ ) is indicated. When its importance in terms of the course is examined, it is mentioned that it increases both the students' interest and activity in the course ( $n = 4$ ) and meaningful and permanent learning ( $n = 4$ ), allowing the examples in the course to multiply and diversify ( $n = 3$ ), breaks the prejudice of the students to the course ( $n = 1$ ), and that the differences will add sincerity to the classroom environment ( $n = 1$ ).

It was thought that mathematics and culture have the same characteristics in terms of bringing together many elements, so cultural diversity facilitates the teaching of mathematics ( $n=5$ ). At the same time, there are teachers who say that although cultures change, the fact that mathematics does not change shows students the universality of mathematics ( $n = 4$ ). The view that as cultural diversity increases, the acceptance and understanding of mathematics in society will increase and that mathematics will make progress ( $n = 2$ ) is one of the answers given in the category examined from a mathematical point of view.

When the importance of cultural diversity from an individual point of view is examined, it is obtained that it will add a rich perspective to the individual ( $n = 7$ ),



improve the mind and increase its capacity to understand (n = 5), and improve the power of reasoning (n = 1).

When mathematics teachers were asked which aspects of cultural diversity, they thought were important for mathematics education, the answers could be quoted as follows:

*"... In cultural diversity, the 'Worldview' is important for mathematics education. Because, in societies that do not develop themselves that do not turn to knowledge and mathematics in their worldview, it is not possible for mathematics to develop as it is not possible for every science to develop..." (T3)*

*"... If cultural diversity is approached in a positive way, that is, if it is seen as a richness, then it is possible to accept what is different among the students or to help him if he is lacking or to introduce himself to him, to share the beauties in himself with him, such things develop. The contribution of this to mathematics is actually very large. Most societies that have advanced in mathematics are societies with multiple cultures. For example, if we give examples from around the world, mathematics education in India is at a good level. There's really a lot of extreme culture in India..." (T4)*

*"... It is interesting for children to know their history, values. It's especially interesting to learn this in mathematics..." (T13)*

*"... Like culture, mathematics consists of many parts, elements. It would be more fruitful for them to merge instead of clash..." (T21)*

*"... Thanks to differences such as the power of analysis of some cultures, the power of comprehension of some, the way in which some interpret them, it is useful in the form of the rise of a wide variety of voices together and the exchange of information from each other..." (T31)*

As cultural diversity comes together in lessons, the combination of the good aspects of different cultures can have positive results in terms of education. For example, as in the case of a participant's quote, the power of comprehension in some cultures may be at a higher level than in other cultures, or the interpretive hound may be more prominent in a culture. It is thought by teachers that cultural diversity will bring this richness to the classroom. Finally, when the views of teachers are examined carefully, it is seen that the vast majority of them think that cultural diversity will make a positive contribution to the education and training process and also to mathematics education. One participant even supported his positive views by giving the example of India, where cultural diversity is rich, by stating that mathematics is at a good level in this country.

**Table 6:** Opinions of Pre-service Elementary Mathematics Teachers on  
 Which Aspects of Cultural Diversity Are Important for Mathematics Education

Categories	Subcategories	Frequency
Socially	It adds different solutions.	8
	It develops tolerance, understanding and empathy.	4
	It helps the student to discover his/her self-culture.	3
	It helps the student to explore different cultures.	3
	The ability to adapt improves.	2
	It can create a sense of timidity and exclusion in students.	2
	The teacher-student relationship may be adversely affected.	1
In Terms of the Course	It adds variety to the learning environment.	10
	It contributes to the proliferation and diversification of examples in the course.	8
	Students' interest/course activity increases.	6
	Permanent, meaningful learning takes place.	3
	Lessons have more fun and enjoyable.	2
	Not every student can learn equally.	1
In Terms of Mathematics	It shows that mathematics responds to the needs of daily life.	4
	It shows the phases of mathematical thought, how it varies according to culture.	4
	It is important for the advancement of mathematics, its sustainability.	2
	It embodies mathematics.	2
	The combination of the strong features of different cultures adds richness to mathematics.	1
Individual Perspective	It gives a rich/multifaceted perspective.	15
	It develops problem-solving skills.	7
	It contributes to critical/analytical thinking.	4
	It develops the ability to associate / analyze.	4
	It develops mathematical thinking skills.	2
	It improves the mind and increases comprehension capacity.	3

The 34 pre-service elementary mathematics teachers interviewed were asked "Which aspects of cultural diversity are particularly important for mathematics education? Why?" and answers that can be divided into 4 categories to be evaluated socially, structurally, mathematically, and individually were obtained. Among these categories, the answers to gain a rich perspective, enrich the learning environment, add different solutions, increase the interest of students in the course, and develop problem-solving skills are supported by more teacher candidates. According to the teachers, the teacher candidates who saw their negative sides were relatively more. The idea of the teacher candidate who gives one of these answers that cultural diversity can benefit in the lesson if the teacher adopts the culture of each child can be considered as a solution when problems are encountered.

When the importance of cultural diversity in social terms is examined, it is stated by the teacher candidates that it adds different solutions (n = 8), develops tolerance, understanding, and empathy (n = 4), helps the student discover both himself and his

culture (n = 3) and different cultures (n = 3), creates a feeling of timidity and exclusion in students (n = 2) and that the relationship between teacher and student will be adversely affected (n = 1).

When its importance in terms of the course is examined, opinions were obtained that it adds diversity to the learning environment and enriches the learning environment (n = 10), allows the examples in the course to multiply and diversify (n = 8), increases both the interest and activity of the students in the course (n = 6) and the course efficiency (n = 3) and that the lessons will be more fun and enjoyable (n = 2). In addition to positive opinions, there is also an answer that cultural diversity will prevent every student from learning equally (n = 1).

When the mathematical importance of cultural diversity is examined, the focus is on showing students that mathematics responds to the needs of daily life (n = 4) and showing the stages of mathematical thought and how mathematics changes according to cultures (n = 4). At the same time, it is stated that cultural diversity is important for the advancement of mathematics, sustainability, and love (n = 2) and that it embodies mathematics (n = 2). While it is thought that the combination of the strengths of different cultures will enrich mathematics (n = 1), it is stated that aspects of cultural diversity, especially emotional, social, linguistic, economic, and physical characteristics, are very important for mathematics education because for mathematics learning, the student's financial status, disability, language used and social characteristics should be good (n = 1).

When the importance of cultural diversity from an individual point of view is examined, positive answers were obtained that it would add a rich perspective to the individual (n = 15), improve problem-solving skills (n = 7), contribute to critical and analytical thinking and lead students to deep thinking (n = 4), associate, analyze skills (n = 4), mathematical thinking skills (n = 2) and increase the capacity to develop and understand the mind (n = 3).

When teacher candidates are asked to define cultural diversity, the answers received can be listed as follows:

*"... I think cultural diversity is very important for the advancement of mathematics, for loving mathematics, and for is teaching it properly. Because mathematics and natural science are universal. Because every different person has a different knowledge and point of view. This is precisely why cultural diversity is so important when it comes to mathematics and science. What is important for us is not to look at this diversity of people with bad intentions, but to look into their hearts and use this diversity in a positive way when studying or learning science..." (PsT4)*

*"... Cultural diversity means wealth. This is a blessing in disguise for mathematics education. Because mathematics cannot be explained in a single way. You have to make sure that everyone makes sense of it. Here, cultural diversity opens your path and opens up opportunities. So, the differences come back to you as a plus..." (PsT7)*

*"... With cultural diversity, the student can realize permanent learning. It helps the student to look at things from multiple sides by providing different perspectives. By examining the objects, he sees, he investigates mathematical relationships and acquires a deep-thinking style..." (PsT10)*

*"... It is especially important for mathematics education that cultural diversity has been accumulating for a long time and is very rich. Because mathematics is a cumulative discipline that has been thought about and researched for many years. It has come down to our day by adding to it like culture..." (PsT13)*

Although mathematics is shaped together with culture, even if it is universal, teacher candidates have evaluated the existence of cultural diversity in mathematics teaching as positive. The systematic and cumulative structure of mathematics makes teacher candidates think that they have taken some parts from the culture they are in. As cultural diversity increases in the classroom, it is thought by teacher candidates that their perspectives on mathematics will diversify solutions will increase, and different ways of thinking will come to the forefront.

#### 4.4. Findings and Interpretation of the Fourth Sub-Problem

The answers from the teachers to the fourth sub-problem "Which of these aspects do you encounter or think you will encounter in your classes?" which investigates the aspects that mathematics teachers and pre-service elementary mathematics teachers encounter or think they will encounter from the answers they give in the third problem are shown in Table 7 and the answers from the teacher candidates are shown in Table 8.

**Table 7:** Opinions of Mathematics Teachers on Which Aspects of Cultural Diversity Are Important to Mathematics Education and What They Encounter or Think They Will Encounter in Their Classrooms

Categories	Subcategories	Frequency
Socially	The ability to unite students from different cultures, to keep them together, to accept what is different from them, to empathize.	8
	Lack of communication.	4
	Experiencing compliance problems.	4
	Students' timid behavior.	3
	Gain the ability to find alternative solutions to everyday problems.	2
	Encountering the distinctive aspect in the future.	2
	Students feel comfortable in an environment of cultural diversity.	1
	The emergence of material differences in the classroom.	1
In Terms of the Course	Increased course efficiency.	5
	Enriching the teaching environment by creating multiple learning environments with different cultures.	4
	Interests, needs, readiness that are different due to cultural differences prolong the learning period.	2
	Increased love and interest in the lesson.	1
	It's a challenging process for both teachers and students	1

	Experiencing motivation problems.	1
	Minority students in the background.	1
In Terms of Mathematics	Demonstrate that mathematics responds to the needs of daily life.	1
Individual Perspective	Gain a well-rounded perspective.	7
	Improving reasoning ability.	2
	Gain critical/analytical thinking skills.	1
Others	In an exam-oriented curriculum, cultural differences cannot be integrated into the course.	2
	I've never encountered it before.	2

When the mathematics teachers who participated in the interview were asked the question "Which of these aspects do you encounter/think you will encounter in your class?", the answers were divided into 4 categories as social, lesson, mathematical, and individual aspects, as in the 3rd research question. It is seen in the findings that teachers have a more pessimistic perspective on this sub-problem. Thinking that students and teachers will have difficulty, especially in social terms, may be related to the environment in which teachers live and the school environment in which they work. In addition, the negative opinions in terms of the course were repeated almost the same number of times as the positive opinions. Since teachers are actively involved in the educational environment, it may be considered normal for them to see more of their negative sides.

When the social contributions of cultural diversity to students are examined, it is stated that students from different cultures will gain the skills of uniting, keeping together, accepting what is different from themselves ( $n = 8$ ), producing alternative solutions to daily problems ( $n = 2$ ) and that students will feel comfortable in intercultural environments ( $n = 1$ ). On the contrary, it is also among the negative opinions that there will be communication problems among the students ( $n = 4$ ), students will exhibit timid behaviors ( $n = 3$ ), adaptation problems will be experienced ( $n = 4$ ) and they will encounter the distinctive aspect in the future ( $n = 2$ ).

When the importance of the course is examined, positive opinions have been reported that since examples from different cultures will increase, the number of students learning the subject will increase ( $n = 5$ ), enriching the learning environment ( $n = 4$ ), and since the teacher will show love and respect for each culture, the student's love and interest in the lesson will also increase ( $n = 1$ ). In addition to these views, there were negative opinions about prolonging the learning period due to the difference in interests, needs, and readiness due to cultural differences ( $n = 2$ ), experiencing motivation problems ( $n = 1$ ), and leaving the students in minority culture in the background ( $n = 1$ ). It is also among the opinions that integrating cultural diversity into the course involves a challenging process for both teachers and students ( $n = 1$ ) and cannot be applied due to the intensity of the curriculum ( $n = 2$ ).

When the mathematical importance of cultural diversity is considered, showing the students that mathematics responds to the needs of daily life ( $n = 1$ ) is the only response from the teachers.

When the importance of cultural diversity from an individual point of view is examined, positive answers were obtained that it would add a rich perspective to the individual (n = 7), improve reasoning power (n = 2), and gain critical and analytical thinking skills (n = 1).

There are also teachers who have not met before (n=2).

When asked which of the important aspects of cultural diversity, which is the fourth sub-problem for mathematics education, and the mathematics teachers they encounter in their classrooms, some of the answers are as follows:

*“... I have encountered the unifying aspect of culture, and I think I may encounter its distinctive aspects in the future. Unfortunately, it is not possible to achieve cultural reconciliation and unity in every environment...” (T1)*

*“... In fact, group work is very important for these differences to come together and produce beautiful things. But in this teamwork, I may have adaptation problems. Or I can get a lot of efficiency and create a rich learning environment...” (T13)*

*“... Students who have been separated from a different culture by migration may experience psychological problems when they enter the new cultural environment, and it can be challenging to motivate the student against the course because of these problems...” (T15)*

*“... It is important for people from different cultures to communicate with each other in order to get rid of prejudices and to see different thoughts and behaviors...” (T18)*

When the opinions of the teachers are examined, it is also among the opinions that it will be a good option to get rid of prejudices and that prejudices will prolong the process and make it inefficient. In fact, although the teachers had a positive attitude in terms of ideas, they also expressed negative facts as they returned to practice. The opinions of teachers are extremely important in terms of seeing and overcoming negative sides.

**Table 8:** Opinions of Pre-service Elementary Mathematics Teachers on Which Aspects of Cultural Diversity Are Important for Mathematics Education and What They Encounter or Think They Will Encounter in Their Classrooms

Categories	Subcategories	Frequency
Socially	The ability to unite students from different cultures, to keep them together, to accept what is different from them, to empathize	5
	Experiencing compliance problems	3
	Exclusion of people from different cultures	3
	Respect for different opinions	2
	Encountering the distinctive aspect in the future	2
	Lack of communication	2
	Students' timid behavior	1
	The emergence of material differences in the classroom	1

In Terms of the Course	Increased course efficiency	15
	Enriching the teaching environment by creating multiple learning environments with different cultures	9
	Increased love and interest in the lesson	1
	Increasing the student's activity in the course	1
Individual Perspective	Gain a well-rounded perspective	2
	Gain a self-criticism ability	1
	Individual differences come to the fore	1
Others	In an exam-oriented curriculum, cultural differences cannot be integrated into the course.	1

When the 34 pre-service elementary mathematics teachers who were interviewed were asked the question "Which of these aspects do you encounter/think you will encounter in your class?", the answers were divided into 3 categories as social, lesson and individual aspects. When evaluated from a social point of view, it is interesting that the negative opinions of the teacher candidates take precedence over the positive opinions. While the candidates showed a very positive attitude in other sub-problems, they expressed their concerns in this sub-problem, perhaps due to the environment in which they lived. The fact that there is no negative opinion in terms of the lesson supports other sub-problems that teacher candidates believe that cultural diversity will increase course performance, success and interest, and motivation in the lesson.

When the contributions of cultural diversity to the classroom were examined from a social point of view, the only positive answers were to unite students from different cultures, to keep them together, to accept what is different from themselves, to empathize ( $n = 5$ ) and to be open to different thoughts ( $n = 2$ ). From a social point of view, it is possible that different cultures will be excluded ( $n = 3$ ), adaptation problems ( $n = 3$ ) and communication problems will be experienced ( $n = 2$ ), students will exhibit timid behaviors ( $n = 1$ ), they will encounter the distinctive aspect in the future ( $n = 2$ ) and material differences will emerge in the classroom ( $n = 1$ ).

When its importance in terms of the course is examined, it is among the opinions that a course in which different cultures are integrated will increase the course efficiency ( $n = 15$ ), enrich the teaching environment ( $n = 9$ ), increase the love and interest in the course ( $n = 1$ ) and increase the student's activity in the course ( $n = 1$ ) since it will have a multiple learning environment.

When the importance of cultural diversity from an individual point of view is examined, it is stated that it will add a rich perspective ( $n = 2$ ) and self-criticism ability ( $n = 1$ ) to the individual and that the courses in which cultural diversity is included will bring individual differences to the forefront ( $n = 1$ ).

However, there is a teacher candidate's opinion that cultural differences cannot be integrated into the course in an exam-oriented curriculum ( $n=1$ ).

When teacher candidates are asked to define cultural diversity, the answers received can be listed as follows:

*"... In these aspects, I think I will encounter the most reluctance of students to express their opinions freely..." (PsT2)*

*"... This culture can be used when a student from Gaziantep talks about the motifs in the Zeugma Museum and informs the class. The mathematical information used in the construction of the Bosphorus bridge can be shared..." (PsT19)*

*"... Each culture has different powers, and it penetrates the most intense part of its thoughts into the individuals who grow up from that culture, and as this becomes more different, it creates a great wealth..." (PsT31)*

While the teacher candidates were generally in a positive attitude based on other sub-problems, they had a worried appearance in this sub-problem. They stated that students' timidity, adaptation and communication problems, prejudices, and similar situations would bring a challenging process in terms of social and even lessons. This may be due to the fact that teacher candidates see these and similar problems in the educational environment or in their own social environment. There are also teachers and teacher candidates who state that cultural differences arising from the exam-oriented curriculum cannot be integrated into the course. The reason for this may be that the curriculum is intensive and it will be difficult to train the subjects during the exam process.

## **5. Results and Discussion**

### **5.1. Results for the First Sub-problem**

When the answers from the participants to the first sub-problem " How would you describe ways of recognizing culture and intercultural situations?" were evaluated, the answer of interacting with different cultures and meeting people from different cultures was the most repeated answer. In addition, when evaluated within the educational processes, unlike the teacher candidates, the teachers also answered to spend time with classes that host different cultures. This classroom environment provides a suitable ground for creating cross-cultural situations, because at the same time, this class is a social group where different cultures come into contact with each other. According to Mato (2012: 109), cross-cultural contact and communication involve relationships between homogeneous and heterogeneous groups on a meaningful basis, interacting with groups that are not themselves as well as within individuals' own groups. Therefore, as with the findings from teachers, cross-cultural communication focuses on social processes.

In addition, traveling, using the internet and social media, learning a language, immigrating, observing, participating in student exchange programs such as Erasmus and Farabi, asking family elders, and watching content such as movies, series, and documentaries are common answers from teachers and teacher candidates. In fact, most of these responses from participants are based on creating a social situation. While



traveling, using social media, immigrating, participating in student exchange programs, listening to grandparents, the individual is in a social interaction every time. This conclusion is supported by many studies (Mert, Albayrak and Serin, 2013: 59; Mamish, 2016: 611-612; D'Ambrosio, 2001: 310).

Unlike teacher candidates, teachers' thoughts of being in an interaction environment rather than an individual breakthrough to get to know new cultures or to be aware of intercultural situations are understood from the findings. It can be said that teachers are older than teacher candidates in terms of age and experience and that the candidates differ from the teachers as a generation. As times change, it is supported by research that generations attach more importance to individuality than the previous generation (Paker, 2011: 64). This may be the reason why teacher candidates are more concerned about the ability of culture to learn in individual ways than teachers.

Of the participants who said that they did not know the ways to recognize intercultural situations, the T17 coded teacher and the T33 coded teacher candidate added that they thought they would learn in their teaching lives. This shows that, in fact, these participants thought that the profession performed in a social environment such as teaching would give them this skill. Although they express what they do not know, this statement they add to their answers reveals that they will actually learn ways to recognize cross-cultural situations through sociality.

## **5.2. Results for the Second Sub-problem**

To the question of the second sub-problem, "How would you define cultural diversity?", it is seen that the both of participants gave almost similar answers. Both teachers and candidates placed particular emphasis on differences and variations. Cultural diversity has been defined as the coexistence of different cultures, their intersection, their free coexistence without assimilating each other. These definitions of the participants are also supported by the literature (Öztürk and Özsoy Somuncuoğlu, 2018: 32). Referring to the benefits of cultural diversity while making a definition, the participants mentioned that it would give individuals a vision and a world view (D'Ambrosio, 1999a: 131), enrich the environment, provide socialization and develop imagination. According to the participants, cultural diversity increases the interaction of individuals from different cultures, and as a result, richness is achieved by supporting each other instead of blunting each other.

The participant who said that he did not know about cultural diversity did not come out in this research. It is conceivable that when each participant knows the definition of cultural diversity, they will actually know ways to recognize cross-cultural situations. However, in the first sub-problem, there were participants who remained timid. The reason why cultural diversity is so widely known may be due to the fact that the country where they live is an environment where different cultures can coexist at any time.

### **5.3. Results for the Third Sub-problem**

When the question of the third sub-problem, "Which aspects of cultural diversity are particularly important for mathematics education?", was managed to the participant group, answers that could be divided into 4 categories were obtained from both groups to be evaluated socially, structurally, mathematically and individually. While teachers focus more on their social benefits, it is seen that teacher candidates focus more on their benefits in terms of lessons. It is thought that the teacher candidates put the success of the course in the foreground due to the fact that they have just taken the "Culture and Mathematics" course on the dates of the interview. It was determined that the negative responses to this sub-problem were higher in teacher candidates. However, the researches contradict the results of this research that although the cultural diversity of the classes increases, teachers have difficulty in adapting (Nayir, 2020: 104), they cannot notice cultural connections sufficiently (Lindsey, 2004: 9), and teachers have a lack of narrative on this subject (DeCastro-Ambrosetti & Cho, 2005: 44).

According to the participants, having different aspects of mathematics combined with cultural diversity will support the learning environment. Concentrating on a subject, a lesson, by bringing together the features that are evident and dominant in different cultures, will support different perspectives and enable different solutions of mathematics to appear. It is thought by the participants that cultural diversity will bring different perspectives, different solutions, and different cultural richness to the classroom. At the same time, this situation, which is also shown in the literature, is in line with the views of teachers and teacher candidates (Arismendi Pardi, 1999: 14-15; D'Ambrosio, 2001: 309; Ascher, 2005: 1-195; Owens, 2012: 591-592; Aikpitanyi & Eraikhuemen, 2017: 37).

### **5.4. Results for the Fourth Sub-problem**

When the fourth sub-problem, "Which of these aspects do you think you encounter or will encounter in your classrooms?", is asked to the participants, it is seen that both teachers and teacher candidates have a more negative perspective than other sub-problems. These negative aspects are concentrated in the sociability of the students and their attitudes in the lesson. Although the participants think that the students will develop individually, they are worried that there will be problems in terms of lessons and socialization. Especially the fact that the majority see the social difficulties and troubles experienced by millions of people who fled the civil war in Syria in 2011 and migrated to Turkey can be the reason for this. While the majority of this migration is made up of school-age children, teachers have identified the problems experienced in the field of education and teacher candidates have been able to foresee them (Disaster and Emergency Management Presidency (AFAD), 2017: 10).

In addition, it is noteworthy that teacher candidates are more pessimistic than teachers in social difficulties. While teacher candidates showed a more positive attitude than teachers during the research, the opposite situation was experienced in the last problem. The reason why teacher candidates have this idea may be the environment they

live in. In addition, while the teacher candidates who took the "Culture and Mathematics" course had more negative opinions on social issues, they did not express any negative opinions in terms of the course. This is an indication that the course contributes to teacher candidates.

## 6. Recommendations

According to the results of the research, the following recommendations can be made to the researchers:

- Studies can be carried out to monitor the mathematical achievements of classroom environments where there is cultural diversity.
- Research can be carried out to determine the attitudes and skills of mathematics teachers in culturally diverse classrooms.
- Studies examining the perceptions of students from different cultures and different races towards mathematics lessons can be included.

According to the results of the research, the following suggestions can be made to practitioners:

- For the mathematics course to be taught in a culturally diverse classroom environment, appropriate elements from the cultures to which the students belong can be given as examples in the lesson plan.
- Mathematics teacher candidates may be asked to make lesson plans on the relationship between culture and mathematics to be used in the Teaching Practice course.

## 7. Conclusion

This study aims to determine the perspectives of mathematics teachers working at elementary and high school levels in National Education in Turkey and pre-service elementary mathematics teachers on the relationship between culture and mathematics teaching. Ethnomathematics in the literature, in other words, is important in terms of the results of this research due to the lack of research on the relationship between culture and mathematics.

According to the findings, mathematics teachers and mathematics teacher candidates agree on the integration of the relationship between culture and mathematics into the course. It is thought by the participants that this integration contributes to increasing the success of the students, reducing mathematics anxiety, and facilitating the solution of daily life problems. Although they predicted that they would experience negative situations such as communication problems and timidity, it was determined that their positive contributions would be more.

### Acknowledgements

The authors would like to thank the teachers and pre-service teachers who shared their thoughts and time with us.

### About the Author(s)

**Özge Özcan** graduated from Yildiz Technical University Primary School Mathematics Teaching undergraduate program in 2018 and Yildiz Technical University Mathematics Education master's degree program in 2022. Since 2019, she has been teaching at a school affiliated to the Ministry of National Education in Turkey. She has worked on ethnomathematics, history of mathematics, interdisciplinary mathematics education.

**Assoc. Prof. Elif Bahadır** graduated from Selcuk University Department of Mathematics Master's degree program in 2005 and Marmara University Mathematics and Science Education PhD program in 2013. Realistic mathematics education, ethnomathematics, mathematical elements in culture, STEM, GEMS are among her research areas. She has worked as a consultant and executive in many important projects. She has been a referee in 2 different journals and his articles have been published in refereed and indexed journals.

### References

- Achor E, Imoko B.I, Uloko, E.S, 2009. Effect of Ethnomathematics Teaching Approach on Senior Secondary Students' Achievement and Retention in Locus. *Educational Research and Review* 4(8): 385-390. Retrieved from [https://www.researchgate.net/publication/228348880\\_Effect\\_of\\_ethnomathematics\\_teaching\\_approach\\_on\\_senior\\_secondary\\_students'\\_achievement\\_and\\_retention\\_in\\_Locus](https://www.researchgate.net/publication/228348880_Effect_of_ethnomathematics_teaching_approach_on_senior_secondary_students'_achievement_and_retention_in_Locus).
- Disaster and Emergency Management Presidency (2017). Latest Situation in Accommodation Centers. Retrieved from <https://www.afad.gov.tr/tr/2374/Barinma-Merkezlerinde-Son-Durum>. Accessed 16 June 2020.
- Aikpitanyi L.A, Eraikhuemen L, 2017. Mathematics Teachers' Use of Ethnomathematics Approach in Mathematics Teaching in Edo State. *Journal of Education and Practice* 8(4): 34-38. Retrieved from <https://eric.ed.gov/?id=EJ1132939>.
- Aktekin D, 2017. Etnomatematik. Master's Thesis, University of Kocaeli.
- Arı A, Demir B, Ar T, 2019. Investigation of "Culture" and "Mathematics" Perceptions of Primary School Mathematics Teacher Candidates. *Bayburt University Journal of the Faculty of Humanities and Social Sciences* 5: 61-71. Retrieved from <https://dergipark.org.tr/tr/pub/butobid/issue/51079/655902>.
- Arismendi Pardi E.J, 1999. What is Ethnomathematics and Why Should We Reach It? *Crossing Cultures: Communicating Through the Curriculum*. National

- Conference of the Center for the Study of Diversity in Teaching and Learning in Higher Education included (2-18. pp.). California, San Diego.
- Ascher M, 2005. *Ethnomathematics: A Multicultural View of the World of Mathematics*. Istanbul: Okyanus Publishing.
- Büyüköztürk Ş, Kılıç Çakmak E, Akgün Ö.E, Karadeniz Ş, Demirel F, 2020. *Scientific Research Methods in Education*. Ankara: Pegem Academy Publishing.
- Carter T.A, Dean E.O, 2006. Mathematics Intervention for Grades 5–11: Teaching Mathematics, Reading, or both?. *Reading Psychology* 27(2-3): 127–146, doi:10.1080/02702710600640248.
- Creswell J.W, 2013. *Research Design*. Ankara: Eğiten Kitap Publishing.
- D'Ambrosio U, 1985. Ethnomathematics and Its Place in the History and Pedagogy of Mathematics. *For the Learning of Mathematics* 5(1): 44-48. Retrieved from <https://flm-journal.org/Articles/72AAA4C74C1AA8F2ADBC208D7E391C.pdf>.
- D'Ambrosio U, 1999a. Literacy, Matheracy, and Technocracy: A Trivium for Today. *Mathematical Thinking and Learning* 1(2): 131–153, doi:10.1207/s15327833mtl0102\_3.
- D'Ambrosio U, 1999b. Ethnomathematics and Its First International Congress. *Zentralblatt Für Didaktik Der Mathematik*, 31(2): 50–53. Retrieved from <https://link.springer.com/article/10.1007/s11858-999-0008-8>.
- D'Ambrosio U, 2001. What is Ethnomathematics, and How can It Help Children in Schools?. *Teaching Children Mathematics*, 7(6): 308-310. Retrieved from [https://www.researchgate.net/publication/284702127\\_What\\_is\\_ethnomathematics\\_and\\_how\\_can\\_it\\_help\\_children\\_in\\_schools](https://www.researchgate.net/publication/284702127_What_is_ethnomathematics_and_how_can_it_help_children_in_schools).
- D'Ambrosio U, 2007. Peace, Social Justice and Ethnomathematics. *The Montana Mathematics Enthusiast*, 25-34. Retrieved from [https://moam.info/peace-social-justice-and-ethnomathematics-citeseerx\\_5bac8a4f097c47ad308b46be.html](https://moam.info/peace-social-justice-and-ethnomathematics-citeseerx_5bac8a4f097c47ad308b46be.html).
- D'Ambrosio U, Borba M.C, 2010. Dynamics of Change of Mathematics Education in Brazil and a Scenario of Current Research. *ZDM*, 42(3): 271-279. Retrieved from <https://link.springer.com/article/10.1007/s11858-010-0261-x>.
- DeCastro-Ambrosetti D, Cho G, 2005. Do Parents Value Education? Teachers' Perceptions of Minority Parents. *Multicultural Education*, 13(2): 44-46. Retrieved from <https://eric.ed.gov/?id=EJ759621>.
- Göçer A, 2012. On the Relationship and Interaction of Language and Culture. *Turkish Language*, 729(1): 50-57. Retrieved from <https://avesis.erciyes.edu.tr/yayin/ed353982-fa5f-4b93-8df1-b2d1888b8481/dil-kultur-iliskisi-ve-etkilesimi-uzerine>.
- Göçer A, 2013. The Opinion of Turkish Student Teachers on the Relationship between Language and Culture: A Phenomenological Analysis. *Erzincan University Journal of Faculty of Education*, 15(2): 25-38. Retrieved from <https://dergipark.org.tr/tr/pub/erziefd/issue/6012/80396>.
- Güvenç B, 2002. *People and Culture*. Istanbul: Remzi Publishing.

- Kıral B, 2021. Phenomenology Design in Qualitative Research: Types and Research Process. *Research in Education and Teaching* 10(4): 92-103. Retrieved from [http://www.jret.org/FileUpload/ks281142/File/jret2021\\_10.cilt\\_sayi4-pages-93-104.pdf](http://www.jret.org/FileUpload/ks281142/File/jret2021_10.cilt_sayi4-pages-93-104.pdf).
- Kotluk N, Kocakaya S, 2019. The Opinions of Teachers' in Turkey on Culturally Sensitive Education: A Mixed Method Study. *Sakarya University Journal of Education*, 9(2): 304-334. Retrieved from <https://dergipark.org.tr/tr/download/article-file/786358>.
- Jankvist U.T, 2009. A Categorization of the “Whys” and “Hows” of Using History in Mathematics Education. *Educational Studies in Mathematics*, 71(3): 235-261. Retrieved from [https://www.researchgate.net/publication/226049853\\_A\\_categorization\\_of\\_the\\_whys\\_and\\_hows\\_of\\_using\\_history\\_in\\_mathematics\\_education](https://www.researchgate.net/publication/226049853_A_categorization_of_the_whys_and_hows_of_using_history_in_mathematics_education).
- Lindsey J, 2004. Culture's Role in Teacher Identity: Prompting Teachers to Explore Their Cultural Background. *Action in Teacher Education*, 25(4): 9-13. doi:10.1080/01626620.2004.10648291.
- Mato D, 2012. Socio-Cultural Differences and Intercultural Communication in Social Participation Experiences. *Intercultural Communication Studies*, 21(1): 101-116. Retrieved from <https://web.uri.edu/iaics/files/11DanielMato.pdf>.
- Mert O, Albayrak F, Serin N, 2013. The Study of Translated Children Books in terms of Cultural Transformation. *Journal of Mother Tongue Education*, 1(3): 58-73. doi: 10.16916/aded.16000.
- Ministry of National Education, 2022. System for Monitoring and Evaluating Curricula. Retrieved from <http://mufredat.meb.gov.tr/Default.aspx>. Accessed 2 Nisan 2022.
- Moyer P.S, 2001. Are We Having Fun Yet? How Teachers Use Manipulatives to Teach Mathematics. *Educational Studies in Mathematics*, 47(2): 175-197. doi: [10.1023/A:1014596316942](https://doi.org/10.1023/A:1014596316942).
- Nayir F, 2020. Kültürel Değerlere Duyarlı Eğitim. Ankara: Anı Publishing.
- Owens K, 2012. Identity and Ethnomathematics Projects in Papua New Guinea. *Mathematics Education Research Group of Australasia included* (586-893. pp.). Australasia, Singapore.
- Özen Y, Gül A, 2007. Population-Sampling Issue on Social and Educational Research Studies. *Kazım Karabekir University Journal of Faculty of Education*, 15: 394-422. Retrieved from <https://dergipark.org.tr/tr/download/article-file/31569>.
- Öztürk Ü, Özsoy Somuncuoğlu S, 2018. Cultural Diversity and Philosophical Criticism. *Journal of Four Elements*, 14: 31-43. Retrieved from [https://dergipark.org.tr/tr/pub/dortoge/issue/42658/514486#article\\_%20cite](https://dergipark.org.tr/tr/pub/dortoge/issue/42658/514486#article_%20cite).
- Presmeg N.C, 1998. Ethnomathematics in Teacher Education. *Journal of Mathematics Teacher Education*, 317-339. doi: [10.1023/A:1009946219294](https://doi.org/10.1023/A:1009946219294).
- Strutchens M, 1995. Multicultural Mathematics: A More Inclusive Mathematics. *ERIC Digest*, 1-8. Retrieved from <https://files.eric.ed.gov/fulltext/ED380295.pdf>.
- Tekindal M, Uğuz Arsu Ş, 2020. A Review on the Scope and Process of Phenomenological Approach as a Qualitative Research Method. *Beyond the Horizon of Scientific*

- Journal, 20(1): 153-182. Retrieved from <https://dergipark.org.tr/en/download/article-file/1355632>.
- Weaver A.D, Watson T.S, 2004. An Idiographic Investigation of the Effects of Ability and Effort-based Praise on Math Performance and Persistence. *The Behavior Analyst Today*, 5(4): 381-390. Retrieved from <https://psycnet.apa.org/fulltext/2014-44014-005.html>.
- Yenilmez K, 2011. Prospective Mathematics Teachers' Opinions about the History of Mathematics Course Pamukkale University Journal of Faculty of Education, 30: 79-90. Retrieved from [https://dergipark.org.tr/tr/pub/pauefd/issue/11113/132873#article\\_cite](https://dergipark.org.tr/tr/pub/pauefd/issue/11113/132873#article_cite).
- Yıldırım A, Şimşek H, 2011. *Qualitative Research Methods in Social Sciences*. Ankara: Seçkin Publishing.
- Yıldırım C, 2010. *Mathematical Thinking*. Istanbul: Remzi Publishing.

Creative Commons licensing terms

Author(s) will retain the copyright of their published articles agreeing that a Creative Commons Attribution 4.0 International License (CC BY 4.0) terms will be applied to their work. Under the terms of this license, no permission is required from the author(s) or publisher for members of the community to copy, distribute, transmit or adapt the article content, providing a proper, prominent and unambiguous attribution to the authors in a manner that makes clear that the materials are being reused under permission of a Creative Commons License. Views, opinions and conclusions expressed in this research article are views, opinions and conclusions of the author(s). Open Access Publishing Group and European Journal of Education Studies shall not be responsible or answerable for any loss, damage or liability caused in relation to/arising out of conflicts of interest, copyright violations and inappropriate or inaccurate use of any kind content related or integrated into the research work. All the published works are meeting the Open Access Publishing requirements and can be freely accessed, shared, modified, distributed and used in educational, commercial and non-commercial purposes under a [Creative Commons Attribution 4.0 International License \(CC BY 4.0\)](https://creativecommons.org/licenses/by/4.0/).