Virtual and Open Integration of Culture for Education (VOICE) with Science Teacher Candidates from Korea during COVID-19

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Abstract

Cultural competencies and confidence in teaching diverse students are needed to close achievement gaps between mainstream and minority students in science. In this study, an online teacher education program, Virtual and Open Integration of Culture for Education (VOICE), was designed to help retain teacher candidates' science affinities and cultural competency during the COVID-19 pandemic. Thirty-two Korean teacher candidates were selected as culturally responsive instructors who were able to reduce their cultural bias and preferences about Korean culture and develop culturally responsive instruction. VOICE proceeded through (1) "collaborating," by connecting seminar speakers worldwide; (2) "designing," by creating culturally responsive science activities based on Korean culture; and (3) "performing," by communicating with

American students, teacher candidates, teachers, and parents. Pre- and post-survey results show that VOICE increased the teacher candidates' cultural proficiency and interest in science. Guidelines for research on designing online programs to enhance teacher candidates' science affinities and cultural competencies are provided.

Keywords

science education – teacher candidates – interest in science – cultural competency – online learning

1 Introduction

As school populations in the United States have changed drastically with increasing enrollments of students from various ethnic and racial groups, schools demand learning environments that are engaging and accessible to a broader range of students. The Census Bureau expected that current racial and ethnic minority students would constitute more than half of all students in U.S. public schools by 2022–23 (Colby & Ortman, 2015). White enrollment decreased from 61% to 52% and minority student enrollment increased from 16% to 23% of the total public-school population over the last 10 years. In the 2022–23 school year, the number of white students is forecasted to decline by another 16%, and numbers of students from minority groups are projected to show significant growth (NCES, 2020). This is also the case in Korea. The minority students in Korean schools who are culturally and linguistically different from Korean majority students make up approximately 4.6% of the student population in 2019, a more than threefold increase compared to the minority student population in 2012 (Korean Educational Statistics Service, 2019).

Teachers in diverse classrooms have been aware of the persistent achievement gap in science between majority and minority students (NCES, 2019). According to studies such as the NAEP (NCES, 2011) and TIMSS (Gonzales et al., 2009), the achievement gap in science starts as early as kindergarten and continues to increase in higher education (Chapin, 2006). Minority graduates' science and engineering degree attainments at the bachelor's (8.3% and 8.2%, respectively), master's (9.4% and 6.6%, respectively), and doctoral (4.9% and 5.8%, respectively) levels were much lower than the white graduates' (NSF, 2011). This achievement gap has led to a continuous divide between majority and minority students in schools (Gopalan, 2019). While the minority population in Korea has rapidly expanded, minority students' school dropout rate

is about two times that of the Korean majority students, and their academic performance lags behind Korean students (Nam, 2019). School teachers need to pay attention to the emerging minority student population in Korea and close the achievement gap between the majority and the minority students in classrooms.

The persistence of unequal educational outcomes among ethnic minority groups in school can be removed by enhancing teachers' abilities. Students from non-dominant cultures require teachers to adapt scientific concepts (Franklin, Slate, & Joyner, 2014). Research on solutions to close the achievement gap has suggested that culturally responsive instruction enables teachers to resolve potential cultural differences among students in the classroom and create an equal learning environment for all students, including minority students (Qian et al., 2017; Theobald et al., 2020; Williams, 2011). However, teachers have revealed that they have limited self-efficacy for implementing teaching for culturally and linguistically diverse students, although they have positive attitudes and beliefs about them (Park, Chu, & Martin, 2016). Thus, there is a demand for a dramatic increase in cultural competencies and confidence in teaching diverse students among teachers in science classrooms (Ladson-Billings, 2014).

Therefore, we designed and implemented a program called Virtual and Open Integration of Culture for Education (VOICE) for Korean teacher candidates to promote their cultural competencies. VOICE was an online teacher education program, integrated with culturally responsive science teaching, to educate the teacher candidate to be more culturally sensitive through interactions with American elementary school students, parents, teacher candidates, and teachers. The teacher candidates were expected to share their strong cultural backgrounds by integrating cultural information with science concepts. The VOICE program aimed to encourage teacher candidates to develop their voices and to maintain and pursue science education and their careers as science teachers by designing culturally responsive science activities and interacting with people from other cultures, even during the COVID-19 pandemic.

The study examined to what extent the Korean teacher candidates' science affinities (teaching efficacy beliefs, competency in teaching science with cultural sensitivity, interest in science, and cultural intelligence) changed before and after they met with the American students, teacher candidates, and teachers in schools through the VOICE program. The guiding research questions were as follows.

- (1) To what extent did the science teacher candidates increase their science teaching efficacy beliefs through the VOICE program?

- (2) To what extent did the science teacher candidates improve their competency in teaching science with cultural sensitivity through the VOICE program?
- (3) To what extent did the science teacher candidates positively develop their interest in science through the VOICE program?
- (4) To what extent did the science teacher candidates promote their cultural intelligence through the VOICE program?

2 Theoretical Background

2.1 *Culturally Responsive Teaching and Intercultural Education*

As the student population is no longer culturally homogenous in Korean schools, Korean teacher education requires professional programs where teacher candidates are trained to be aware of and appreciate cultural differences in classrooms (Kim & Kim, 2012). These teacher education programs should provide teacher candidates educational opportunities that emphasize diverse cultures among their future students and engage all students, including not only the majority but also minority students, in learning science. Enabling teacher candidates to understand the cultural differences of the minority students and develop and implement culturally responsive instruction in their classrooms can help close the academic performance gap between majority and the minority students.

To maximize minority students' learning opportunities, their knowledge and skills need to be situated within their daily experience, which helps them feel more personally meaningful, increases students' interest, and helps them learn more easily and thoroughly (Gay, 2000). When minority students are taught in ways that draw on their own cultural experience, their academic achievement improves. Culturally responsive teaching connects students' cultural knowledge to academic knowledge (Kozleski, 2010) and improves their learning of scientific concepts. Therefore, teachers in diverse classrooms need to gain knowledge of the cultures represented in their classrooms and connect this knowledge to their teaching.

Culturally responsive teaching is grounded in intercultural education. Intercultural education requires a deep understanding and respect for all cultures, exchanging ideas and cultures, and developing strong relationships among culturally different societies (Guilherme & Dietz, 2015). Students learn best in interactive classrooms within their various cultures rather than in classical classrooms that focus only on Western culture (National Scientific Council on the Developing Child, 2009). Culturally and linguistically diverse students

successfully achieve when their strengths are nurtured and connected to new knowledge and their culture and home languages are recognized as essential elements of learning (Ladson-Billings, 2009). Culturally responsive teaching gets students from non-dominant cultures engaged in demonstrating proficiencies in their own languages and culture and translates the logical structures of their culture and languages into the school curriculum, which helps them to experience intellectual growth as a result of classroom interaction. Therefore, culturally responsive teachers are expected to transform their own cultural biases and preferences for learning and communicating to engage and sustain student participation and achievement in science classrooms (Kozleski, 2010).

2.2 *Distance Education during the COVID-19 Pandemic*

The COVID-19 pandemic has forced schools around the world to close classrooms and choose distance education (Li & Lalani, 2020), resulting in the use of digital teaching platforms. Distance education has the benefit of making educational resources accessible regardless of time and place, satisfying the diverse demands of students (Geith & Vignare, 2008). On average, students retain 25–60% more of material learned online, compared to only 8–10% presented in a classroom (Gutierrez, 2016). This is mostly due to the students being able to learn faster online; distance learning requires 40–60% less time to learn than in a traditional classroom setting because the distance learning environment supports independent study (Schoox, 2018). Students can learn at their own pace, going back and re-reading, skipping, or accelerating through concepts as they choose.

To get the full benefit of distance education, there needs to be a synergetic effort to provide a structured environment and go beyond replicating a physical class/lecture through video capabilities, using a range of collaboration tools and engagement methods that promote *inclusion*, *personalization*, and *intelligence* (Loeb, 2020). Integration of cultures is one online learning strategy that promotes greater engagement and motivation to learn, especially among diverse learners in multicultural classrooms, by approaching learners personally and making them truly feel comfortable and respected, and empathically inspiring them to learn. Also, distance education makes teachers across the world collaborate to create culturally responsive science teaching by sharing their own cultures across the world. The adoption of the online integration of cultures continues to have an impact on science education worldwide, especially in multicultural societies.

An online teacher education program, Virtual and Open Integration of Culture for Education (VOICE), was designed in this study with the aim of

exploring how VOICE could help to support and retain teacher candidates in science in a pandemic setting. VOICE focused on Korean culture for this study. To optimize the use of VOICE, this study worked with Korean teacher candidates as culturally responsive instructors who reduced their cultural affection and inclination toward Korean culture.

2.3 *Need for Educating Teachers to Be Culturally Responsive*

Culturally responsive teachers need to accomplish cultural competency in their science classrooms (Ladson-Billings, 2014). Cultural competency is the ability to negotiate new standards and norms that acknowledge the differences and the similarities among and between individuals and student groups, which involves understanding and accessing multicultural information. By helping students appreciate and celebrate their cultures and creating an equitable learning environment that nurtures the healthy development of all children, including students from non-dominant cultures, culturally responsive teachers provide opportunities to help students grow intellectually. This kind of classroom requires careful planning and clear teaching around social interactions, so that students demand learning, feel comfortable exploring differences between cultures and languages, and accept that they may have help from their classmates and teachers to be successful. In such classrooms, students are enabled to view the classroom from more than one perspective, understand possible challenges in interactions with their classmates and teachers, and correctly assess their performance and competency in science, which helps them to grow intellectually and close their achievement gaps.

The concept of cultural intelligence (CQ), suggested by Earley and Ang (2003), can be an indicator of the extent to which teachers are culturally sensitive and capable of functioning and managing in culturally diverse settings (Brislin, Worthley, & MacNab, 2006; Earley & Ang, 2003; Gozzoli & Gazzaroli, 2018; Triandis, 2006; Van Dyne, Ang, & Koh, 2008). Van Dyne and colleagues (2012) identified four dimensions of cultural intelligence and developed its measurement: metacognitive, cognitive, motivational, and behavioral. Based on their definition, CQ-metacognitive is used to measure how much a person is cognitively aware of others' cultural experience and develops a strategy to adjust their minds. CQ-cognitive is used to evaluate how much a person understands other cultures, knowing similarities and differences between cultures. CQ-motivational is used to assess how much a person is interested in experiencing other cultures. CQ-behavioral is used to determine how much a person can adapt verbal and nonverbal behavior appropriate to other cultures.

Cultural intelligence (CQ) is not conceptually bound to professional contexts but can be translated into teaching contexts (Gozzoli & Gazzaroli, 2018).

Teachers should develop their teaching competencies with cultural sensitivity. Teaching competency indicates what teachers should know and be able to do to teach effectively (Danielson, 2007; Kang et al., 2020; Vogt & Rogalla, 2009). For example, Kang et al. (2020) identified 44 indicators of teaching competency in the context of science teaching. Such indicators can be applied to culturally responsive teaching. It means that teachers, especially the ones who have rarely been exposed to a multicultural classroom environment, need to learn how to plan, prepare, and formulate a classroom environment for minority students and to practice implementing it (Danielson, 2007). Another important indicator that predicts successful culturally responsive teaching is the self-efficacy of teachers (Bandura, 1977). Self-efficacy is an important driving force for overcoming difficult tasks. Although the process of designing and implementing culturally responsive lessons is challenging, science teachers with high self-efficacy are likely to approach it as a task to overcome and strive to achieve the goal (Mulholland, Dorman, & Odgers, 2004; Palmer, 2006a). In particular, teachers' mastery experiences, successful experiences, and vicarious experiences contribute to increasing their self-efficacy (Palmer, 2006b). Therefore, providing opportunities to participate in programs such as VOICE and to experience a sense of accomplishment may bring positive effects that enhance teachers' self-efficacy in culturally responsive teaching.

3 Methods

3.1 *Participants*

The participants in the study were 32 Korean teacher candidates who were enrolled in a secondary science teacher education program at a Korean university located in Seoul, Korea. The online teacher education program, VOICE, was announced across the campus and the participants voluntarily applied. Thirty-two teacher candidates were selected based on their GPAs and need for culturally responsive instruction. They were divided into eight groups, with four members per group. They ranged from first-year students to seniors, with majors in physics (3), chemistry (8), biology (7), earth and space science (10), and undeclared (4).

For the VOICE program, we contacted American elementary schools. As the statistics show, in Korean schools, in 2019 there were more minority students from Asian countries than ones from America (Korean Educational Statistics Service, 2019). However, since it was likely that there would be language barriers for teacher candidates in using languages other than English, we decided to start the VOICE program with American schools for this study.

3.2 *Culturally Responsive Science Activities for VOICE*

The culturally responsive science activities used in this study were designed by Korean teacher candidates, based on eight different science concepts: circular motion, chemical reaction, heat conduction, properties of light, fermentation, structures of plants, properties of sound, and chromatography. Eight science concepts were introduced through Korean cultural items and practices: Jwibulnori, *dalgona*, *ondol*, Gyeongbok Palace, kimchi, Korean dyeing, *gaya-geum*, and *sumukwha*. Table 1 provides the descriptions of culturally responsive science activities used in VOICE.

TABLE 1 Culturally responsive science activities for the VOICE

Group	Topics	Contents	Science concept
1	Circle the flame in the air with us!	The concepts of centrifugal force and centripetal force are introduced using a Korean traditional game called Jwibulnori (a game creating streaks of light by swinging cans filled with flammable materials) and experimenting with using LEDs to mimic it.	Circular motion
2	How can we make Korean sweets?	Various Korean sweets and candies are introduced and dalgona (Korean sugar candy using baking powder) is used to explain chemical reactions (i.e., generating carbon dioxide) and change of phases.	Chemical reaction
3	Ondol, a unique Korean heating system	Comparing heating systems in Korea and the United States, the ondol heating system used in traditional Korean houses (underfloor heating using direct heat transfer from wood smoke to the underside of a thick masonry floor) is used to introduce the concept of heat conduction and an experiment to show heat conduction by making human models on iron and copper plates is performed.	Heat conduction

TABLE 1 Culturally responsive science activities for the VOICE (cont.)

Group	Topics	Contents	Science concept
4	Put your Twinklothes ^a on!	A media façade using a mixture of light is shown and then an activity is performed to create a media façade on the Gyeongbok Palace with shadow play.	Properties of light
5	Find fermentation in Korean food	Fermented foods from various countries are introduced and then kimchi, a Korean fermented food, is introduced. How to make kimchi is then demonstrated.	Fermentation
6	The secret within balsam	Balsam flowers and Korean dyeing culture using balsam are introduced and a demonstration of how to dye Korean traditional paper with balsam, cabbage, and gardenia is performed.	Structures of plants
7	Korean music and science	The properties of sound are introduced using the gayageum, a traditional Korean string instrument. A demonstration on how to make a simple string instrument using a small box available at home, a rubber band, and wooden chopsticks or pencils is then performed.	Properties of sound
8	Is black really black?	A Korean non-smudge style of ink painting called sumukwha is introduced and contrasted with chromatography, which is a method of separating mixtures. An activity involving decorating <i>hanbok</i> (Korean traditional clothes) is then done using paper napkins and water-based color pencils.	Chromatography

a Note: “Twinklothes” is a new word created by the teacher candidates to express clothing that twinkles with light.

Korean science teacher candidates were scheduled to meet American students from different grade levels through Zoom:

- (1) Online classroom presentation with American teacher candidates. As part of a college class, the Korean science teacher candidates presented their culturally responsive activities and participated in group discussions with American science teacher candidates. During the group discussions, Korean teacher candidates reviewed their presentations and exchanged ideas about how American teacher candidates could implement those activities into American classrooms.
- (2) Online classroom presentation with American students in Grade 4. The eight groups of Korean teacher candidates introduced their culturally responsive science activities to American students in Grade 4 as a whole class for two class hours. The American students in Grade 4 were the appropriate grade level for the Korean teacher candidates to discuss Korean cultural items and practices in English. The Korean teacher candidates met the American students through Zoom and provided hands-on activities with the materials to teach the science concepts related to Korean cultural items and practices.
- (3) VOICE with students and their parents at two American elementary schools. As the final performance, the Korean teacher candidates presented their different culturally responsive science activities to American students and their parents at two elementary schools. This lasted for 60 minutes. Each activity was repeated every 15 minutes, a total of 4 times. The eight different culturally responsive science activities were posted by using Padlet. The students and their parents were informed in advance about the Padlet site and visited each of the activities through a Zoom link provided from the Padlet site.

Three consecutive VOICE series provided the Korean science teacher candidates opportunities to repeatedly practice the culturally responsive science activities and understand American culture and the American education system by interacting with American students and their parents and teachers at various levels.

3.3 *The Procedure of the Study*

This study proceeded based on three steps (shown in Table 2): collaborating, designing, and performing. For collaborating internationally, the research team, which was composed of researchers from both America and Korea, recruited participating teacher candidates in Korea, contacted seminar speakers in different countries to discuss teaching science around the world, and contacted American schools where the VOICE program could be performed.

For designing culturally responsive science activities during the pandemic, the Korean teacher candidates attended four seminars. First, a biology teacher from America introduced various topics of the American education system, including three types of schools (public, private, and charter), testing, and college preparation. He also explained the teacher preparation process and professional development for in-service teachers and brought up some challenges in America's curriculum reform. Since he had stayed in Korea for a year to study the Korean educational system, he could effectively compare American education cultures with Korean ones. Second, a physics teacher from Hong Kong was invited. He was a well-known teacher who had been implementing inquiry-based teaching for years. He started his talk by introducing the general school and classroom atmosphere in Hong Kong. He also explained education systems and recent reform movements such as STEM, ICT, and e-learning. Then, he introduced various inquiry physics activities that he had done with his students. Third, an Indonesian science teacher was invited to explain current educational reforms in Indonesia. She introduced Rumah Belajar (see <https://belajar.kemdikbud.go.id/>), a learning portal that provides learning materials and communication facilities. She explained how they had been utilizing the portal during the COVID-19 situation and how it facilitated student learning. She also described newly adapted teaching strategies such as flipped learning and synchronous and asynchronous online teaching. Last, a professor in the field of science education in the United States (the first author of the present study) introduced how to integrate culture into teaching science. We believe that the seminars provided the teacher candidates opportunities to understand how three countries have adopted different historical and cultural approaches in their education and produced different outcomes and why we need to consider the issues of diversity in science teaching.

The teacher candidates understood the relationships between science education, multiculturalism, and online learning, which enabled them to develop their own culturally responsive science activities for VOICE. After participating in the series of seminars, the teacher candidates had 2 weeks to develop and practice their culturally responsive science activities and place them on the VOICE site created by Padlet (see <https://padlet.com/hyunju25/ejiam1s8bjtpnuha>).

For performing the culturally responsive science activities, each group of teacher candidates engaged in the VOICE series held in America by creating a Zoom link where the Korean teacher candidates could meet the American visitors during the VOICE program. During the final VOICE, each activity lasted 15 minutes. Before the teacher candidates participated in the series of seminars and after they performed the final VOICE, they were asked to take pre- and post-survey tests for the study.

TABLE 2 The procedure of the VOICE program

Topic		Explanation	Time
Collaborating		Recruited participants in Korea and speaker contacts internationally	1 month
Designing	Science teaching in the United States	Invited lecture of a biology teacher on the U.S. science education system and policies (e.g., school types, evaluation systems, teacher preparation) and science teaching strategies	2 hours
	Science teaching in Hong Kong	Invited lecture of a high school physics teacher on Hong Kong's education system, policies, and the current emphasis on science teaching (e.g., inquiry-based experiments, ICT use, STEAM).	2 hours
	Science teaching in Indonesia	Invited lecture of a middle school teacher on the Indonesian science curriculum, online teaching and learning platform, and new teaching strategies (e.g., flipped learning)	2 hours
	Theory of culturally responsive science teaching	Invited lecture on what culturally responsive science teaching means and why science teachers should be sensitive to cultural diversity. Discussion with preservice teachers in the United States on the topic of culturally responsive teaching.	2 hours
	Designing practice	Group work to design lessons integrating science with Korean cultural items and practices	4 hours + mentoring
	Microteaching	Microteaching of the lesson plans	4 hours

TABLE 2 The procedure of the VOICE program (*cont.*)

Topic		Explanation	Time
Performing	Presenting and discussing with American teacher candidates	Presentation and discussion with American teacher candidates through Zoom	2 hours
	Teaching in elementary school classrooms	Implementation of lesson plans for elementary school students (fifth graders in the United States) through Google Meet (20 minutes for each lesson)	4 hours
	Organizing VOICES	Online demonstration of their lessons for elementary students and their parents through Zoom	2 hours

3.4 *Data Collection and Analysis*

This study employed mixed methods to explore the effects of the VOICE program on Korean science teacher candidates. The quantitative data were collected through pre- and post-surveys, and qualitative data included their journals reflecting on each step of the program.

3.4.1 Instruments

We used four questionnaires to measure the effects of the VOICE program: personal science teaching efficacy belief, competency in teaching science with cultural sensitivity, personal interest in science, and the Cultural Intelligence Scale (see Appendix). There were 42 items in the questionnaire, and all the items used 5-point Likert scales, using ratings from 1, *strongly disagree*, to 5, *strongly agree*, and from 1, *not very good*, to 5, *very good*.

To measure personal science teaching efficacy beliefs, we used Science Teaching Efficacy Belief Instrument Form B (STEBI-B; Enochs & Riggs, 1990). STEBI-B consists of two sub-scales: personal science teaching efficacy belief (PSTEB) and science teaching outcome expectancy (STOE). This study only used the PSTEB scale because it better emphasized to what extent teacher candidates perceived themselves as confident in science teaching after the program. The PSTEB scale includes 13 5-point Likert scale items, ranging from 1, *strongly disagree*, to 5, *strongly agree*. Some items were negatively stated and so reversely coded. For competency in teaching science with cultural sensitivity,

we created items based on the concept of teaching competency suggested by Danielson (2007) and Kang et al. (2020). Such literature listed indicators of teaching competency, but they were not bound to culturally responsive science teaching. Thus, we created 10 Likert scale items that included major components through continuous discussion among the researchers. We also measured personal interest in science because we wondered if the experience of culturally responsive teaching in VOICE would also increase the teacher candidates' interest in the subject matter. The questionnaire was modified from Adams et al.'s (2006) study. There were changes in words from the original survey questions. There was a total of six items in the test, and all of the questions were designed to support participants' personal interest in science. Higher scores mean that the participating teacher candidates are likely to improve personal interest in science, develop positive attitudes toward science, and promote the self-concept of ability. Lower scores tend to mean that teacher candidates do not like science, push away from building a science identity, have role confusion, and do not adopt their identities positively. Last, for cultural intelligence we used the Cultural Intelligence Scale (CQS) (Gozzoli & Gazzaroli, 2018; Van Dyne, et al., 2012). CQS has four dimensions, but in this study, we only used three dimensions and did not include CQ-cognitive. While CQ-cognitive is a very important dimension, the VOICE program did not explicitly emphasize understanding aspects of American culture such as economic systems, rules, religious beliefs, marriage system, or arts and crafts, which CQ-cognitive examines. Table 3 shows information about the questionnaires. We conducted a dependent *t*-test and correlation analysis using the data and did a descriptive analysis.

TABLE 3 Questionnaires in the study

Factors	No. of items	Cronbach α
PSTEB	13	.779
CTS-CS	10	.896
PIS	6	.799
CQ	13	.911

Note: PSTEB: personal science teaching efficacy belief; CTS-CS: competency in teaching science with cultural sensitivity; PIS: personal interest in science; CQ: cultural intelligence

3.4.2 Qualitative Data

We also collected reflection journals from the teacher candidates. The teacher candidates were required to fill in the journals from the beginning to the end of the program at each step of the program, such as the presentations of the international speakers, group work in developing culturally responsive science lessons, microteaching of lessons, and performance with the American teacher candidates and students. At the end of the program, the teacher candidates submitted their journals to the program researchers. We also collected all the materials they developed including lesson plans and presentation slides.

For analysis, we carefully read their journals and tried to examine what they felt and learned as they designed and implemented culturally responsive science lessons themselves or observed peers' lessons in the VOICE program. We inductively coded meaningful passages that showed changes in their understanding, confidence, and competency in culturally responsive teaching and their reflection. Then we iteratively evaluated whether the codes were pervasive and dominant in the journals of teacher candidates in order to avoid our bias on the effects of the program. We selected representative passages through continuous discussions and used them to show consistencies and discrepancies, if any, with the quantitative results (Greene, 2007). This process also contributed to increasing the credibility of the study (Lincoln & Guba, 1985).

4 Results

After participating in the program, the science teacher candidates' personal science teaching efficacy belief (PSTEB), competency in teaching science with cultural sensitivity (CTS-CS), personal interest in science (PIS), and cultural intelligence (CQ) all showed statistically significant improvement ($p < .001$). As shown in Table 4, the significant effects were more dominant in CQ and CTS-CS respectively ($d_{CQ} = 1.441$, $d_{CTS-CS} = 1.058$). Such results well represented the main characteristics of the VOICE program integrating science content with cultural elements. Responses of teacher candidates to all questionnaire items are presented in Appendices A–D.

TABLE 4 Comparison of pre- and post-test

Factors	Pre-test		Post-test		<i>t</i>	<i>p</i>	Cohen's <i>d</i>
	M	SD	M	SD			
PSTEB	3.58	0.379	3.92	0.561	5.062	.000	0.895
CTS-CS	4.00	0.414	4.58	0.467	5.985	.000	1.058
PIS	4.12	0.514	4.58	0.434	4.111	.000	0.727
CQ	3.72	0.519	4.46	0.512	8.152	.000	1.441

Note: PSTEB: personal science teaching efficacy belief, CTS-CS: competency in teaching science with cultural sensitivity, PIS: personal interest in science, CQ: cultural intelligence

4.1 *Effects of the Program on Teacher Candidates' Personal Science Teaching Efficacy Belief (PSTEB)*

Regarding the responses to the PSTEB items, the mean score of Q3 (“I know the steps necessary to teach science concepts effectively”) improved the most among the 13 items, meaning that participants felt more confident in completing important steps to effectively teach science concepts after the program. During the program, the teacher candidates spent quite a large amount of time and effort to come up with ideas to develop lessons appropriate for elementary school students in America. Since they were not familiar with the curriculum, classroom atmosphere, and characteristics of students in America, they kept considering whether their lessons would be appropriate for students from different cultures. The following reflections showed their efforts.

While preparing the lesson, we worried if they could understand terms like “centrifugal force” and “centripetal force.” So, we changed the terms to “inner force” and “outer force” to help their understanding. And we decided to introduce *Doctor Strange* [an American superhero film] to attract their attention and to compare the scene in the video [circular shape of flame] with Jwibulnori. We knew that kids usually cannot concentrate for very long, and so we tried to make various changes in the class.

TEACHER CANDIDATE 2

We seriously thought about how to explain the concept of fermentation using kimchi as a context. We wondered at what level we should explain

the fermentation to American students.... I thought that it would be most important for me to not form their misconceptions in this process, so I kept thinking about how to make a simple explanation at the elementary school level.... We conducted the class in such a way that after the students observed phenomena, they were curious about the scientific principles contained therein and could understand the principles in detail. So, we added an activity of finding and comparing fermented foods familiar to them, like cheese or yogurt, with Korean kimchi.

TEACHER CANDIDATE 17

The Korean teacher candidates admitted that they were not well aware of school cultures and curriculum in America and tried to come up with various teaching approaches to meet students' achievement levels and interest in science. For instance, they changed terms (e.g., "centripetal force" and "centrifugal force") into easier ones (e.g., "inner force" and "outer force") or prepared more attractive materials, such as video clips from the movie *Doctor Strange* and example pictures of fermented food in America. Their efforts to prepare well for the expected difficulties contributed to a better understanding of the process of systematically planning lessons.

One major barrier that caused teacher candidates to feel burdened was their lack of English proficiency. While preparing for classes, they were concerned that they might not fully understand the meaning of students' questions in class or that they might not be able to provide faithful answers due to their language barrier. In addition, since they were not familiar with teaching their lessons through Google Meet, their concerns were even greater. However, the responses to Q8 and Q12 ("I will typically be able to answer students' science questions" and "When teaching science, I will usually welcome student questions," respectively) show that they gained the confidence to overcome these difficulties as they proceeded.

We organized the class by revising several times, from deciding on the cultural topic to considering the curriculum of the target grade, stimulating student interest, meeting the level of terminology, generating questions, and so on. Since English is not my native language, it took a lot of effort to prepare. But I think it was a good opportunity for me to learn about American culture. Also, I was surprised and stimulated by the fluency of English of the classmates who participated. I'm usually good at giving presentations and giving opinions, but I felt that I could not open my mouth in class. It became a good motivation for studying English.

TEACHER CANDIDATE 25

[Before the program] I lacked confidence in teaching someone, and I also felt pressure to speak English. I also found it difficult to consider the cultural aspect. However, as I set the topic of dalgona with the members and prepared for the class, a positive expectation for the class arose in me.... When I finished my first class at B Elementary School, all my hard memories were wiped out as soon as I saw the students' thumbs up, laughter, and applause.

TEACHER CANDIDATE 6

As shown above, Korean teacher candidates overcame their barriers and fears to some extent by receiving positive feedback from their students and experiencing a sense of accomplishment. Although the process of preparing for the class was difficult, they felt a large sense of accomplishment and the experience generated new motivation to take on further challenges.

4.2 *Effects of the Program on Teacher Candidates' Competency in Teaching Science with Cultural Sensitivity (CTS-CS)*

Among the responses to the 10 CTS-CS items, the mean score of Q16 ("I can effectively teach science to students from different cultures") increased the most. Q16 is tightly connected with the goal of the program. After the program, Korean teacher candidates became more confident that they could effectively teach science to students from different cultural backgrounds. Although they lacked understanding of the curriculum and cultures in America, they demonstrated science concepts by comparing something familiar in American culture with something from Korean culture so that the students could immerse themselves in the class. The following excerpts show their efforts.

We introduced the conduction of heat with the theme of ondol ... Before teaching about ondol, I first introduced heat and had time for them to observe that the heat of hot water is transferred to the cup using Zion stickers [temperature indicator labels that change color to indicate temperature changes]. And we moved to compare ondol with fireplaces, which are traditional heating facilities in the United States. Then, the structure of the ondol was dealt with in a little more detail along with the fact that the ondol was located under the floor and the fire was outside the room.

TEACHER CANDIDATE 10

We thought that the way to communicate with multicultural students is to compare each other's cultures. For example, in the class where we

met pre-service teachers in the United States, they heard our class idea and asked what dalgona tasted like and what kind of American sweets it was similar to. Inspired by this, my group also decided to ask students which sweets are the most popular in the United States. I think we were able to understand each other's cultures better in the process of talking with students about culturally different aspects of the same topic.

TEACHER CANDIDATE 8

The excerpts above showed that teacher candidates made efforts to help the American students understand science concepts by comparing objects (i.e., ondol vs. fireplaces, dalgona vs. American sweets). When introducing the gayageum (Korean traditional string instrument), they presented a harp or guitar that they could recognize, and also introduced a photo of the White House when presenting Gyeongbok Palace. Simply knowing the heating system or sweets in each other country did not necessarily mean that they became aware of other cultures. However, the teacher candidates at least recognized that introducing only items from Korean culture to the students might not be enough to build a common feeling of sharing cultures. The teacher candidates may have been able to cultivate their CTS-CS in the process of not simply introducing the culture to which they belonged, but also by trying to understand and share other cultures.

Other items presenting a large increase were Q14 and Q15. On the pre-test, Q14, Q15, and Q16 ("I can design science lessons considering cultural diversity," "I can implement science lessons considering cultural diversity," and "I can effectively teach science to students from different cultures," respectively), which asked about participants' confidence in designing and implementing science classes that consider cultural diversity, had lower mean scores compared to other item scores in CTS-CS ($M_{14} = 3.75$, $M_{15} = 3.75$, $M_{16} = 3.56$ respectively). However, after the program, the teacher candidates answered positively and reported that they had gained confidence in planning and enacting classes for students with diverse backgrounds. The teacher candidates looked for activities they could do with their students across cultural barriers. Representative examples were the shadow play with the media façade of Gyeongbok Palace, and the decoration of *hanbok* (Korean traditional clothes) using chromatography. They envisioned activities that the students could actively participate in while being familiar with Korean cultural items and practices. In the class, as shown in Figure 1, the students followed teacher candidates to make various animal shadows by hand, drew hanbok on kitchen towels, and decorated them using the spreading properties of water-based pens.

FIGURE 1 Media façade of Gyeongbok Palace and decoration of hanbok

Our group prepared a science class on the media façade of Gyeongbok Palace. First, we drew students' interest with a video on the media façade of Gyeongbok Palace and explained the composition of light and the nature of light. Then students made animal shadows with their own hands. It is a kind of STEM model.... We put a lot of effort into weaving our class and the reaction of the students into one. We tried a lot to interact with the students by giving them a lot of compliments and calling them by name to help them focus.

TEACHER CANDIDATE 13

We wanted to prepare a student-centered class, so we tried to organize the activities [decorating hanbok] to make them as easy and fun as possible. The students were so immersed in the activity, and so I wondered if they listened to the related science as well.... I was really happy to see the

students enjoying the lessons we prepared so much. On the other hand, I thought about how to make sure the students were able to learn science concepts in a fun enough way.

TEACHER CANDIDATE 31

The teacher candidates felt confident in planning and executing science classes that considered cultural diversity as they watched the students actively participate as planned. In addition, as indicated by the large mean increase of Q23 ("I believe I am a science teacher with sensitivity to cultural diversity"), teacher candidates themselves felt that they had grown into science teachers with cultural sensitivity. They also realized that it is important to design classes that consider cultural diversity as science teachers.

As time goes by, students' backgrounds in Korea will be diversifying. I realized that I might marginalize them in my class (without any intention). If you do not understand the students' cultures and teach science to the majority of Korean students, some students will be marginalized from the class. I think that students can naturally accept other cultures without much resistance if they learn science by connecting various cultures. And science can be a common language across cultures. So, by integrating science with society or cultures, successful multicultural education can be achieved.

TEACHER CANDIDATE 5

4.3 *Effects of the Program on Teacher Candidates' Personal Interest in Science (PIS) and Cultural Intelligence (CQ)*

Most of the participating teacher candidates were considering being science teachers. Thus, the mean scores on the PIS were quite high even before the program ($M_{\text{pre-PIS}} = 4.12$). Among the six items in the PIS, the mean scores of Q24 ("I think about the science I experience in everyday life") and Q26 ("I study science to learn knowledge that will be useful in my life outside of school") largely increased. Both items asked about participants' interest in the relation of science-related topics to everyday life or outside of school. In the program, teacher candidates searched for topics that could introduce Korean cultural items and practices, which means that the topics they chose were not science textbook oriented. While trying to explain science content in an everyday context, they became more interested in learning and teaching science and were more convinced that science was closely related to their life. This seems to have contributed to increasing their personal interest in science.

I really liked the process of watching other groups' presentations and giving each other feedback. I realized many things when I saw how they explained topics in surprising ways that I had never even thought of. Making the sound of the gayageum using a cell phone box, explaining heat conduction by showing a very intuitive experiment for ondol, and introducing the media façade in connection with Gyeongbok Palace to explain light were all surprising.

TEACHER CANDIDATE 32

While observing each other's lessons, teacher candidates were very impressed by a variety of topics that linked science concepts to cultures. Before participating in the program, they thought it vague to link science concepts with culture, but they saw concrete examples of how science could be connected to cultures. Such experiences increased their interest in science.

Regarding teacher candidates' responses to the 13 items of the CQ, mean scores of almost all items showed a large increase, ranging from 0.56 to 1.0 points. The teacher candidates must have felt that it was burdensome to meet foreign students and communicate with them, but it seems that these burdens were greatly reduced by actually having the experience of interacting with them. They responded that they gained confidence that they could also try changing their language or behavior to better interact with people from different cultures (Q39) and that they could get along with people from different cultures (Q35). In addition, they said that they could handle stress caused by cultural differences (Q36).

Meeting various people from overseas and learning about the educational environment in other countries, I could feel how diverse the world is and broaden my horizons. I tended to be reluctant to take on a challenge because I was afraid of having such new experiences. But now, curiosity and pleasure far outweigh the fear. I am thinking of becoming a secondary school teacher in Korea.... Through the program, I realized that teachers need to experience a wide and diverse world. Only teachers who have a sensitivity to diversity can provide a richer education to their students.

TEACHER CANDIDATE 9

Besides the experience of teaching elementary school kids, it was very special to meet and talk with American pre-service teachers in person. Being able to meet people of different nationalities but wanting the same job was a good stimulus in itself. Although it lasted a short time, I

really enjoyed being able to talk about each country's culture with them. I thought it would be nice if these meetings would not end as a one-time thing but would continue regularly.

TEACHER CANDIDATE 21

Although teacher candidates had little experience in communicating with foreigners, they highly valued the new experience of teaching foreign students in class and talking with other teacher candidates. To interact with the elementary school students, they studied and researched American culture and curriculum, and constantly pondered what it meant to speak and behave in culturally appropriate ways. So, they responded that they were a little afraid to face cultural differences at first, but they were able to overcome those fears through this program. Some students rated this experience very positively even in non-face-to-face situations.

It was around 11 pm in Korea when we taught the students. But at B Elementary School in the United States, it was around 9 am. I was amazed because teachers and students from different times, different places, and different countries were able to share learning on the same subject across borders. I believed it could be possible because of the non-face-to-face context. I thought that using these technologies, it would be possible to form a dynamic learning exchange between countries and an international network of teachers.

TEACHER CANDIDATE 7

Some of the teacher candidates felt regret that they were not able to directly visit American schools to teach students, but they expressed surprise that active exchanges could occur through non-face-to-face communication. They observed the potential of such interactions, which would help teachers better understand cultural diversity.

4.4 *Correlations among the Factors*

Table 5 shows the correlations among the four factors in the pre-test and the post-test. In both the pre-test and the post-test, CTS-CS showed a very significant correlation with PIS and CQ ($p < .01$, $p < .001$). In the post-test, it was found that the correlation coefficients became larger. In other words, this can be interpreted as teacher candidates with high levels of cultural sensitivity and interest in science tending to have high scores in competency in teaching science with cultural sensitivity. Notably, although PSTEB improved after the program, it did not show a statistically significant correlation with any factor.

TABLE 5 Correlations among factors in the pre- and post-test

		Pre-test				Post-test			
		PSTEB	CTS-CS	PIS	CQ	PSTEB	CTS-CS	PIS	CQ
Pre-test	PSTEB	1							
	CTS-CS	.298	1						
	PIS	.221	.555**	1					
	CQ	.020	.589***	.564**	1				
Post-test	PSTEB	.741***	.280	.232	.023	1			
	CTS-CS	.056	.236	-.037	.129	.071	1		
	PIS	-.065	.277	.122	.184	.112	.840***	1	
	CQ	.114	.379*	.087	.497**	.076	.711***	.705***	1

Note: PSTEB: personal science teaching efficacy belief, CTS-CS: competency in teaching science with cultural sensitivity, PIS: personal interest in science, CQ: cultural intelligence, * $p < .05$, ** $p < .01$, *** $p < .001$

TABLE 6 Correlations among the differences of factors in the pre- and post-test

	Diff-PIS	Diff-CI	Diff-PSTEB
Diff-CTS-CS	.718***	.654***	-.047
Diff-PSTEB	.059	-.017	1

Note: *** $p < .001$

An examination of the correlations between the pre-test and post-test scores of the factors showed that PSTEB had a high correlation with the two scores ($r = .741$), which indicates that pre-service science teachers with low PSTEB still scored low after the program while teachers with high PSTEB maintained high PSTEB. This can be interpreted as experience planning and executing lessons integrating science content with cultural elements helping increase PSTEB, although PSTEB was not significantly correlated with PIS and CQ. On the other hand, for the CTS-CS scores, the correlation between the pre-score and the post-score was not significant because even the science teacher candidates who had low CTS-CS before the program showed high scores after the program. In addition, as shown in Table 6, it was found that the degree of improvement of CTS-CS (difference of pre- and post-test scores in CTS-CS) had a statistically significant correlation with the degree of improvement of PIS (diff-PIS) and

CQ (diff-CQ). On the other hand, the degree of improvement of PSTEB (diff-PSTEB) had little correlation with the degree of improvement of PIS and CQ.

5 Discussion and Conclusions

The purpose of the study was to examine the effects of the online teacher education program VOICE on Korean science teacher candidates' formation of self-efficacy and their cultural competency to support and retain their science education during the COVID-19 pandemic. This study was designed to train 32 Korean teacher candidates as culturally responsive instructors who did not have a cultural bias about Korean culture and could develop and deliver science activities professionally integrated with Korean cultural items and practices. Their efficacy in teaching science, their interest in science, and their cultural competency showed that the VOICE program effectively helped them to sustain and increase their science affinities and cultural capabilities even in the difficult times of COVID-19. Their self-efficacy as science teachers, their interest in science, and their cultural proficiency changed in a statistically significant manner after they participated in the series of VOICE experiences. Also, the study found that there was a strong correlation between their competency in teaching science with cultural sensitivity, personal interest in science, and cultural intelligence.

The Korean science teacher candidates' participation in the series of VOICE seminars, designing of culturally responsive activities, and the performance of VOICE activities helped them to build their competency in teaching science with cultural sensitivity by understanding how to create culturally responsive science instruction, constructing science instruction based on their own culture, and interactively communicating with the students, teacher candidates, and teachers from another country even during the pandemic (Muniz, 2019). The major factor in their competency formation through the VOICE program was the privilege they could have as culturally responsive instructors. Because they were from Korean culture, they could be experts in Korean culture, diminishing a cultural barrier about Korea and openly explaining science concepts through Korean cultural items and practices, which sparked their interest in science and enabled them to increase their science affinities and thus teach the science concepts effectively (Briccia & Pessoa de Carvalho, 2016; OECD, 2009; Pan et al., 2018). This demonstrated a positive relationship between teacher candidates' interest in science and their science competencies. In particular, when they went through the process of integrating the culture that they are from into their lessons, they were able to shape their ideas about how to formulate their culturally responsive science instruction with

active involvement, which built their ability to teach science, or in other words, developed their voices.

The VOICE program supported the teacher candidates to develop and confirm repeatedly their abilities of cultural competency. Through the VOICE program, the Korean teacher candidates had opportunities to see themselves as both cultural professionals and science teachers who were knowledgeable about both science and culture. The interactions between the Korean teacher candidates and their learners through VOICE allowed the teacher candidates to view American students as approachable and friendly people, and to begin to understand their range of scientific understanding and their culture. The interactions with American students as cultural and scientific professionals at VOICE became a vehicle for the Korean teacher candidates to form their confidence in teaching and at the same time become accustomed to students from different cultures. The Korean teacher candidates could perceive that the American students were mostly like their students in Korea, which helped them to develop their confidence in teaching and also their cultural competencies to understand diverse students. Therefore, the VOICE program can practically help Korean teacher candidates to teach the growing minority student population at schools in Korea. The VOICE program can prepare Korean teacher candidates to meet the minority students, respect their cultures, and adapt their teaching to these cultures, which can help build an equitable learning environment for all students and close the achievement gap between the minority and the majority students in Korea.

This study provided valuable insight for educators and administrators in science on how to better retain and support teacher candidates' interests in science and at the same time increase cultural competencies that are required for multicultural science classrooms. This study attempted to bridge the knowledge and culture gap in science by involving Korean teacher candidates as culturally responsive instructors and having them actively interact with students from another country in an online setting. The Korean teacher candidates could attain their interests in science and their science identity through producing their own culturally responsive science activities and increase their confidence in teaching by having access to proper resources, information, advice, guidance, and support from the series of seminars. Also, they could cope with cultural skills by reaching out to students, teacher candidates, and teachers who were from different cultures. In this way, the science teacher candidates could further develop their interests and cultural competencies with other people living in Korea, valuing, and appreciating their cultures and languages and enhancing their academic competitiveness in science.

This study concluded that, even in the COVID-19 pandemic setting, the online teacher education program with science teacher candidates serving

as culturally responsive science instructors successfully helped them to increase and retain their interest in science, thus forming their confidence in teaching and improving their capabilities in cultural competency. It is necessary to have an online teacher education program where science teacher candidates create culturally responsive science instruction based on their own cultures and interact with students whose cultures are different from the teacher candidates'. VOICE provides opportunities to teacher candidates not only to learn science and retain their interest in science but also to support their confidence in teaching and improve their cultural competency for diverse classrooms.

6 Limitations and Implications for Future Research

This study finds that while global online meetings integrated with culturally responsive science instruction promoted science teacher candidates' ability to teach science to diverse students even from other cultures, three limitations need to be addressed by future research.

First, this study focused on the experiences of 32 female teacher candidates from Korea in the field of science education; thus, the findings are limited to this defined population of teacher candidates. Future research may seek to further explore experiences from a more diverse population of teacher candidates who can lower their cultural bias and barrier and develop their own voices in teaching science so that the results can be generalized regarding learning and teaching culturally responsive instruction and how this supports science affinities and cultural competency in online environments during difficult times such as the COVID-19 pandemic.

Second, this study was limited to the experiences of Korean teacher candidates at one time during the pandemic. A longitudinal study of teacher candidates' experiences is recommended in order to understand changes in experiences throughout COVID-19, including how online integration of culture among teacher candidates has been changing and evolving from a long-term perspective and how their science affinities and cultural abilities have been modified after the pandemic in their practicum schools.

And finally, while this study specifically aimed to explore teacher candidates' science affinities and cultural abilities through the VOICE program, additional attention should be paid to their culturally responsive teaching competencies. Culturally responsive teaching contributes to the academic and affective development of students, and its effective implementation depends on teachers with culturally responsive teaching competencies (Karatas, 2020). Given the fact that teacher candidates in teacher education programs should

be responsive to cultural values (Karatas & Oral, 2019), it is suggested that further studies be conducted on the teacher education program to explore how teachers are expected to gain culturally responsive teaching competencies. The concept of culturally responsive teaching should be at the center of teacher education (Ellerbrock, Cruz, Vásquez, & Howes, 2016).

Abbreviations

CQ	Cultural Intelligence
CTS-CS	Competency in Teaching Science with Cultural Sensitivity
PIS	Personal Interest in Science
PSTEB	Personal Science Teaching Efficacy Belief
VOICE	Virtual and Open Integration of Culture for Education

Ethical Consideration

Approval to conduct this study was granted by the (University of Texas Arlington) Institutional Review Board (IRB). This study was approved as Minimal Risk. The data collected from this project were de-identified. The names of the school and participants used in this study are all de-identified. All images have been obscured with editing software to protect the participant privacy.

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Appendix

Responses of Korean Pre-service Science Teachers to Items

A. Responses to personal science teaching efficacy belief

Items	Pre-test		Post-test		Mean
	M	SD	M	SD	Difference
1. I will continually find better ways to teach science.	4.41	0.665	4.75	0.508	0.34
2. Even if I try very hard, I will not teach science as well as I will most subjects. (N)	3.47	0.879	3.69	1.176	0.22
3. I know the steps necessary to teach science concepts effectively.	3.66	0.653	4.50	0.622	0.84
4. I will not be very effective in monitoring science experiments. (N)	3.78	0.751	3.97	1.177	0.19
5. I will generally teach science ineffectively. (N)	3.91	0.928	4.09	1.088	0.18
6. I understand science concepts well enough to be effective in teaching science.	3.78	0.706	4.44	0.619	0.66
7. I will find it difficult to explain to students why science experiments work. (N)	3.53	0.842	3.97	1.031	0.44

A. Responses to personal science teaching efficacy belief (*cont.*)

Items	Pre-test		Post-test		Mean
	M	SD	M	SD	Difference
8. I will typically be able to answer students' science questions.	3.59	0.911	4.28	0.813	0.69
9. I wonder if I will have the necessary skills to teach science. (N)	2.28	0.888	2.69	1.424	0.41
10. Given a choice, I will not invite the principal to evaluate my science teaching. (N)	3.22	0.870	3.00	1.320	(0.22)
11. When a student has difficulty understanding a science concept, I will usually be at a loss as to how to help the student understand it better. (N)	3.38	0.871	3.13	1.621	(0.25)
12. When teaching science, I will usually welcome student questions.	3.97	0.897	4.72	0.523	0.75
13. I do not know what to do to turn students on to science. (N)	3.56	0.759	3.72	1.250	0.16

Note. The items with (N) had negative connotations and so were reverse coded.

B. Responses to competency in teaching science with cultural sensitivity

Items	Pre-test		Post-test		Mean
	M	SD	M	SD	Difference
14. I can design science lessons considering cultural diversity.	3.75	0.842	4.56	0.564	0.81
15. I can implement science lessons considering cultural diversity.	3.75	0.672	4.56	0.564	0.81
16. I can effectively teach science to students from different cultures.	3.56	0.759	4.53	0.671	0.97
17. As a science teacher, I can respect the cultural diversity of my students.	4.47	0.621	4.81	0.397	0.34
18. I believe that science lessons considering cultural diversity need to be provided to my students.	4.44	0.564	4.81	0.397	0.37

B. Responses to competency in teaching science with cultural sensitivity (*cont.*)

Items	Pre-test		Post-test		Mean
	M	SD	M	SD	Difference
19. I believe that the way students learn science can be different depending on their cultures.	4.22	0.608	4.44	0.840	0.22
20. I believe that science contents that students learn in science classes can be different depending on their cultures.	4.03	0.695	4.44	0.914	0.41
21. I believe that science is a kind of cultural product of human endeavor.	3.97	0.647	4.53	0.671	0.56
22. I believe that science teachers need to include cultural elements when teaching science.	4.03	0.695	4.59	0.615	0.56
23. I believe I am a science teacher with sensitivity to cultural diversity.	3.81	0.780	4.53	0.671	0.72

C. Responses to personal interest in science

Items	Pre-test		Post-test		Mean
	M	SD	M	SD	Difference
24. I think about the science I experience in everyday life.	4.09	0.893	4.69	0.535	0.60
25. I am not satisfied until I understand why something works the way it does.	4.09	0.466	4.25	0.950	0.16
26. I study science to learn knowledge that will be useful in my life outside of school.	3.84	0.884	4.66	0.483	0.82
27. I enjoy solving science problems.	4.16	0.628	4.53	0.567	0.37
28. Learning science changes my ideas about how the world works.	4.28	0.634	4.66	0.483	0.38
29. Reasoning skills used to understand science can be useful in my everyday life.	4.25	0.718	4.69	0.535	0.44

D. Responses to cultural intelligence

Items	Pre-test		Post-test		Mean
	M	SD	M	SD	Difference
30. I am conscious of the cultural knowledge I use when interacting with people with different cultural backgrounds.	3.88	0.707	4.44	0.619	0.56
31. I adjust my cultural knowledge as I interact with people from a culture that is unfamiliar to me.	3.81	0.738	4.47	0.879	0.66
32. I am conscious of the cultural knowledge I apply to cross-cultural interactions.	3.72	0.683	4.41	0.798	0.69
33. I check the accuracy of my cultural knowledge as I interact with people from different cultures.	3.84	0.767	4.50	0.622	0.66
34. I enjoy interacting with people from different cultures.	3.91	0.856	4.69	0.592	0.78
35. I am confident that I can socialize with locals in a culture that is unfamiliar to me.	3.53	0.879	4.47	0.761	0.94
36. I am sure I can deal with the stresses of adjusting to a culture that is new to me.	3.75	0.672	4.56	0.669	0.81
37. I enjoy living in cultures that are unfamiliar to me.	3.44	0.948	4.19	0.896	0.75
38. I am confident that I can get accustomed to the shopping conditions in a different culture.	3.69	0.780	4.41	0.712	0.72
39. I change my verbal behavior (e.g., accent, tone) when a cross-cultural interaction requires it.	3.53	0.983	4.53	0.718	1.00
40. I use pause and silence differently to suit different cross-cultural situations.	3.56	0.914	4.25	0.950	0.69

D. Responses to cultural intelligence (*cont.*)

Items	Pre-test		Post-test		Mean
	M	SD	M	SD	Difference
41. I vary the rate of my speaking when a cross-cultural situation requires it.	3.72	0.851	4.53	0.621	0.81
42. I change my non-verbal behavior when a cross-cultural interaction requires it.	3.97	0.695	4.59	0.615	0.62

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