Van Yüzüncü Yıl University Journal of Education, 2025; 22(2), p. 513-547. DOI: 10.33711/yyuefd.1653954

Preservice Science Teachers' Views on Comparative Multicultural Practices: Turkey and United States of America Sample

İlke ÇALIŞKAN[1]

Abstract: Multiculturalism is a multidisciplinary concept that has gained importance in educational environments in the 21st century and includes integrated skills, especially empathy and cooperation. The aim is to find out the preservice teachers' views from two different countries about their experiential skills of multicultural science education. The study was conducted with 200 preservice science teachers. 120 of them were from Hacettepe University and 80 of them were from the University of Iowa within the context of Science Instruction and Planning Class during the 2023-2024 spring semester. Research is a case study design Practical instruction about multiculturalist learning environments was given for five weeks. The interactive education covering multicultural skills during the science instructional design process was shared to two countries' preservice teachers. Sample lesson plans were shown. They constructed their own science lesson plans considering multicultural skills after implementation. A semi-structured interview form about multicultural learning environments was used for data collection. Data were analyzed by descriptive and content analyses. It was suggested that using creative drama method, brainstorming and six-hat thinking technique in learning-teaching processes, designing for the needs of learners and providing trainings on these issues would increase the awareness and competence of science teachers about inclusive education.

Keywords: Multicultural learning environments, pre-service teacher education, science education

Hizmet Öncesi Fen Öğretmenlerinin Karşılaştırmalı Çokkültürlü Eğitim Uygulamalarına İlişkin Görüşleri: Türkiye ve Amerika Birleşik Devletleri Örneği

Öz: Çok kültürlülük, 21. yüzyılda eğitim ortamlarında önem kazanan ve başta empati ve işbirliği olmak üzere bütünleşik becerileri içeren multidisipliner bir kavramdır. Bu araştırmanın amacı, iki farklı ülkeden öğretmen adaylarının çok kültürlü fen eğitimi deneyimsel becerileri hakkındaki görüşlerini ortaya çıkarmak ve incelemektir. Çalışma 200 fen bilgisi öğretmen adayı ile yürütülmüştür. Öğretmen adaylarının 120'si Hacettepe Üniversitesinde, 80'i ise Iowa Üniversitesinde 2023-2024 bahar döneminde Fen Öğretimi ve Planlaması dersi kapsamında öğrenim görmektedir. Bu çalışma nitel araştırmaya yöntemine ait durum çalışması deseni olarak tasarlanmıştır. Katılımcılara beş hafta boyunca çok kültürlü öğrenme ortamları hakkında uygulamalı eğitim verilmiştir. Fen öğretim tasarımı sürecinde çok kültürlü becerileri kapsayan interaktif eğitim, iki ülkenin öğretmen adaylarıyla paylaşılmıştır. Örnek ders planları gösterilmiştir. Etkileşimli çalıştay sonrasında çok kültürlü becerileri dikkate alarak kendi fen ders planlarını oluşturmuşlardır. Bu çalışmada veri toplama aracı olarak çok kültürlü öğrenme ortamları hakkında yarı yapılandırılmış bir görüşme formu kullanılmıştır. Veriler betimsel ve içerik analizi teknikleri ile analiz

Geliş tarihi/Received: 09.03.2025 Kabul Tarihi/Accepted: 12.06.2025 Makale Türü: **Araştırma Makalesi**

[1] Doç.Dr., Hacettepe Üniversitesi, Matematik ve Fen Bilimleri Eğitimi Bölümü, ilkeonal@hacettepe.edu.tr, 0000-0003-4413-8514

Atıf için/To cite: Çalışkan, İ. (2025). Hizmet öncesi fen öğretmenlerinin karşılaştırmalı çokkültürlü eğitim uygulamalarına ilişkin görüşleri: Türkiye ve Amerika Birleşik Devletleri örneği. *Van Yüzüncü Yıl Üniversitesi Eğitim Fakültesi Dergisi, 22*(2), 513-547. https://doi.org/10.33711/yyuefd.1653954

edilmiştir. Araştırmanın sonunda öğrenme-öğretme süreçlerinde yaratıcı drama yöntemi, beyin fırtınası ve altı şapkalı düşünme tekniği kullanılarak öğrenenlerin ihtiyaçlarına yönelik tasarımların yapılması ve bu konularda eğitimlerin verilmesinin fen öğretmenlerinin kapsayıcı eğitime dair farkındalık ve yeterliğini arttıracağına dair önerilerde bulunulmuştur.

Anahtar kelimeler: Çok kültürlü öğrenme ortamları, hizmet öncesi öğretmen eğitimi, fen eğitimi

Introduction

The term culture is a general and broad term that is related to human-related variables such as gender, religious views, nationality, ethnicity, etc. Culture is also an educational-related term in which humans can bring traditional characteristics into teaching and learning environments (Banks, 2006). One of the most cultic definitions of culture was made by Kongar in 1994 as follows that is generally defined as the sum of material and psychological properties of which human state into nature.

Different sociological characteristics construct the individuals' perceptions related to fundamental concepts. Teachers should consider that every student can bring different characteristics from different cultures into the classroom so students have different fundamental bases of sociological and psychological characteristics. Perceptions are shaped by them. Students come from varied sociocultural backgrounds and their foundational understandings differ. Learning styles, different components of intelligence, level of literacy, and intellectual dimensions can also be considered as the elements of culture (Aktan, 2024; Aydın & Tonbuloğlu, 2014; Bakır & Akcan, 2021; Çapçı & Durmuşoğlu, 2022). Culture reflects the characteristics of different geographical regions and sociological structures. Turkey exemplifies this notion well, as it is composed of diverse regions, each possessing its own unique cultural identity. These distinct regional cultures form a mosaic that contributes to the broader national identity, much like pieces of a puzzle (Institute of International Education [IIE], 2023). Ankara, the capital and the second-largest city of Turkey, serves as a representative microcosm of this diversity. As a hub for higher education, Ankara attracts students from various parts of the country, creating a multicultural environment within its universities (Assegaf, 2021). Higher education institutions in general are key sites for cultural exchange and social integration, acting as environments where students from different backgrounds interact and learn from one another.

The United States, on the other hand, provides a more advanced example of multiculturalism in education due to its long-standing experience in hosting international students across K-12, undergraduate, and graduate levels. The U.S. education system has been shaped by policies that promote diversity and inclusion, and its campuses reflect a wide range of cultural and linguistic backgrounds (Institute of International Education [IIE], 2023). Both Turkey and the United States demonstrate multicultural textures within their educational and social environments, illustrating how cultural diversity enriches academic settings and promotes mutual understanding.

Multiculturalism means that different cultures exist in one region or one country and considering the different cultural dimensions such as ethnic structure, gender, age, having physical or mental obstacles, social class, educational level, religious orientation (American Psychological Association [APA], 2002; Şengül, 2021). This multi-layered structure profoundly affects the identities of individuals and their relationships with society, while also determining the dynamics of multicultural societies. In this framework; United States which is one of the leading countries where different identities live together and cultural diversity manifests itself prominently both in daily life

and at the institutional level, is a striking example of how multiculturalism functions both as a source of wealth and sometimes as a source of social tension. Especially African American people who live in the United States state their expectations about national rights and give a form of this action process (Banks, 1989; Ogunleye, 2009). These expectations of rights are extended to educational environments in terms of giving equalimportance of women and men genders in learning materials and teaching processes (Hsiu et.al.,2017; Luft, 1998; Güner & Batı, 2024; Sinagatullin, 2003). In recent decades, research on multiculturalism has expanded significantly beyond the borders of the United States, reflecting a growing global interest in understanding and promoting cultural diversity in education. Studies on this topic have increasingly emerged from a wide range of countries, including Greece, Japan, Mexico, Taiwan, Malaysia, South Africa, China, Spain, and Australia, indicating a broadening recognition of the importance of multicultural perspectives in diverse educational settings (Grant & Portera, 2011; Joshi et al., 2020). This global shift underscores the relevance of multicultural education as a critical pedagogical approach aimed at fostering inclusivity and equity across different cultural contexts.

Multicultural education is grounded in democratic values and principles, emphasizing respect for diversity, social justice, and equal opportunity for all students, regardless of their cultural or ethnic backgrounds. It seeks to create educational environments that acknowledge and celebrate cultural pluralism while equipping learners with the knowledge, attitudes, and skills necessary to thrive in a multicultural world (Bennett, 2011; Robertson & Atkins, 2017; Sorge et al., 2023). By incorporating diverse cultural perspectives into curricula, teaching strategies, and classroom interactions, multicultural education promotes greater intercultural understanding and prepares students to participate meaningfully in increasingly interconnected and diverse societies.

Implementing multicultural learning and teaching environments could be existed by the teachers who have the knowledge and skills of multicultural education. Literature started to develop in the United States and extended to European countries and all over the world. Experts suggested from the results of the research studies that courses should be given to both preservice and in-service teachers related to multiculturalism (Coşkun, 1999; Dewi et al., 2020; Gouvea, 2018; Tovar-Gálvez, 2023). The National Accreditation Council for Teacher Education (NCATE) in the United States accepted "Studying Different Characteristics of Students" theme as one of the six professional standards of teaching in terms of Turkish Ministry of National Education (MONE) reports. Teaching standards are defined in two dimensions as "Teaching Profession General Qualifications" and "Special Field Qualifications". Teachers should have the professional development of multiculturalist education in terms of these qualifications (Başbay & Kağnıcı, 2011). Although Turkey and the United States are big countries that have different regions and states with multiple characteristics of culture and consist of people with different nationalities and ethnicities, there is no specifically constructed curriculum about multiculturalist education in both pre-service and in-service teacher education processes (Aktan, 2024; Kılavuz, 2023; Polat & Barka, 2012; Yazıcı et al., 2009). No Child Left Behind is one of the biggest projects in the United States and all over the world for providing equal educational rights for different cultural groups. The Iowa Chataqua Project is constructed by Robert Yager for science teachers to learn how to organize multiculturalist science classrooms. The Turkish Ministry of National Education organized "Let's Go to the School Girls" for providing girls with educational rights in disadvantageous regions. In this context, both the Iowa Chataqua Project's contributions to multicultural classroom organization for science teachers and the Turkish Ministry of National Education's "Let's Go to School Girls" project to provide girls in disadvantaged areas

with the right to education suggest that the practical aspects of multicultural science education and its implications for teacher education in this field need to be examined in more depth considering physchological, philosophical and sociological aspects.

Today, increasing diversity and interactions on a global scale necessitate the inclusion of multicultural science education in teacher education programs. Although there are some studies on multicultural science education that support conceptual construction processes and bridge epistemological beliefs (Huang et al., 2017; Robertson & Atkins, 2017; De Aquino et al., 2019; Tovar-Gálvez, 2023), there are no studies in the literature that focus specifically on practice-based approaches and their reflections, address multiculturalism in the context of science teacher training, and make cross-country comparisons. However, the reflections of multicultural competencies on practice can provide functional suggestions for teacher training programs and educators on how to establish multicultural standards in science education. In this context, developing practice-based tips on how multicultural classroom environments can be structured and enabling pre-service teachers to gain the competencies to evaluate their multicultural skills fills an important gap in the field of science education. A comparative study to be conducted in Turkey and the United States will contribute to equipping prospective science teachers to respond effectively to various student profiles by revealing how multicultural science education takes place in different education systems.

Research Problem

Multiculturalism is an important movement in the United States beginning in 1960 by pursuing the rights of African American society. Turkey is also a big country where different cultures live, and multiculturalism in educational environments becomes a critical point after immigrants started to come to Turkey because of the Syrian Civil War. The United States is also a big country that has different states. Each state has their own cultures, educational standards, and management. The United States is also a country that hosts students from many countries and has a voice in education, where colorful cultural textures are synthesized. The main focus of this study was to identify the experiences and views of pre-service science teachers' from Turkey and the United States about multiculturalist learning environments. It was focused on how pre-service science teachers perceive multiculturalism and how they integrate multiculturalist issues into science education. This study makes a unique and comprehensive contribution to the field by focusing on important issues such as the global importance of multicultural science education, the experiences of pre-service teachers in different cultural contexts, the effectiveness of experiential learning, and the potential of active learning techniques. The results provide valuable insights for the development of teacher education programs, professional development of teachers, and ultimately for reaching multicultural student groups more effectively. Therefore, it can be said that the study has an important place in the field of science education and teacher training.

Research Aim and Research Questions

The aim of this research study was to find out and review the preservice science teachers views about their experiences of multiculturalist learning environments. In terms of carrying out this aim, interactive seminar about multiculturalist learning environments were given to preservice teachers for five weeks, and they constructed their own multiculturalist learning plans and presented their plans at the teaching and learning process. Before and after the teaching

process, the researcher took the preservice teachers' views about multiculturalism with semi-structured interview questions. The general research questions of this study are listed as follows;

1. How is multiculturalism conceptualized and defined within school and classroom environments?
2. What strategies and indicators are used to identify diverse cultural dimensions in school and classroom settings?
3. In what ways do cultural differences influence teachers' cognitive processes, instructional decision-making, and lesson planning?
4. What instructional methods and techniques are most effective in multicultural science education contexts?
5. What types of educational materials and classroom activities support multicultural engagement in science education?
6. How can assessment and evaluation methods be structured to equitably address cultural diversity in science education?
7. What are the perceived challenges and limitations associated with implementing multicultural science education?
8. What are the benefits and positive impacts of integrating multicultural approaches into science education?
9. What design principles and recommendations can guide the instructional planning of multicultural science education?

Methodology

General Background

A qualitative research methodology was employed in this study, involving the collection and analysis of non-numerical data—such as text, video, or audio—to explore concepts, opinions, and experiences. This contrasts with quantitative research, which operates within a post-positivist framework and relies on the collection and statistical analysis of numerical data (Nowell et al., 2017). Within this qualitative framework, a case study research design was chosen. Yin (2018) describes a case study as an empirical inquiry that examines a contemporary phenomenon within its real-life context, particularly when the boundaries between the phenomenon and its surroundings are not clear, and when multiple sources of evidence are utilized. This design allows for a close examination of data within a specific context, often focusing on a small geographical area or a limited number of individuals (Merriam & Tisdell, 2016). Ultimately, case studies serve to explore and identify contemporary real-world phenomena through detailed contextual analysis of a restricted set of events or conditions and their relationships (Tracy, 2020).

Participants

In this study, 120 second, third, and fourth grade pre-service science teachers from Turkey and 80 second, third, and fourth grade U . S . pre-service science teachers were selected through convenience sampling methodology. The participants were selected for inclusion in the sample because they are practical for the researchers to access. Participants took field area classes such as physics, chemistry, biology, mathematics, introduction to educational sciences, and

educational psychology. The pre-service teachers at the University of Iowa were reached within the scope of the Science Teaching course of the instructor with whom the researcher was in contact during and after the post-doctoral process. Support was received from the course instructor for the motivation of the students. Examples of training and plans for the transfer of multicultural skills to science learning and teaching processes were shared on the zoom platform. At this point, American pre-service teachers and Turkish pre-service teachers came together and interacted in two sessions by scheduling time. In Iowa, the instructor of the course supported the researcher in transportation, seminars and delivery of assessment tools to American pre-service teachers. In Turkey, seminars, questionnaires and interviews were conducted by the researcher.

Thirty pre-service science teachers from Turkey and 20 pre-service science teachers from the United States were selected purposefully in terms of their voluntariness, academic success level, socio-economic status, and region in which they were born. Among the pre-service teachers in both the US and Turkey study groups, the pre-service teachers with high achievement levels stated that they were volunteers. In addition, in terms of socio-economic status, upper, middle and lower levels were included and pre-service teachers from regions where heterogeneous human communities live were purposively selected within the scope of this study. Demographic characteristics of the prospective teachers were determined through a form given to them. In the classification of socio-economic status and academic achievement variables, a classification was made based on family income status and year-end achievement averages. Within the scope of this research, for the United States and Turkey, those with a monthly income level below 1000 dollars are defined as low socio-economic level, those with a monthly income level between 1500-3000 dollars as medium and those with a monthly income level above 3000 dollars as high socio-economic level. Within the scope of this study, the achievement levels of pre-service teachers in the United States and Turkey were determined as low achievement level (50 and below out of 100), medium achievement level (50-70) and high achievement level (above 70). Participants' demographical characteristics are shown in Table 1.

Table 1
Demographical Characteristics of the Participants-Turkey and United States Sample

Demographical Characteristics	Grade			Region come from			Socio-economic status			Academic achievement		
	2	3	4	West	Middle	East	High	Middle	Low	High	Middle	Low
Turkey	23	63	34	38	26	56	15	47	61	28	67	25
United States	20	35	25	44	36		27	36	17	21	35	24

Table 1 indicates that 23 (19%) of the participants are second, 63 (47%) of them are third, and 34 (28%) of the participants are fourth-year pre-service teachers in Turkey respectively. It is seen that almost half of the total number of participants were third grade and the other half were second and fourth grade pre-service teachers with close ratios. From United States sample, 20 (25%) of the participants second, 35 (44%) of them third, and 25 (31%) of the participants are fourth year student teachers. It was determined from the transcripts that all of the both U.S. and Turkish pre-service teachers had taken the necessary field and pedagogy- based courses in order to take the Science Teaching Planning course. It was determined that 38 (32%) of the pre-service teachers came from the western, 26 (22%) from the central, and 56 (65%) from the eastern regions of the country in Turkey. Most of the participating pre-service teachers were located in the

Eastern Anatolia Region, while the rest were located in the context of Western Anatolia and Central Anatolia. Iowa is accommodated mid-west part of United States. It was determined that 44 (55%) of the pre-service teachers came from the west, 36 (45%) originally came from middle part of United States When the socio-economic distribution was analyzed, it was found that 15 (13%) of the pre-service teachers had a high family income (3000 USD per month and above), 47 (39%) had a medium family income (between 1500 and 3000 USD per month), and 61 (48%) had a low family income (low than 1000 USD). It is seen that the majority of the participant pre-service teachers' socio-economic status is low and middle level. Social economic level of United States participants were calculated from 27 (34%) of the pre-service teachers had a high family income (3000 USD per month and above), 47 (59%) had a medium family income (between 1500-3000 USD per month) and 17 (21%) had a low family income lower than 1000 USD per month. Different from Turkey, the majority of the participant pre-service teachers' socio-economic status is high and middle level.

In terms of academic achievement, it was concluded that 28 (23%) of the pre-service science teachers had an average of 70-100 over 100, 67 (56%) had an average of 50-70, and 25 (21%) had an average of less than 50. It was determined that more than half of the prospective teachers were at the medium achievement level in Turkey.

In terms of academic achievement. When analyzing academic achievement variable, 21 (26%) of the pre-service science teachers had an average of 70-100 over 100, 35 (44%) had an average of 50-70, and 24 (30%) had an average of less than 50. It was identified that most of the participants of United States were high and medium academic achievement level.

Instrument and Procedures

Research study was conducted in the context of Science Learning and Teaching class at University of Iowa and Hacettepe University during 2023-2024 spring semester. Interactive seminar about multiculturalist learning environments were given to pre-service teachers for five weeks via Zoom platform. Researcher prepared five week multicultural concept and skill development in science education programme and open-ended survey questions for identifying the perceptions, skills of pre-service teachers. Two academics' views who are expert in science education, measurement and assessment fields were taken for providing reliability and validity issues. After the corrections in terms of experts' views cultural adaptation of the survey was done by one Turkish and one American linguistics expert. Pilot study was realized with 5 Turkish and 5 US students via Google Survey platform. Open-ended survey was applied to pre-service teachers both before and after the seminar. After the seminar, pre-service teachers constructed their own multiculturalist learning plans and presented their plans during learning and teaching processes. Application process covers the following themes in Table 2.

Table 2

Process of Multicultural Education and Designing Multicultural Science Education Module

Weeks	Themes
1	Introduction to Multiculturalism, Historical Development Process of Multiculturalism
2	Multiculturalism Movements and Projects in World and Turkey
3	Multicultural Identifiers in Educational Environments and Science Education

4	How to Make an Instructional Design In Multicultural Science Learning Environments
5	Measurement and Evaluation-Feedback Processes in Multicultural Science Learning Environments

Table 2 shows the general implementation process of the multicultural education and its design process of science education. Researcher gave the definition and epistemological transitions of multiculturalism as a concept and explain the historical, sociological, psychological and economical aspects of multiculturalism at the first week of the process. Second week she shared the most influenced national and international movements and projects of multiculturalism. Concepts were explained which is related to the identifiers of multiculturalism and their implications to science education. Pre-service science teachers started to learn how to construct an instructional design combine the multiculturalist issues with science education standards in terms of investigating sample lesson plans. Last week of the application process, pre-service science teachers constructed their multicultural science lesson plans and they learnt how to design measurement and assessment processes for following skill development and give feedback related to multicultural science learning environments. Researcher gave seminar to pre-service science teachers via Zoom platform and in some sessions Turkish and United States group came together for discussing to design multiculturalist science lessons.

Data Analysis

Descriptive and content analyses were used for analyzing qualitative data. Answers of pre-service science teachers in terms of interview questions were coded and collected into meaningful themes in terms of research questions. Both validity and reliability issues of qualitative research methodology were considered in this research study. For providing validity interview questions and coding lists were given to three experts who are from science education, curriculum and instruction and measurement and evaluation fields. They listed their suggestions about the interview questions and coding list and researcher did the corrections in terms of their suggestions. For providing inter-rater reliability, semi-structured interview answers taken from pre-service teachers were coded by two instructors of science education and curriculum and instruction besides the researcher. In order to check the reliability of the coding, the formula "Reliability = Consensus/(Consensus + Disagreement)" proposed by Miles and Huberman (1994) was used. The reliability coefficient of the coding protocol was calculated as .83.

Ethical Issues

Ethical principles were considered for this research study. Researcher applied to Hacettepe University Educational Sciences Ethical Commission and got permission statement. Permission forms were taken from University of Iowa pre-service science teachers. The Ethical Commission Proof Certificate was given as an attachment of the journal submission system.

Results

First research question is related to find out the definition of multiculturalism in school and classroom environments. Answers from Turkish pre-service science teachers are listed in Table 3.

Table 3

Definition of Multiculturalism

Pre-Application Definitions	f	%	Post-Application Themes	f	%
Language differences	100	83	Socio-economic status	112	93
Religion differences	85	71	Gender	108	90
Tradition differences	63	53	Environmental factors	82	68
Ethnicity differences	40	33	Living styles	60	50
Living in different regions of the same country	12	10	Having different learning styles	75	63
Influenced from different cultures	8	7	Having different intelligence areas	69	58
			Different cognitive, affective and psychomotor domains	54	45
			Needing special education or not	32	27

Cultural difference was perceived as mostly language, religion, tradition, and ethnicity differences before the application process from the pre-service science teachers. They stated more specifically educational and instructional factors such as environmental factors, gender, socio-economic factors, having different learning styles, intelligence areas, cognitive, affective and psycho-motor domains and special education characteristics. Turkish pre-service science teachers can be able to focus on individual differences and operational characteristics of students in terms of multiculturalism after the application process in terms ofTable 4. Sample quotations of Turkish pre-service science teachers are given as follows:

Pre-service science teacher A (High academic achievement, low socio-economic status, east region)-Pre-application "*Our cultural characteristics change from region to region, and these characteristics, such as different dialects and traditions, effect classroom environments"*

386 Pre-service science teacher D (Low academic achievement, low socio-economic status, west region)-Post-application *"Coming from different cultures. In United States, there is no so much students from different countries in elementary school level but differences generally come from regional and socio-economic status differences…"*

Turkish pre-service science teachers identified cultural differences in terms of fundamental concepts such as language, religion, and ethnicity before the application process. They understand that culture is a concept related and interact with educational settings such as different intelligence areas like mathematics, literacy, visual, musical, kinesthetic, spatial, natural, endogenous, etc., learning styles such as visual, audial, kinesthetic, having special needs such as superior intelligent or having learning disabilities such as dyslexia, autism spectrum, etc. Answers from the United States study group are listed in Table 4.

Table 4

Definition of Multiculturalism-United States Study Group

Pre-Application Themes	f	%	Post-Application Themes	f	%

Ethnicity differences	65	81	Having different learning styles	67	84
Tradition differences	56	70	Having different intelligence areas	54	68
Living in different regions of the same country	44	55	Having special needs of learning.	45	56
			Different cognitive, affective and psychomotor domains	36	45

United States pre-service science teachers defined multiculturalism as the difference of ethnicity, tradition and region where they live before seminar process. They mentioned learning styles, intelligence areas, special needs of learning, different cognitive, affective and psychomotor domains after the implementation process. Sample quotations from United States sample were given below

Pre-service science teacher B (High academic achievement, high socio-economic status, mid region)-Pre-application *"Cultural differences in school and classes are religion, language and traditions. Students can have difficulty if they have different ethnic background…"*

Pre-service science teacher D (Low academic achievement, low socio-economic status, west region)-Post-application *"Coming from different cultures. In United States, there is no so much students from different countries in elementary school level but differences generally come from regional and socio-economic status differences…"*

Pre-service science teachers from United States identified cultural differences ethnicity, tradition and region differences. They mostly emphasized the ethnicity and tradition differences before the application process. They did not mention about religion and language differences mostly. This is the difference from Turkish sample. They mostly emphasized different learning styles, different intelligence areas and special needs of learning after the application process.

Second research question is related to the cultural dimensions and classroom environments. Answers of Turkish pre-service science teachers are listed in Table 5.

Table 5

Cultural Dimensions in School and Classroom Environments-Turkish Study Group

Pre-Application Themes	f	%	Post-Application Themes	f	%
Observation	80	67	Cooperation with teacher and counseling service	89	74
Recognizing individual characteristics	54	45	Student checklists	74	62
Interviewing with family	32	27	Student diaries	49	41
			Portfolios (Individual Development Files)	35	29
			Behavioral Analysis	21	18
			Parent Support	13	11

Pre-service science teachers in Turkey generally listed the identification ways of cultural dimensions as observation, recognizing individual characteristics and interviewing with family before the application process. They recognized more operational and concrete ways of identification ways such as cooperation with teacher and counseling service, student checklist, student diaries, portfolios and behavioral analyses after the application process. Teacher candidates understood the function of guidance and counseling services and complementary measurement and assessment tools providing longitudinal monitoring like portfolios, checklists and diaries after application related to Table 6. Sample quotations of Turkish pre-service science teachers are given as follows;

Pre-service science teacher A (High academic achievement, low socio-economic status, east region)-Pre-application *"We should usually be good observers and we can recognize different cultural characteristics of students from their different behaviors…"*

Pre-service science teacher C (High academic achievement, high socio-economic status, west region)-Post-application *"Principles and school staff are not very capable of understanding students' cultural differences. Cooperation with teacher and counseling service and individual observation process of teacher are the best ways of identifying cultural differences of students. Parent support is necessary for this process also…"*

Answers of U.S. pre-service science teachers are listed in Table 6.

Table 6

Cultural Dimensions in School and Classroom Environments-U.S. Study Group

Pre-Application Themes	f	%	Post-Application Themes	f	%
External appearance	60	75	Psychological aspects	57	71
Family background	46	58	Observation checklists	45	56
			Process assessment	38	48
			Parent Support	24	30

Pre-service teachers in United States mostly emphasized the external appearance and family background before the seminar process. They stated more than half of them cultural dimensions as psychological aspects, observation checklists. They also listed the importance of process assessment and parental support. Sample quotations of U.S. pre-service science teachers are listed below;

Pre-service science teacher B (Low academic achievement, high socio-economic status, west region)-Pre-application *"We can understand by asking our students where they came from. But it could be difficult to just learn by asking their born city we can observe them in a longitudinal process to understand their cultural differences"*

Pre-service science teacher D (Low academic achievement, low socio-economic status, mid region)-Post-application *"I believe it is possible to recognize cultural differences by structured portfolios, observation checklists, student diaries making detailed interviews with families…"*

Both Turkish and American pre-service science teachers had limited knowledge about identifying cultural characteristics of the students before the application process. They

comprehended the importance of the function of counseling, parental support, longitudinal observation and process-based measurement and assessment tools and techniques such as portfolios and diaries.

Third question is related to cultural differences effect teachers' thinking, decision making and planning processes and their sample lesson plans. Turkish pre-service science teachers' answers are listed in Table 7.

Table 7

Cultural Issues That Affect Teacher Thinking, Decision Making And Planning Processes-Turkish Sample

Pre-Application Themes	f	%	Post-Application Themes	f	%
Richness in instruction	76	63	Purification of pre-judgment	72	60
Infrastructure of teachers	65	54	Cultural cooperation in planning	56	47
Considering language differences	58	48	Designing classrooms in terms of cultural differences	41	34
Different living styles	31	26	Material using and instructional design in	30	25
			terms of cultural differences	18	15
			Using performance based assessment considering different cultural characteristics		

Turkish pre-service science teachers mostly emphasized that using different materials in an instructional design process as an infrastructure of teachers, considering language differences give a shape to teachers' planning processes. They stated the purification of pre- judgment, cultural cooperation in planning, designing classrooms in terms of cultural differences, material using and instructional design in terms of cultural differences, using performance based assessment considering different cultural characteristics in teachers' decision making and planning processes after the application process in terms of Table 8. Some quotations of Turkish pre-service science teachers related to this theme are given as follows;

Pre-service science teacher A (High academic achievement, low socio-economic status, east region)-Pre-application *"We should consider general tendencies. For example, I saw in a school observation that there are some Syrian students in classes, but their Turkish is not so good. The teacher should give complementary courses to this student after the class…"*

Pre-service science teacher C (High academic achievement, high socio-economic status, west region)-Post-application *"In my science class, I handled the "Evolution" topic and told Darwin's Theory. This is a sensual topic. I gave this topic in a scientific way, considering the religious beliefs of my students. I never used dominant language and imposed any partisan view. This sample shows that cultural differences affect teachers' thinking, decision-making, and planning processes."*

Answers of U.S. pre-service science teachers are mentioned in Table 8.

Table 8

Cultural Issues That Affect Teacher Thinking, Decision Making and Planning Processes-U.S. Sample

Pre-Application Themes	f	%	Post-Application Themes	f	%
Background of students	66	83	Using multi strategies, methods and techniques	65	81
Infrastructure of teachers	54	68	Considering affective domain	54	68
Considering ethnic differences	33	41	Constructing materials in terms of special needs	26	33

American pre-service teachers mostly stated the cultural issues affecting teachers' thinking, decision making and planning processes is the background of the students, more than half of them listed infrastructure of teachers before the interactive seminar process in terms of Table 8. They generally emphasized using multi strategies, methods and techniques and affective domains as cultural issues after the implementation process. Sample quotations of U.S. pre-service science teachers are listed as follows;

Pre-service science teacher B (Low academic achievement, high socio-economic status, west region)-Pre-application *"Cultural differences effect our lesson plans. We should pay attention to our discourse and conversation styles because we have the possibility of offending some students. Teachers should be good role models for their students…"*

Pre-service teacher D (Low academic achievement, low socio-economic status, mid region)-Post-application *"Every student has a different learning style. This constructs an important role in learning. Teachers should consider cultural differences. For example, if students' visual intelligence is high, teachers can draw shapes or use a model for providing communication…"*

Both Turkish and U.S. pre-service science teachers' knowledge about planning processes considering cultural differences was limited by language and social living differences. They gave concrete samples about dynamic relations of aims, content, learning-teaching, measurement and evaluation processes after the application process. In terms of the lesson plan used in application process (Appendix A), pre-service science teachers related the gene, genotype, phenotype concepts with heredity and constructed epistemological relations with the multiculturalist issues. They internalized different characteristics of people with the principles and generalizations of science and fundamentals of multiculturalism. They thought both cognitive and affective domains of multicultural science education.

Fourth research question is related to the methods and techniques preferred in multicultural science education and wanted to give their original, specific samples. Answers of Turkish pre-service science teachers are listed in Table 9.

Table 9

Methods and Techniques Preferred to Use in Multicultural Science Education-Turkish Study Group

Methods and Techniques in Multicultural Science Education	f	%
Problem-Based Learning	120	100

Question and answer	90	75
Inquiry-based learning	55	46
Creative Drama	32	27
Show and do technique	11	9
Research and Investigation Based Learning	8	7

Pre-service science teachers in Turkey can only gave answers during the post-application process because they could not have idea about multicultural science education implementation. After the application process, they stated that they mostly prefer presentation and problem-based learning, question-answer methods and techniques are proper for designing multicultural science education. Some of them emphasized the importance of using inquiry- based learning principles and creative drama applications. Few of the pre-service teachers indicated show and do technique, research-investigation approaches should be used for providing interaction in multicultural science education related to Table 10. Sample quotations of Turkish pre-service science teachers are given as follows;

Pre-service teacher A (High academic achievement, low socio-economic status, east region) *"There are so limited methods and techniques in multicultural science education. Showing visual characteristics can be meaningful for students understanding cultural differences. We can use creative drama for teaching genotype, phenotype, nutrition topics, and concepts…"*

Pre-service teacher C (High academic achievement, high socio-economic status, west region) *"Showing and acting technique can be used in multicultural science education classes because we have questions about how to make some of our application-based assignments… "*

Answers of U.S. pre-service science teachers related to the fourth question explained in Table 10.

Table 10

Methods and Techniques Preferred to Use in Multicultural Science Education-Turkish study group

-U.S. study group

Pre-Application Themes	f	%	Post-Application Themes	f	%
Inquiry-based learning	44	55	Problem-Based Learning	67	84
Discussion	37	46	Creative Drama Method	55	69
Photographs and stories	23	29	Six hats technique	21	26

Half of the pre-service science teachers in United States emphasized inquiry-based learning approach and discussion method can be used in multicultural science learning and teaching environments. They also stated photographs and stories can be used. After seminar process, they mostly told the importance of problem-based learning approach and creative drama method. They highlighted that six hats technique can be used for covering multi-cultural issues in science education. Sample quotations of U.S. pre-service teachers are given as follows;

Pre-service teacher B (Low academic achievement, high socio-economic status, west region) *"Teachers can use discussion technique for making the class interactive and student-centered. Problem based scenarios for different states and question-answer technique can be used in multicultural science education."*

Pre-service teacher D (Low academic achievement, low socio-economic status, mid region) -Post-application *"Teachers can use more than one method or technique because if a teacher only uses presentation methodology, we get bored and have difficulty understanding the concepts…"*

Both Turkish and U.S. science teacher candidates explained the importance of using more interactive, student-centered methodologies and techniques in multicultural science education classrooms. They suggested using visual characteristics and construct discussion groups during implementation process. They emphasized that they have ability to get bored and have difficulty to understand if the teachers only use one methodology or only prefer teacher centered methodologies for understanding concept of multiculturalism in science education.

Fifth question is related to the types of materials and activities used in multicultural science education. They gave their own specific examples about this topic. Turkish pre-service science teachers could only give answers to this question after the implementation process.

Turkish pre-service science teachers' answers are listed in Table 11. 595

Table 11

Materials and Activities Used in Multicultural Science Education-Turkish Study Group

Materials and Activities Used in Multicultural Science Education	f	%
Basic Daily materials for Creative Drama Applications	85	71
Concept maps	65	54
Tables and graphics	36	30
Audio-visual materials	28	23
Simulations	32	27
Digital platforms for making stories like PowToon	4	3

Table 11 is shown that Turkish pre-service science teachers mostly preferred materials and activities for implementing multicultural science education. They mostly underlined that they want to use basic daily life materials which can be reached easily and apply creative drama sessions to develop individuals' empathy skills for understanding multiculturalism. Some of them explained the importance of analytical figures, audio-visual materials and digital platforms for interacting different people and cultures in the world and understanding scientific concepts.

Sample quotations of Turkish pre-service science teachers are given as follows;

Pre-service science teacher A (High academic achievement, low socio-economic status, east region) *"Pictures, diagrams, and tables can be used to understand concepts. For example, when we are handling different kinds of animals from different countries, cultures, and their characteristics using pictures and audio-visual materials can be more interesting for students than traditional presentation."*

Pre-service science teacher C (High academic achievement, high socio-economic status, west region) *"Material can be selected in terms of our learning aims, mental development of our students and make concepts more concrete and easy. We can use different digital platforms, for instance we used PowToon for making digital stories about living things and their surroundings. Concept maps are very useful in multicultural concepts in science education"*

U.S. pre-service science teachers' answers are listed in Table 12.

Table 12

Materials and Activities Used in Multicultural Science Education-U.S. Study Group

Pre-Application Themes	f	%	Post-Application Themes	f	%
Discussion Cards	64	80	Digital forum platforms	56	70
News and stories	48	60	Role play	44	55
Photographs	35	44	Conceptual shift text	23	29

Table 12 is indicated that U.S. pre-service science teachers mostly listed discussion cards. They also told news, stories and photographs in order before the seminar process. They emphasized mostly digital forum platforms for using materials and activities in multicultural science education. They indicated the importance of role play as a learning-teaching technique and conceptual shift text as a material after the implementation process of seminar about multicultural science education.

Pre-service science teacher B (Low academic achievement, high socio-economic status, west region) *"We can use different digital platforms, for instance we used PowToon for making digital stories about living things and their surroundings, for example, food chain topic, living things' nutrition styles in terms of regional and cultural differences…"*

Pre-service science teacher D (Low academic achievement, low socio-economic status, mid-region) *"Instructors can use daily life materials, costumes for showing cultural differences in terms of scientific concepts such as biological diversity, environmental consciousness, and sustainable development…"*

As understood from the answers and quotations, both Turkish and U.S. pre-service science teachers emphasized that basic and daily home materials can be very useful for creative drama applications to make global problems concrete. They told that concept maps, tables, and graphics are also important materials for assimilation and accommodation of concepts and provide cognitively meaningful learning. They also stated that the variation of the software in multicultural science education helps to construct rich experiences for students.

Sixth question is related to measurement and evaluation process can be organized in multicultural science education and their own unique specific examples. Turkish pre-service science teachers only gave answers to this question after the application process. Answers are listed in Table 13.

Table 13

Measurement and Evaluation Approaches Used in Multicultural Science Education-Turkish Study Group

Measurement and evaluation approaches in Multicultural Science Education	f	%
Portfolios	64	53
Projects	23	19
Paper-based examinations	18	15
Performance-based activities	45	38
Individual and group assignments	58	48
Self and group assessment	29	24
Digital platforms for providing periodical feedback.	7	6
Observation checklist	19	16
Conducting interviews	21	18

Turkish pre-service science teachers mostly emphasized the importance of portfolios, individual and group assessments for following multiculturalist skills developed during the implementation of science education. They also underlined the process-based measurement and assessment techniques and tools such as performance-based activities, projects and also interviews for identifying different skills and characteristics of the students for providing multiculturalist learning environments of science education in terms of Table 13.

Sample quotations of Turkish pre-service science teachers are given below;

Pre-service science teacher A (High academic achievement, low socio-economic status, east region) *"Process-based assessment is very important in multicultural science education because all students don't have the same opportunities. If teachers make decisions in terms of one multiple-choice examination, it is not fair, and this doesn't give valid and reliable results, the process should be followed in terms of their learning, intelligence area differences…"*

Pre-service science teacher C (High academic achievement, high socio-economic status, east region) *"Traditional, such as classical examinations, and alternative assessment techniques, such as portfolios and performance-based assessment. The system should be flexible and process-based in terms of equalizing resources and conditions for students."*

U.S. pre-service science teachers' answers to sixth question about measurement and evaluation approaches in science education are shown in Table 14.

Table 14

Measurement and Evaluation Approaches Used in Multicultural Science Education-U.S. Study Group

Pre-Application Themes	f	%	Post-Application Themes	f	%
Observation Checklist	47	59	Portfolio assessment	67	84
Interviews	24	30	Self and group assessment	55	69

	Peer assessment	43	54
	Performance-based assessment	34	43

More than half of the U.S. pre-service science teachers indicated observation checklists and 30% of them told interviews as measurement and evaluation approaches before seminar about multicultural science education. They mostly emphasized portfolio assessment, self and group assessment. They also listed peer assessment and performance-based assessment as process-based measurement and evaluation approaches used in multicultural science education according to Table 14.

Sample quotations of Turkish pre-service science teachers are given.

Pre-service science teacher B (Low academic achievement, high socio-economic status, west region) *"Measurement and evaluation system should depend on performance-based assessment and assignments. Self-assessment and group assessment tools can be added to activities and assignments because of providing reliability issues for different cultural characteristics in terms of learning scientific concepts…"*

Pre-service science teacher D (Low academic achievement, low socio-economic status, mid-region) *"Platforms that give periodic feedback can be constructed in the measurement, and assessment process because multicultural education is a new experience for us, so mostly we could not be sure if we are in the right way or not…"*

Both Turkish and U.S. pre-service science teachers mostly focused on providing same opportunities for students and claimed that using generally process-based measurement and evaluation approaches and tools such as portfolios, performance-based activities and assignments supported with self and group assessment forms can give more valid and reliable results. They also stated the importance of longitudinal observations and making semi- structured interviews for understanding the students' skills and problems about different learning processes. Some teacher candidates emphasized the importance of periodical feedback in multicultural science education for improving and they suggest instructors to use some feedback platforms for realizing this aim.

Seventh question is about what the threats and disadvantages of multicultural science education?" Both Turkish and U.S. pre-service science teachers could only give answers to this question after the implementation process. Turkish pre-service science teachers' answers are explained in Table 15.

Table 15

Threats and Disadvantages of Multicultural Science Education-Turkish Study Group

Threats and Disadvantages of Multicultural Science Education	f	%
Lack of knowledge and infrastructure about multiculturalism and their reflections to science education	82 98	
Lack of application processes	86	68
Lack of experiencing micro-teaching processes	35	29

Intensive assignment load	23	19
Different application processes of instructors	14	12

Turkish pre-service science teachers gave the answers of seventh question application process. They mostly underlined the threats and disadvantages of multicultural science education as the lack of experience and the nature of multicultural science education. Some of them emphasized the misconceptions, lack of empathy skills, application-based micro- teaching processes and the load of the work in terms of process-based activities and assessment procedures according to Table 15.

Sample quotations of Turkish pre-service science teachers are given as follows; Pre-service science teacher A (High academic achievement, low socio-economic status, east region) "Instructors generally do not have infrastructure and knowledge about multiculturalism in educational settings. They usually ignore the differences in classrooms. After 15-20 minutes in terms of traditional approaches we get bored. They are suffering to construct discussion platforms because of the limitation of time…"

Pre-service science teacher C (High academic achievement, high socio-economic status, west region) *"Some instructors can implicate the higher intelligence students into their science classes. This brings about unequal conditions for students. Instructors do not have an equal viewpoint to every student"*

U.S. pre-service science teachers' answers are explained in Table 16.

Table 16

Threats and Disadvantages of Multicultural Science Education-U.S. Study Group

Threats and Disadvantages of Multicultural Science Education	f	%
Being able to make connection between multiculturalism and science education	64	80
Different perceptions of teachers to multiculturalism	55	69
Experience of teachers	43	54
Quality of in-service training	32	40

U.S. pre-service science teachers gave the answers of seventh question after the application process. They mostly emphasized the ability of teachers making connections between science education and multiculturalism and their perceptions about multicultural education. They also listed the importance of experience and in-service training qualifications in terms of Table 16. Sample quotations of U.S. pre-service science teachers are given as follows;

Pre-service science teacher B (Low academic achievement, high socio-economic status, west region) *"Workshops and applications referring to sensitive organs are very important in multicultural science education, but we have no chance to reach these opportunities. Some concepts are so abstract because lacking of application…"*

Pre-service science teacher D (Low academic achievement, low socio-economic status, mid region) *"Instructors can use different ways some of them present the topic in a detailed manner, some of them just deal with the topic and give lots of assignments rising our level of intelligence and learning skills. I am very stressed about if I can get the response of my intensive load of labor…"*

Both Turkish and U.S. pre-service science teachers generally summarized the threats and disadvantages of multicultural science education process. They stated that teachers can have lack of knowledge and experience about multicultural education, they give intensive load of assignment without understanding anything, different application ways of teachers for handling the classes and socio-economic factors that prevent and ignore. Most of them emphasized the importance of workshops considering differences of students for learning concepts in a meaningful way and they expect from the instructors to use more interactive instructional methodologies and techniques for enjoying the courses.

Eighth question is asking what the positive sides of multicultural science education. Both Turkish and U.S. pre-service science teachers could only give answers to this question after the implementation process. Turkish pre-service science teachers' answers are identified in Table 17.

Table 17

Positive Sides of Multicultural Science Education-Turkish Study Group

Positive Sides of Multicultural Science Education	f	%
Considering different intelligence areas and learning styles	72	60
Having pedagogical content knowledge and skills	40	33
Developing empathy skills	38	32
Gaining positive attitude to science classes	25	21
Have a chance to communicate different characteristics of classmates	18	15
Extra opportunities provided by teachers such as assignments	13	11

In terms of Table 18, Turkish pre-service science teachers mostly emphasized the positive side of multicultural science education as considering different intelligence areas and learning styles during the preparation process of science lesson plans. They also underlined the importance of developing their pedagogical content knowledge and skills like empathy, critical thinking, having positive attitudes and interactions of students who have different cultural characteristics.

Sample quotations of Turkish pre-service science teachers are given as follows;

Pre-service science teacher A (High academic achievement, low socio-economic status, east region) *"It is a good chance for me to introduce my classmates coming from different regions of the country, I have the experience to learn different cultures in the same country…"*

Pre-service science teacher C (High academic achievement, high socio-economic status, west region) *"It is a very fabulous experience that I put myself into a character who is very different from me so I can develop different perspectives about science lesson planning processes…"*

Answers of U.S. pre-service science teachers are listed in Table 18.

Table 18

Positive Sides of Multicultural Science Education-U.S. Study Group

Positive Sides of Multicultural Science Education	f	%
Integrating different cultural characteristics in one class	71	89
Treating everyone equally	63	79
Learning interactive methodologies addressing multicultural science education	55	69
Developing empathy skills	47	59
Internalizing socio-scientific initiatives	26	33

According to Table 19, U.S. pre-service science teachers mostly mentioned integration of different cultural characteristics in one class, approaching everyone equally in class, internalizing cultural-oriented instructional methodologies. They also told about developing empathy skills and internalizing socio-scientific initiative which are important aspects of multicultural science education. Sample quotations of U.S. pre-service science teachers are listed below;

Pre-service science teacher B (Low academic achievement, high socio-economic status, west region) *"I have the ability to participate in every part of the course, and I can listen in a detailed manner. I take an active role in the science learning process… "*

Pre-service science teacher D (Low academic achievement, low socio-economic status, mid-region) *"Using interactive engagement methodologies in science instruction classes help me to decide and think students have different cultural characteristics. I really recognize cultural differences are more than gender, socio-economic status. My empathy skills are developed at this process…"*

Both Turkish and U.S. pre-service science teachers generally told the positive sides of multicultural science education are considering different intelligent areas and learning styles, having pedagogical knowledge, skills and developing empathy skills. Some of them emphasized gaining positive attitude to science classes, having a chance to communicate different characteristics of classmates and few of them stated the importance of process-based assignments. They recognize the importance of considering issues of multiculturalism in science education for designing humanist, effective teaching and learning environments. They also have skills of planning with use of different student-centered application-based approaches, methodologies and techniques.

Ninth question is about the suggestion of organizing instructional design for multicultural science classrooms. Both Turkish and U.S. pre-service science teachers could only give answers to this question after the implementation process. Turkish pre-service science teachers'answers are listed in Table 19.

Table 19

Suggestion of Organizing Instruction for Multicultural Science Classrooms-Turkish Study Group

Suggestion of Organizing Instruction for Multicultural Science Classrooms	f	%
Identifying operational standards of multiculturalist science education	53	44
Constructing interactive measurement and assessment infrastructure	37	31
Developing interactive plans considering multiculturalism	29	24
Offering elective courses in pre-service and organizing in-service training about multiculturalist science education	19	16
Providing different equipment considering different characteristics of students	15	13

Turkish pre-service science teachers mostly suggested to make operational definitions of the multicultural science education standards. They also emphasized the necessity of constructing interactive feedback mechanisms for students and developing interactive lesson plans considering different cultural characteristics of the students in terms of Table 19. Student teachers give a suggestion of elective courses and equipment that can be offered in both pre- service and in-service training processes.

Sample quotations of Turkish pre-service science teachers are given as follows;

Pre-service science teacher A (High academic achievement, low socio-economic status, east region) *"The first step for planning multicultural science education explaining standards. The duration of the course time should be limited for applying student-centered methodologies considering different characteristics of students…"*

Pre-service science teacher C (High academic achievement, high socio-economic status, east region) "Interactive lesson plans and elective courses are very important for multicultural science education, making concepts more concrete and meaningful. There may be some infrastructure for giving periodic feedback about our knowledge and skill development…"

Answers of U.S. pre-service science teachers are listed in Table 20.

Table 20

Suggestion of Organizing Instruction for Multicultural Science Classrooms-U.S. Study Group

Suggestion of Organizing Instruction for Multicultural Science Classrooms	f	%
Constructing state based standards about multicultural science education	65	81
Organizing pre-service and in-service training multicultural science education programs	58	73
Making cooperation with civil society organizations for mainstreaming multicultural education	34	43
Providing equipment for special needs of instruction throughout industrial cooperation	26	33

In terms of Table 20, more than half of the U.S. pre-service science teachers suggested construction of state-based standards about multicultural science education and organization of pre-service and in-service multicultural science education programs. They emphasize also the importance of cooperation with civil society organizations for make the sustainability of multicultural education and provide equipment for special needs of instruction in multicultural science classrooms. Sample quotations of U.S. pre-service science teachers are listed below;

Pre-service science teacher B (Low academic achievement, high socio-economic status, west region) *"Some seminars can be conducted to both students and instructors because both instructors and students introduce firstly multicultural education and don't know how to design and integrate multiculturalism into their classes… "*

Pre-service science teacher D (Low academic achievement, low socio-economic status, mid region) *"Every student has not the same facilities, so there may be some projects conducted with the cooperation of state boards and universities for providing equipment for every student to have an education in equal conditions."*

Both Turkish and U.S. pre-service science teachers suggested identifying operational and concrete standards of multiculturalism in science education programs. They also emphasized the importance of systems to use periodic feedback options and audio-visual materials for developing knowledge and skills in a concrete manner. Pre-service teachers needed to have equal rights for having education, so providing equipment for every student is a vital necessity in multicultural science education. They also claimed to have elective courses, and the Ministry of National Education offers in-service training programs about multicultural education and their reflections on science education.

Discussion

The results of this research study indicated that both Turkish and U.S. pre-service science teachers have ver limited knowledge and experience about multiculturalism and multiculturalist science education. U.S. pre-service science teachers stated general terms such as language and nationality. Turkish pre-service science teachers' religion and ethnicity differences as their perception of multiculturalism. This result is similar to Banks (2003) statements. They perceived the educational multiculturalist statements like learning style, intelligence area, gender, socio-economic status, gender, needing special education process or not after the application process of multicultural science education. Constructing multiculturalist learning environments for students is a very important international qualification accepted by most of the countries, especially those identified by the United States (Başbay et al., 2003; Sorge et al., 2023). The way multiculturalism is perceived is closely related to the historical and cultural structure of societies. The US, as a country with a long history of immigration and ethnic diversity, tends to associate multiculturalism with visible differences such as language, race and nationality. Turkey, on the other hand, has a historically more homogeneous social structure and focuses on more sensitive differences such as religion and ethnicity when it comes to multiculturalism. This shows that pre-service teachers' initial perceptions of multicultural education are shaped based on different contexts.

Both Turkish and U.S. pre-service science teachers have also limited knowledge about identifying multiculturalist characteristics. They thought that they could identify the multiculturalist characteristics of their students only by observation and interviewing with students. Their perceptions are extended, and they underlined the function of counseling services, the importance of parent support, and complementary measurement and assessment techniques, for

instance portfolios, student diaries, and longitudinal observations. Those properties are very similar to Bennett (2011) and Joshi et al. (2020). The findings indicate that both Turkish and U.S. pre-service science teachers possess limited knowledge regarding the identification of students' multicultural characteristics. A majority of the participants initially believed that such characteristics could be recognized solely through observation and interviews with students. However, over time, their perceptions appeared to broaden, reflecting a more comprehensive understanding of multiculturalism. In particular, they emphasized the significance of guidance and counseling services, parental involvement, and the utilization of complementary assessment techniques such as portfolios, student diaries, and longitudinal observations. This evolving perspective aligns closely with the multicultural education frameworks proposed by Bennett (2011). Therefore, it is essential for teacher education programs to move beyond observation-based approaches and incorporate structured, multidimensional assessment tools that better support pre-service teachers in recognizing and addressing the diverse cultural backgrounds of their students.

Both Turkish and U.S. pre-service science teachers have a chance to widen their thinking and decision-making processes and they reflect their abilities into their multiculturalist lesson plans after the implementation process of multiculturalist science education. After the implementation of multicultural education, they learned how to design their classrooms by taking into account cultural differences such as gender, prior conceptual knowledge, special education needs, various areas and levels of intelligence, different learning styles, and by promoting cultural collaboration through interactive teaching methods like creative drama and the use of culturally sensitive interactive materials such as pictures and videos. This result is supported by the study of Polat (2009), Yazıcı et al. (2009), and Le & Matias (2019). The main reason for these results is that multicultural science education has a profound impact on pre-service teachers' pedagogical awareness and classroom practice skills. During the implementation process, pre-service teachers assumed the responsibility of being not only knowledge transmitters but also guides who are sensitive to cultural differences. The experiences gained in this process enabled them to develop empathy towards students from different cultural backgrounds and to see this diversity not as a disadvantage but as a factor that enriches the teaching process. Moreover, the use of interactive methods such as creative drama strengthened the inclusiveness of learning environments by increasing intercultural dialogue and collaboration among students. The experiences of pre-service teachers in this process made them more competent in planning lessons with materials that center individual differences and appeal to different intelligence areas and learning styles. Therefore, the practical experience of multicultural education facilitated the internalization of theoretical knowledge and contributed to the adoption of a multicultural education approach by transforming the pedagogical approaches of pre-service teachers. This situation shows that important gains were achieved not only in cognitive but also in affective areas.

Multiculturalist education was given to pre-service teachers via interactive engagement strategies, methods, and techniques such as inquiry-based learning, creative drama, brainstorming, etc. This finding is similar to Boda (2019). Turkish pre-service science teachers told that instructors generally use presentation methodology with power point slides; it is a limitation for skill development related to multicultural science education. U.S. student teachers claimed that there is a big need for using more interactive teaching and learning approaches like inquiry, research and problem-based learning, question and answer methodology, show and do technique especially in laboratory classes. This is also a similar result with Brown & Livstorm (2020). The key factor for these results is the effect of the methods and techniques used in the teaching process on pre-service

teachers' skill development towards multicultural education. Interactive participation strategies, such as inquiry-based learning, creative drama, and brainstorming, facilitate pre-service teachers' understanding of different cultural perspectives, empathy, and scientific thinking skills. The predominance of traditional presentation-oriented teaching methods in Turkey limits preservice teachers' active participation and hinders the development of practical skills related to multicultural science education. On the other hand, the fact that pre-service teachers in the USA similarly stated that they need more interactive, problem-based and experimental learning processes shows that the quality of teaching strategies on a global scale is a determining factor in preparing pre-service teachers for multicultural education. This situation reveals that both in Turkey and in the USA, teaching strategies need to be transformed and multicultural education should be supported not only by content but also by pedagogical approaches.

Both Turkish and U.S. student teachers emphasized using more audio-visual materials for making the concepts more concrete related to multicultural science education, like tables and graphics. Different simulations, digital platforms, and software provide teacher candidates with opportunities to use technology in an effective and operational way. Turkish student teachers also stated the importance of making experiments in science classes with daily life materials. Those are also the statements of Turkish HEC-Higher Education Council (2020) reports. The main reason for these results is the impact of contemporary teaching approaches and technological developments on pre-service teachers. In the context of multicultural science education, both Turkish and US pre-service teachers' emphasis on audiovisual materials for concretizing concepts is a reflection of their efforts to make learning more permanent and inclusive. In particular, the effective and functional use of technological tools such as digital platforms, simulations and software offers significant advantages to pre-service teachers in addressing different cultural and individual learning needs. In the case of Turkey, as emphasized in HEC's (Higher Education Council) 2020 reports, the fact that pre-service teachers emphasize the importance of conducting experiments using materials related to daily life is indicative of a desire to bridge scientific knowledge with life and a practical teaching approach. This situation reveals that pre-service teachers are influenced by both global education trends and national education policies.

Both Turkish and U.S. pre-service science teachers emphasized the importance of conducting longitudinal observations and providing periodical feedback within the measurement and assessment processes. They recognized that assessments, which go beyond traditional testing methods, are crucial for gaining a comprehensive understanding of student progress and skill development, especially in a multicultural science education context. These teachers asserted that the use of complementary assessment methodologies—such as performance-based activities, portfolios, self- and group assessments, observation checklists, and semi-structured interview forms—can provide educators with valid, reliable, and nuanced insights into students' learning journeys. By employing these varied assessment strategies, teachers can capture a broader spectrum of student skills and competencies, including creativity, critical thinking, problem-solving, and teamwork, which are vital in today's diverse classrooms. The emphasis on observational assessments also allows teachers to track students' growth over time, offering a more holistic view of their abilities than single-point evaluations can provide. This approach not only ensures more accurate measurement of student development but also promotes a deeper understanding of how students engage with the curriculum in multicultural settings. Moreover, the feedback from these assessments can guide teachers in adjusting their teaching strategies, fostering an environment that supports the continuous improvement of both teaching and learning. These findings align with

previous studies, including Boda (2019) and Brown & Livstorm (2020), which highlight the value of diverse assessment tools in supporting the effective measurement of skills in multicultural educational contexts.

Both Turkish and U.S. pre-service science teachers emphasized that one of the significant disadvantages of using presentations in the classroom is their tendency to limit student interaction. Presentations, especially when delivered in a lecture-style format, can create a one-way flow of information from teacher to student. This dynamic often reduces opportunities for students to engage with the content actively. In science classes, where hands-on activities and experimental learning are crucial for understanding complex concepts, this lack of interaction becomes particularly detrimental. Students may struggle to make connections between theoretical knowledge and practical application, limiting their critical thinking and problem-solving abilities.

Additionally, the absence of application processes in science lessons, such as experiments, investigations, and real-world problem-solving tasks, can hinder the development of key scientific skills. Science education is not just about memorizing facts or understanding theories; it requires the ability to apply knowledge to novel situations, think critically, and collaborate with others. Without opportunities to apply what they learn, students may fail to internalize the material effectively, and their interest in the subject might decrease. This issue aligns with the findings of Baptista (2018), who highlighted the challenges that arise when technology, like PowerPoint presentations, is used in ways that don't encourage student interaction or engagement. Baptista argued that when teachers overly rely on technology without considering how it affects student involvement, the learning experience can become passive and disconnected from real-life contexts. Furthermore, the absence of interactive learning opportunities may also contribute to the development of surface-level understanding, where students can recall facts but struggle to apply them in meaningful ways. In light of these findings, it is crucial for pre-service teachers to be trained in methods that balance the use of technology with interactive and application-based learning strategies. Incorporating hands-on experiments, group work, and problem-solving activities into science lessons can enhance the learning experience, making it more engaging and effective. Teachers could also explore other forms of technology, such as simulations or virtual labs, which offer opportunities for students to actively engage with scientific concepts in an applied setting.

The results of the study highlight that both Turkish and U.S. pre-service science teachers internalized the advantages of multicultural science education, particularly in recognizing the importance of considering students' diverse cultural characteristics in the classroom. These include variations in learning styles, intelligence areas, attitudes, and personal backgrounds, which significantly influence how students engage with science content. Both groups of pre-service teachers demonstrated a clear understanding of the value of employing diverse, interactive instructional strategies and assessment techniques to cater to these differences. By embracing these methods, teachers can create a more inclusive and engaging learning environment that encourages active participation from all students, regardless of their cultural background. Additionally, the study underscores the potential for science teachers to further develop their pedagogical content knowledge and teaching skills through the integration of multicultural science education. This process not only helps educators become more adaptable in meeting the needs of a diverse student body but also enables them to foster critical thinking, creativity, and problem-solving skills in their students. Multicultural education encourages the appreciation of diverse perspectives, which can enrich the science curriculum by introducing students to a variety of scientific contributions from

different cultures around the world. Building on these findings, it is suggested that teacher education programs incorporate more targeted training on multicultural teaching strategies, emphasizing cultural responsiveness and inclusivity. Professional development workshops could also be designed to explore culturally relevant science pedagogy and provide pre-service teachers with practical tools to implement in diverse classrooms. Moreover, fostering collaboration between teachers from different cultural backgrounds could promote cross-cultural exchanges of teaching practices and insights, further strengthening the quality of science education. By continuing to prioritize multicultural science education, teachers can better prepare themselves to address the dynamic and diverse needs of future generations. These findings align with those of Le Matias (2019), who similarly found that multicultural education enhances teachers' ability to engage students from varied cultural contexts and supports the development of a more holistic and equitable science education system. In light of this, it is recommended that further research be conducted to explore the long-term impacts of multicultural training on science teaching effectiveness and student outcomes, particularly in terms of student engagement, achievement, and overall satisfaction with their learning experiences.

The findings of this research study strongly highlight the importance of moving beyond theoretical understanding in the field of multicultural education. While theoretical frameworks are essential for establishing the foundational concepts, they are insufficient if not complemented by practical experiences that allow pre-service teachers to engage with and understand the complexities of diverse classroom environments. Teachers must not only grasp the principles of multicultural education but also have the opportunity to apply these concepts in real-world settings. Practical exposure helps bridge the gap between theory and practice, equipping future educators with the skills necessary to navigate cultural differences effectively in the classroom. Moreover, it is imperative that teacher training programs in both Turkey and the USA adopt a more holistic approach when addressing multicultural education. This approach should not be limited to individual courses or isolated activities but integrated across the entire curriculum, fostering an environment that encourages reflection, critical thinking, and the development of cultural competence. Such integration ensures that pre-service teachers do not merely gain isolated knowledge about multicultural education but internalize these ideas as part of their broader pedagogical philosophy. To truly prepare educators for the increasingly diverse classrooms they will face, teacher training programs must emphasize the significance of multicultural learning environments. These environments should be designed to reflect the richness of cultural diversity, where students' backgrounds, perspectives, and experiences are valued and incorporated into teaching practices. In doing so, teacher programs will not only meet international educational standards but also contribute to fostering inclusive and equitable learning communities. In both Turkey and the USA, where cultural diversity is a defining characteristic of many communities, teacher preparation programs must prioritize the development of intercultural communication skills, empathy, and the ability to create culturally responsive teaching strategies. This entails a shift in how educators are trained—from focusing solely on content knowledge to recognizing and addressing the diverse needs of all students. Such a comprehensive, multi-faceted approach can help bridge cultural divides, promote social justice, and prepare teachers to contribute to a more inclusive and harmonious society. Furthermore, it is essential that these programs involve collaboration with diverse communities, encourage fieldwork in multicultural settings, and provide mentorship from educators who have successfully implemented multicultural education strategies. By giving pre-service teachers a chance to learn from the lived experiences of those who have

navigated diverse classrooms, they will be better equipped to face the challenges that arise in their own teaching careers.

In conclusion, the integration of multicultural education within teacher training programs must go beyond mere theory. It requires intentional, hands-on experiences, a commitment to diversity and inclusion, and an understanding of the transformative role that education plays in shaping a more tolerant and just society. By embracing a holistic approach to multicultural education, teacher preparation programs in both Turkey and the USA will play a critical role in developing educators who are not only knowledgeable but also deeply empathetic, culturally responsive, and capable of fostering inclusive educational environments.

Conclusions and Implications

Research results of this study imply that pre-service science teachers in Turkey don't internalize the term multiculturalism in educational environments. They have no experience how to design instruction for providing effective communication styles for different cultures. U.S. pre-service science teachers have more knowledge and experience about multicultural classrooms, but their knowledge is limited to ethnicity, nation, religion and tradition differences. Instructors should offer different forms of interactive engagement strategies for instruction. Pre-service science teachers in both countries recognize different methods and techniques considering students' different cultural characteristics, and they stated their perceptions about multiculturalist learning environments.

Following suggestions are given to both researchers and practitioners in terms of this research study results:

- Both pre-service and in-service trainings can be organized for developing the multiculturalist skills of science instruction.
- Multiculturalist teacher qualifications and multicultural education standards can be organized and integrated into the curricula with the definition of content, learning-teaching, measurement and assessment components.
- Multicultural education programs can be extended into the teacher education bachelor degree, master or PhD program, or institutional organizations in universities.
- Exchange programs of different countries can be extended in universities at the elementary and secondary levels so that learners can be able to introduce different countries' cultures.
- Projects for aiming to identify the needs of different regions and socio-economic structures of Turkey can be organized and students can visit different schools and making platforms for providing interaction of students all over the country.
- Projects can be conducted all over the world and in our country for providing infrastructure and equal educational conditions for students.
- Teachers can come together for constructing digital forums to give periodical feedback to students for providing equal rights through reaching and considering different cultural characteristics of students.
- Exchange programs for different levels of teaching offered to learners that they can able to introduce different countries' cultures.

- Research studies related to comparative educational politics can be conducted for analyzing the aspects of multicultural education.

- Accreditation and standardization of programs are necessary for providing qualified multicultural learning and teaching environments.

Acknowledgements: I thanked to Hacettepe University and University of Iowa Faculty of Education Department of Science Education students to participate and act voluntarily and consecratively.

Ethics Committee Permission Information: This study was conducted with the permission of Hacettepe University Educational Sciences Institute Scientific Research and Publication Ethics Committee dated 16/05/2024 and numbered E-82474949-600-00003537702.

Author Conflict of Interest Information: There is no conflict of interest in this study and no financial support was received.

Author Contribution: The study has a single author.

References

Aktan, M. B. (2024). Çokkültürlü bilim eğitimi: Türkiye'de fen bilimleri öğretimi için bir gereklilik. *Milli Eğitim, 53*(241), 571-590. https://doi.org/10.37669/milliegitim.1189910

American Psychological Association. (2002). Ethical principles of psychologists and code of conduct. *American Psychologist, 57*(12), 1060–1073.

Assegaf, N. A. (2021). Migration and economic development in Turkey. *AHBV Akdeniz Havzası ve Afrika Medeniyetleri Dergisi, 3*(2), 43-52.

Aydın, H., & Tonbuloğlu, B. (2014). Students' perceptions on multicultural education: A qualitative case study. *Eurasian Journal of Educational Research, (57)*, 29-50. https://doi.org/10.14689/ejer.2014.57.3

Bakır, K. F., & Akcan, E. (2021). Examination of the texts in life sciences textbooks in the context of multicultural education. *Turkish Journal of Educational Sciences, 19*(2), 1323-1343. https://doi.org/10.37217/tebd.970889

Banks, J. A. (1989). Approaches to multicultural curriculum reform. *Trotter Review, 3*, 3-18.

Banks, J. A. (2002). *An introduction to multicultural education* (3rd ed.). Allyn & Bacon.

Banks, J. A. (2006). *Cultural diversity and education: Foundations, curriculum, and teaching* (5th ed.). Pearson Education.

Baptista, G. C. S. (2018). Tables of contextual cognition: A proposal for intercultural research in science education. *Cultural Studies of Science Education, 13*, 845-863.

Başbay, A., & Kağnıcı, Y. (2011). Multicultural competence perceptions scale: A scale development study. *Education and Science, 36*(*161*), 199–212.

Bennett, C. I. (2011). *Comprehensive multicultural education: Theory and practice* (7th ed.). Allyn & Bacon.

Boda, P. A. (2019). Conceptualizing the margins in science education: The limits of multicultural analyses. *Cultural Studies of Science Education, 14*, 493-514. https://doi.org/10.1007/s11422-019-09926-x

Brown, J. C., & Livstrom, I. C. (2020). Secondary science teachers' pedagogical design capacities for multicultural curriculum design. *Journal of Science Teacher Education, 31*(8), 821-840. https://doi.org/10.1080/1046560X.2020.1756588

Coşkun, M. K. (1999). Attitudes of religion culture and ethics knowledge pre-service teachers towards multiculturalist education (Comparison of Theology-Education). *Dumlupınar University Social Sciences Journal, 34*, 33-44.

Çapçı, S., & Durmuşoğlu, M. C. (2022). Examination of preschool teachers' multicultural competence perceptions. *Education and Science, 47*(211). http://dx.doi.org/10.15390/EB.2022.11046

De Aquino, R. S., Carneiro-Leão, A. M., & Amaral, E. M. R. (2019). Teaching in cross-culture: A worldwide concern to improve the science education in a multicultural perspective. *International Journal of Informics*. https://infonomics-society.org

Dewi, N. R., Saputri, E., Nurkhalisa, S., & Akhlis, I. (2020). The effectiveness of multicultural education through traditional games-based inquiry toward improving student scientific attitude. *Journal of Physics: Conference Series, 1567*(4). https://doi.org/10.1088/1742-6596/1567/4/042051

Gouvea, J. S. (2018). Culture and equity in science classrooms. *CBE Life Sciences Education, 17*(4), 1–3.

Grant, C. A., & Portera, A. (2011). *Intercultural and multicultural education: Enhancing global interconnectedness*. Routledge.

Güner, E. G., & Batı, K. (2024). Investigation of science teachers' perceptions of multicultural education and perceptions of competence for multicultural education. *Mersin University Journal of the Faculty of Education, 20*(1). https://doi.org/10.17860/mersinefd.1332443

HEC. (2020). Explanation of distance education in universities. Retrieved from https://www.yok.gov.tr/Sayfalar/Haberler/2020/

Hsiu, P. H., Ying, Y. C., & Cheng, F. Y. (2017). Science teacher perception on multicultural education literacy and curriculum practices. *EURASIA Journal of Mathematics Science and Technology Education, 13*(6), 2761-2775. https://doi.org/10.12973/eurasia.2017.01252a

Huang, H. P., Cheng, Y. Y., & Yang, C. F. (2017). Science teachers' perception on multicultural education literacy and curriculum practices. *EURASIA Journal of Mathematics, Science and Technology Education, 13*(6), 2761-2775.

Institute of International Education. (2023). *Open doors report on international educational exchange*. https://opendoorsdata.org/

Joshi, R., Adwoa Brantoo, M., Schutt, E., & Fynewever, H. (2020). Cultural mismatches in the multicultural science classroom. *Journal of Underrepresented and Minority Progress, 4*(1), 127-142.

Kılavuz, R. (2023). Multicultural education in Türkiye: A systematic review. *Journal of Human and Social Sciences, 6* (Education Special Issue), 510-535.

Kongar, E. (1994). *Toward culture*. Remzi Bookstore.

Le, P. T., & Matias, C. E. (2019). Toward a truer multicultural science education: How whiteness impacts science education. *Cultural Studies of Science Education, 14*, 15-31. https://doi.org/10.1007/s11422-017-9854-9

Luft, J. (1998). Multicultural science education: An overview. *Journal of Science Teacher Education, 9*(2), 103-122.

Merriam, S. B., & Tisdell, E. J. (2016). *Qualitative research: A guide to design and implementation* (4th ed.). Jossey-Bass.

Miles, M. B., & Huberman, A. M. (1994). *Qualitative data analysis: An expanded sourcebook* (2nd ed.). Sage Publications.

Nowell, L. S., Norris, J. M., White, D. E., & Moules, N. J. (2017). Thematic analysis: Striving to meet the trustworthiness criteria. *International Journal of Qualitative Methods, 16*(1), 1–13. https://doi.org/10.1177/1609406917733847

Ogunleye, A. O. (2009). Defining science from multicultural and universal perspectives: A review of research and its implications for science education in Africa. *Journal of College Teaching & Learning, 6*(5). https://doi.org/10.19030/tlc.v6i5.1142

Polat, T., & Barka, T. O. (2012). Multiculturalism and intercultural education: A comparative study with a sample of Swiss and Turkish candidate teachers. *World Applied Sciences Journal, 18*(9), 1180-1189. https://doi.org/10.5829/idosi.wasj.2012.18.09.1242

Robertson, A. D., & Atkins Elliott, L. J. (2017). All students are brilliant: A confession of injustice and a call to action. *The Physics Teacher, 55*(9), 519–523. https://doi.org/10.1119/1.5011823

Sinagatullin, I. M. (2003). *Constructing multicultural education in a diverse society*. The Scarecrow Press.

Sorge, S., Doorman, M., & Maass, K. (2023). Supporting mathematics and science teachers in implementing intercultural learning. *ZDM Mathematics Education, 55*, 981–993. https://doi.org/10.1007/s11858-023-01478-3

Şengül, F. N. (2021). The relationship between multiculturalism and religious attitudes in teacher candidates. *Journal of Bozok University Faculty of Theology, 20*(20), 89-117.

Tovar-Gálvez, J. C. (2023). Intercultural teaching practices for science education to support teachers in culturally diverse classrooms. *Teaching Education, 34*(4), 420-437. https://doi.org/10.1080/10476210.2023.2167975

Tracy, S. J. (2020). *Qualitative research methods: Collecting evidence, crafting analysis, communicating impact* (2nd ed.). Wiley-Blackwell.

Yazıcı, S., Başol, G., & Toprak, G. (2009). The attitudes of teachers toward multiculturalism: A reliability and validity study. *Hacettepe University Faculty of Education Journal, 43*, 229-242.

Yin, R. K. (2018). *Case study research and applications: Design and methods* (6th ed.). Sage Publications.

Geniş Özet

Giriş

Çokkültürlülük, Amerika Birleşik Devletleri'nde 1960 yılında Afro-Amerikan toplumunun haklarını arayarak başlayan önemli bir harekettir. Türkiye de kültürlerin yaşadığı büyük bir ülkedir ve Suriye İç Savaşı nedeniyle göçmenlerin Türkiye'ye gelmeye başlamasından sonra eğitim ortamlarında çok kültürlülük kritik bir nokta haline gelmiştir. Amerika Birleşik Devletleri de farklı eyaletlere sahip büyük bir ülkedir. Her eyaletin kendi kültürleri, eğitim standartları ve yönetimi vardır. Amerika Birleşik Devletleri aynı zamanda birçok ülkeden öğrenciye ev sahipliği yapan ve renkli kültürel dokuların sentezlendiği eğitimde söz sahibi bir ülkedir. Çokkültürlü fen eğitimi ile ilgili kavramların yapılandırılmasını sağlama ve epistemolojik inançlar arasında köprü kurma ile ilgili bazı çalışmalar olmasına rağmen alanyazında uygulama temelli ve çokkültürlülüğün fen bilgisi öğretmen eğitimi özelindeki etkileri ve karşılaştırmalar yapan bir çalışma bulunmamaktadır. Hizmet öncesi fen bilgisi öğretmen eğitimi çokkültürlü özelliklerden doğrudan etkilenmektedir, bu nedenle çokkültürlülük kavramı ile çalışmaların yapılması oldukça anlamlıdır.

Bu araştırmanın amacı, fen bilgisi öğretmen adaylarının çokkültürlü öğrenme ortamlarına ilişkin deneyimleri hakkındaki görüşlerini ortaya çıkarmak ve incelemektir. Bu çalışmanın genel araştırma soruları aşağıdaki gibi sıralanmıştır;

1. Çokkültürlülük okul ve sınıf ortamlarında nasıl kavramsallaştırılır ve tanımlanır?
2. Okul ve sınıf ortamlarındaki farklı kültürel boyutları belirlemek için hangi stratejiler ve göstergeler kullanılmaktadır?
3. Kültürel farklılıklar öğretmenlerin bilişsel süreçlerini, öğretimsel karar verme süreçlerini ve ders planlamalarını ne şekilde etkilemektedir?
4. Çok kültürlü fen eğitimi bağlamlarında en etkili öğretim yöntem ve teknikleri nelerdir?
5. Ne tür eğitim materyalleri ve sınıf etkinlikleri fen eğitiminde çok kültürlü katılımı destekler?
6. Ölçme ve değerlendirme yöntemleri, fen eğitiminde kültürel çeşitliliği eşit bir şekilde ele alacak şekilde nasıl yapılandırılabilir?
7. Çok kültürlü fen eğitiminin uygulanmasıyla ilgili algılanan zorluklar ve sınırlamalar nelerdir?
8. Çok kültürlü yaklaşımları fen eğitimine entegre etmenin faydaları ve olumlu etkileri nelerdir?
9. Çok kültürlü fen eğitiminin öğretimsel planlamasına hangi tasarım ilkeleri ve öneriler rehberlik edebilir?

Yöntem

Bu çalışmanın araştırma deseni bir durum çalışmasıdır. Durum çalışması tasarımı, araştırmacının verileri belirli bir bağlam içinde yakından incelemesine olanak tanır. Durum çalışması tasarımı çoğunlukla küçük bir coğrafi alanı veya çok sınırlı sayıda bireyi çalışma konusu olarak seçer (Merriam, 1998). Bu çalışmada, Türkiye'den 120 ikinci, üçüncü ve dördüncü sınıf fen

bilgisi öğretmen adayı ve 80 ikinci, üçüncü ve dördüncü sınıf fen bilgisi öğretmen adayı kolayda örnekleme yöntemiyle seçilmiştir. Katılımcıların örnekleme dahil edilmek üzere seçilmesinin nedeni, araştırmacıların erişiminin pratik olmasıdır. Katılımcılar fizik, kimya, biyoloji, matematik, eğitim bilimlerine giriş ve eğitim psikolojisi gibi alan derslerini almışlardır. Iowa Üniversitesi'ndeki öğretmen adaylarına, araştırmacının doktora sonrası süreçte ve sonrasında iletişim halinde olduğu öğretim üyesinin Fen Öğretimi dersi kapsamında ulaşılmıştır. Yarı yapılandırılmış görüşmeler için Türkiye'den 30 fen bilgisi öğretmen adayı ve Amerika Birleşik Devletleri'nden 20 fen bilgisi öğretmen adayı gönüllülükleri ve akademik başarıları göz önünde bulundurularak amaçlı olarak seçilmiştir.

Araştırma, 2023-2024 bahar döneminde Iowa Üniversitesi ve Hacettepe Üniversitesi'nde Fen Öğrenimi ve Öğretimi dersi kapsamında yürütülmüştür. Öğretmen adaylarına Zoom platformu üzerinden beş hafta boyunca çokkültürlü öğrenme ortamları hakkında interaktif seminer verilmiştir. Araştırmacı, beş haftalık fen eğitiminde çok kültürlü kavram ve beceri geliştirme programı ve öğretmen adaylarının algılarını, becerilerini belirlemek için açık uçlu anket soruları hazırlamıştır. Geçerlik ve güvenirlik için fen eğitimi, ölçme ve değerlendirme alanlarında uzman iki akademisyenin görüşü alınmıştır. Uzman görüşleri doğrultusunda yapılan düzeltmelerden sonra anketin kültürel uyarlaması bir Türk ve bir Amerikalı dilbilim uzmanı tarafından yapılmıştır. Pilot çalışma Google Survey platformu üzerinden 5 Türk ve 5 ABD'li öğrenci ile gerçekleştirilmiştir. Açık uçlu anket öğretmen adaylarına hem seminer öncesinde hem de seminer sonrasında uygulanmıştır. Seminer sonrasında öğretmen adayları kendi çokkültürlü öğrenme planlarını oluşturmuş ve bu planları öğrenme ve öğretme süreçlerinde sunmuşlardır.

Nitel verilerin analizinde betimsel ve içerik analizleri kullanılmıştır. Öğretmen adaylarının görüşme sorularına verdikleri yanıtlar kodlanmış ve araştırma soruları açısından anlamlı temalar halinde toplanmıştır. Bu araştırmada nitel araştırma yönteminin hem geçerlilik hem de güvenilirlik konuları dikkate alınmıştır. Öğretmen adaylarından alınan yarı yapılandırılmış mülakat cevapları, fen eğitimi ve eğitim programları ve öğretim alanında çalışan iki öğretim elemanı tarafından kodlanarak güvenirlik ve değerlendiriciler arası geçerlik sağlanmıştır. Kodlamanın güvenilirliğini kontrol etmek için Miles ve Huberman (1994) tarafından önerilen "Güvenilirlik = Görüş Birliği/(Görüş Birliği + Görüş Ayrılığı)" formülü kullanılmıştır. Kodlama protokolünün güvenirlik katsayısı .83 olarak hesaplanmıştır.

Bulgular

Bu araştırmanın sonuçları, hem Türk hem de ABD'li fen bilgisi öğretmen adaylarının çokkültürlülük ve çokkültürcü fen eğitimi hakkında çok sınırlı bilgi ve deneyime sahip olduğunu göstermiştir. ABD'li fen bilgisi öğretmen adayları dil ve milliyet gibi genel kavramları ifade etmişlerdir. Türk fen bilgisi öğretmen adaylarının çokkültürlülük algısı ise din ve etnik köken farklılıklarına dayanmaktadır. Hem Türk hem de ABD'li fen bilgisi öğretmen adaylarının çokkültürlülük özelliklerini belirleme konusunda da sınırlı bilgileri vardır. Öğrencilerinin çokkültürlülük özelliklerini sadece gözlem ve öğrencilerle görüşme yoluyla belirleyebileceklerini düşünmektedirler. Algıları genişletilmiş ve danışmanlık hizmetlerinin işlevi, ebeveyn desteğinin önemi ve portfolyolar, öğrenci günlükleri ve boylamsal gözlemler gibi tamamlayıcı ölçme ve değerlendirme tekniklerinin altını çizmişlerdir. Hem Türk hem de ABD'li fen bilgisi öğretmen adayları çokkültürlü fen eğitiminin uygulama sürecinden sonra düşünme ve karar verme süreçlerini genişletme şansı bulmuş ve bu becerilerini çokkültürlü ders planlarına yansıtmışlardır. Öğretmen adayları çokkültürlü eğitimin uygulama sürecinden sonra sınıflarını cinsiyet, kavramsal ön hazırlık,

özel eğitime ihtiyaç duyma, farklı zeka alanlarına ve düzeylerine sahip olma, farklı öğrenme stilleri gibi kültürel farklılıklar açısından nasıl tasarlayacaklarını, yaratıcı drama gibi etkileşimli öğretim yöntemleriyle kültürel işbirliğini nasıl sağlayacaklarını ve kültürel farklılıkları dikkate alarak etkileşimli materyaller (resim, video) kullanmayı öğrenmişlerdir.

Sonuç ve Öneriler

Çalışmanın sonuçları, hem Türk hem de ABD'li fen bilgisi öğretmen adaylarının çok kültürlü fen eğitiminin avantajlarını, öğrencilerin farklı öğrenme stilleri, zeka alanları, tutumları gibi farklı kültürel özelliklerini sınıfta göz önünde bulundurarak, farklı etkileşimli öğretim stratejileri ve değerlendirme teknikleri kullanarak içselleştirdiklerini ortaya koymaktadır. Fen öğretmenleri pedagojik alan bilgilerini ve becerilerini çok kültürlü fen eğitimi yoluyla geliştirebilirler. Araştırmanın sonunda çokkültürlü fen eğitimine ilişkin değişim programları, uluslararası proje tasarımları gibi önerilere yer verilmiştir.

APPENDIX A-SAMPLE LESSON PLAN

Course Name: Science

Grade: 8

Unit: DNA and Genetic Code/Living and Living Things

Topic: Heritage

Duration: 40 min + 40 min (2 course time)

Aims

1-Make the definitions related to heritage.

2-List the concepts of gene, phenotype, genotype, pure offspring, hybrid offspring

3-Define the concepts of dominant and recessive gene.

Concepts of the Unit: Gene, genotype, phenotype, pure offspring, hybrid offspring, dominant, recessive

Instructional Methods and Techniques: Question and answer, discussion, inquiry.

Learning and Teaching Activities

Taking attention: The teacher comes to the classroom and distributes colored pencils and paper with a human figure on it. The teacher asks the students to color this figure. The teacher tells them to color the figure's hair orange and the clothes purple. Then the teacher tells the students to paint the skin of the figure in the color they want. The teacher looks at the figures after painting. She asks the students why they chose the color they want to paint.

Motivation: Teacher draws a diagram on the blackboard. Teacher lists the physical characteristics of a mother and a father on this diagram. After the integration process of mother and father characteristics each student lists his or her own physical properties.

Review: Teacher wants to inquire students in terms of human figure and their lists that why people have different characteristics. Teacher asks a student whose mother and father have very different

characteristics that if he/she likes his/her mother or father. After every student group discuss this topic, they construct a common problem sentence.

Transition to Course/Development Part: Students make groups and each group constructs hypotheses in terms of their problems. They discuss how they provide solutions to control their hypotheses. Groups make researches to solve their problems. Each groups note their data. Groups present their data after class. All data are integrated to have common judgement.

Measurement and Evaluation: The teacher asks the students to draw a picture about multiculturalism and create a poster about it. The posters are presented on the class board in the next lesson.

Explanation of Applying the Plan: Teachers pay attention that every student has a mother and a father and they are alive in multiculturalist classrooms because students who never sees his or her father or mother can sadden or offend.