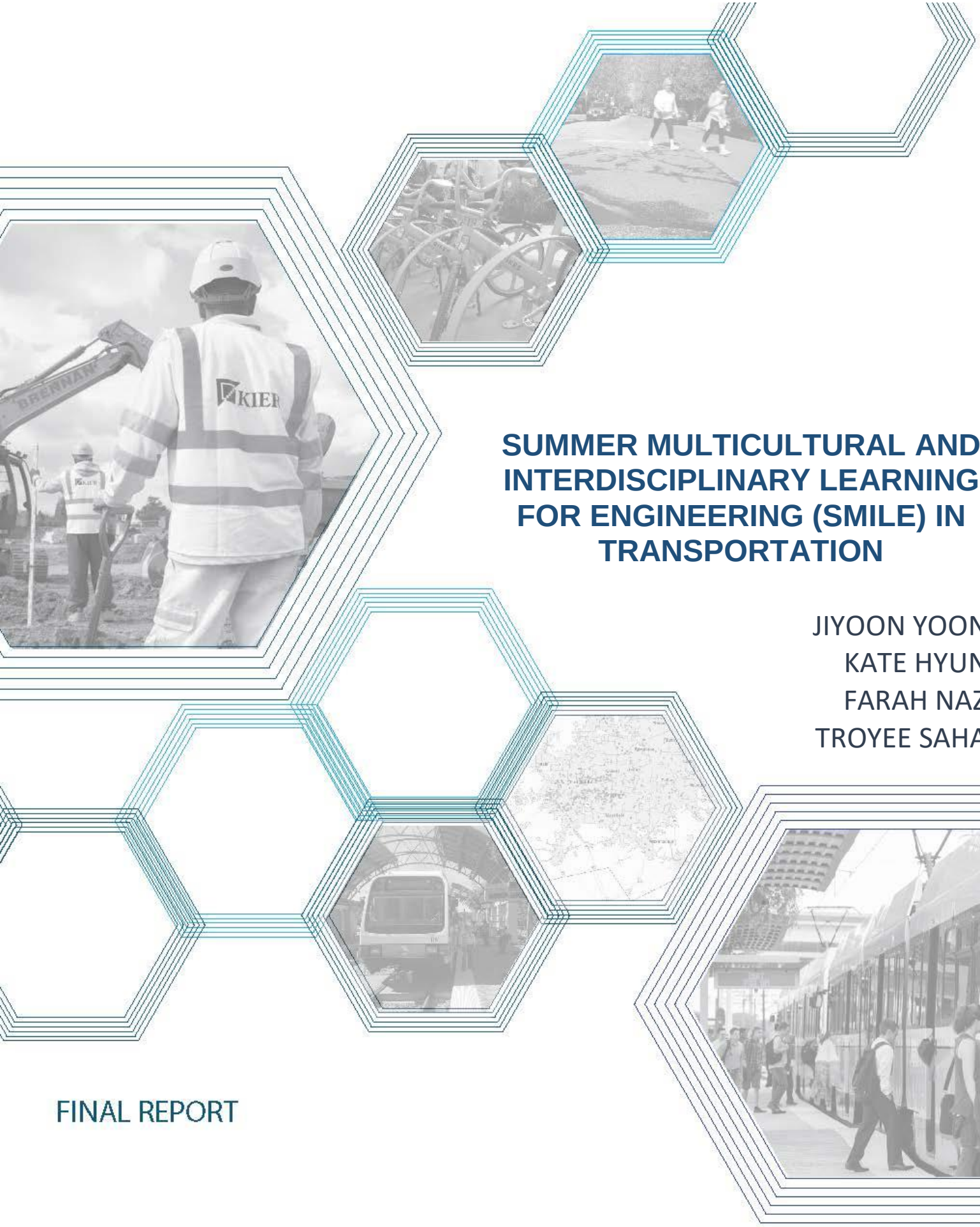

SUMMER MULTICULTURAL AND INTERDISCIPLINARY LEARNING FOR ENGINEERING (SMILE) IN TRANSPORTATION

JIYOON YOON
KATE HYUN
FARAH NAZ
TROYEE SAHA

FINAL REPORT

CENTER FOR TRANSPORTATION EQUITY, DECISIONS & DOLLARS

SUMMER MULTICULTURAL AND INTERDISCIPLINARY LEARNING FOR ENGINEERING (SMILE) IN TRANSPORTATION: PROFESSIONAL DEVELOPMENT FOR SCIENCE TEACHERS OF CULTURALLY AND LINGUISTICALLY DIVERSE STUDENTS

FINAL PROJECT REPORT

By:

JIYOON YOON
KATE HYUN
FARAH NAZ
TROYEE SAHA
UNIVERSITY OF TEXAS ARLINGTON

Sponsorship:
CTEDD

For:
Center for Transportation, Equity, Decisions and Dollars **(CTEDD)**
USDOT University Transportation Center
The University of Texas at Arlington
Woolf Hall, Suite 325

Acknowledgments

This work was supported by a grant from the Center for Transportation Equity, Decisions, and Dollars (CTEDD) funded by U.S. Department of Transportation Research and Innovative Technology Administration (OST-R) and housed at The University of Texas at Arlington.

Disclaimer

Technical Report Documentation Page

1. Report No. CTEDD 021-12	**2. Government Accession No.**	**3. Recipient's Catalog No.**
4. Title and Subtitle		**5. Report Date: 9/2/2023** **6. Performing Organization Code**
7. Author(s) Jiyoon Yoon, https://orcid.org/0000-0002-1268-5604 Kate Hyun, Farah Naz, Troyee Saha,		**8. Performing Organization Report No.** I
9. Performing Organization Name and Address University of Texas Arlington 502 Yates Street, BOX19777, Arlington 76019		**10. Work Unit No. (TRAIS)** **11. Contract or Grant No.** USDOT - 69A3551747134
12. Sponsoring Organization Name and Address Center for Transportation, Equity, Decisions and Dollars (CTEDD) USDOT University Transportation Center The University of Texas at Arlington Woolf Hall, Suite 325 Arlington TX 76019 United States		**13. Type of Report and Period Covered** Final Report **14. Sponsoring Agency Code**

15. Supplementary Notes

Additional project information is available at https://padlet.com/jiyoonyoon/smile-in-transportation-x1yj2fm8bedajr3f. Project performed under a grant from the U.S. Department of Transportation's University Transportation Centers (UTC) Program.

16. Abstract

This study aimed to provide an online professional development opportunity called "Summer Multicultural and Interdisciplinary Learning for Engineering (SMILE) in Transportation." Its purpose was to enhance the knowledge and skills of future elementary STEM teachers and the engineering workforce while assessing the impact on participants. With the increasing diversity among student populations, schools encounter significant challenges in delivering effective instruction on transportation, especially to minority students who speak English as a second language. SMILE in Transportation offered future science teachers and engineering students the chance to engage with cultural professionals specializing in transportation. These professionals possessed expertise in transportation and also brought their unique cultural backgrounds, allowing them to present transportation systems through the lens of their respective cultures. The involvement of interdisciplinary professionals in transportation extended beyond the college campus to include experts from the communities. The primary goal of SMILE in Transportation was to expand the knowledge of future science teachers and the engineering workforce in transportation. Additionally, it aimed to develop a distinctive teaching methodology that integrates the backgrounds of culturally and linguistically diverse students into the process of teaching and learning transportation engineering. To evaluate the program's effectiveness, data was collected through pre- and post-surveys administered to participating future teachers. These surveys measured science affinities, cultural competency (including teaching efficacy, cultural competency, personal interest, and cultural IQ), and science knowledge tests. Furthermore, a qualitative survey was conducted at the end of the project to gather feedback that would help enhance future teachers' understanding of transportation and other cultures. This data was also utilized to improve the SMILE workshop for subsequent sessions. A comparison was drawn between the survey results of future teachers and engineering students to assess the effectiveness of culturally responsive instructions for diverse student populations in classrooms. In summary, this study designed and implemented the SMILE in Transportation program to provide professional development for future STEM teachers and the engineering workforce. By incorporating cultural professionals and emphasizing culturally responsive instructions, the program aimed to enhance participants' knowledge of transportation and diverse cultures. The data collected from the quantitative surveys and qualitative feedback contributed to refining the program and improving future teaching practices in transportation education.

17. Key Words Transportation, Multicultural, culturally and linguistically diverse students, interdisciplinary, professional development.		**18. Distribution Statement** No restrictions. This document is available to the public through the Transport Research International Documentation (TRID) repository.	
19. Security Classification (of this report) Unclassified.	**20. Security Classification (of this page)** Unclassified.	**21. No. of Pages** 34	**22. Price** N/A

Table of Contents

Chapter I

Chapter II

Abstract

This study aimed to provide an online professional development opportunity called "Summer Multicultural and Interdisciplinary Learning for Engineering (SMILE) in Transportation." Its purpose was to enhance the knowledge and skills of future elementary STEM teachers and the engineering workforce while assessing the impact on participants. With the increasing diversity among student populations, schools encounter significant challenges in delivering effective instruction on transportation, especially to minority students who speak English as a second language. SMILE in Transportation offered future science teachers and engineering students the chance to engage with cultural professionals specializing in transportation. These professionals possessed expertise in transportation and also brought their unique cultural backgrounds, allowing them to present transportation systems through the lens of their respective cultures. The involvement of interdisciplinary professionals in transportation extended beyond the college campus to include experts from the communities. The primary goal of SMILE in Transportation was to expand the knowledge of future science teachers and the engineering workforce in transportation. Additionally, it aimed to develop a distinctive teaching methodology that integrates the backgrounds of culturally and linguistically diverse students into the process of teaching and learning transportation engineering. To evaluate the program's effectiveness, data was collected through pre- and post-surveys administered to participating future teachers. These surveys measured science affinities, cultural competency (including teaching efficacy, cultural competency, personal interest, and cultural IQ), and science knowledge tests. Furthermore, a qualitative survey was conducted at the end of the project to gather feedback that would help enhance future teachers' understanding of transportation and other cultures. This data was also utilized to improve the SMILE workshop for subsequent sessions. A comparison was drawn between the survey results of future teachers and engineering students to assess the effectiveness of culturally responsive instructions for diverse student populations in classrooms. In summary, this study designed and implemented the SMILE in Transportation program to provide professional development for future STEM teachers and the engineering workforce. By incorporating cultural professionals and emphasizing culturally responsive instructions, the program aimed to enhance participants' knowledge of transportation and diverse cultures. The data collected from the quantitative surveys and qualitative feedback contributed to refining the program and improving future teaching practices in transportation education.

Chapter I:

INTRODUCTION

As the student population has become increasingly diverse and ethnic minority students have demonstrated difficulties in meeting academic expectations in STEM science, schools are facing significant challenges in effectively delivering science instruction to close the achievement gap (Colby & Ortman, 2015; Franklin, et al., 2014; Wilson, 2014). School teachers pay attention to creating a learning environment that is engaging and accessible to a broader range of students. Minority students in the U.S. are continuously experiencing isolated and inequitable learning in schools (Darling-Hammond, 2001), resulting in failing schools. According to the studies of NAEP (NCES, 2011) and TIMSS (Gonzales et al., 2009), the achievement gap in science that starts as early as elementary schools become increasingly more comprehensive in higher education (Chapin, 2006). The ethnic minority students' performance lags behind that of white students, and the gap has widened in math and science areas.

The persistence of unequal educational outcomes among ethnic minority groups can be removed by enhancing teachers' abilities. Research has continuously demonstrated that minority students need to be situated within their diverse, daily experiences (William, 2011; Quian, et. al., 2017; Theobald, E. J., et. al., 2020), which makes them feel more personally meaningful, increase their interest positively, and learn more easily and thoroughly (Hurtado, et al., 2009; Baurhoo & Asghar, 2014). The culturally-responsive instructions enable the teachers to resolve potential cultural differences among students in the classroom and create an equal learning environment for all the students, including the minority students. However, to see this change occur, a dramatic shift in the confidence in teaching diverse students, cultural competencies, and science affinities (personal interest and efficacy) is required from teachers in classrooms (Ladson-Billings, 2014).

LITERATURE REVIEW

To enhance the ethnic minority students' learning opportunities, teachers connect the minority students' cultural knowledge to academic knowledge, which helps the students extend their learning to academic concepts (Gay, 2000; Kozleski, 2010). School teachers in diverse classrooms must gain knowledge of the cultures represented in their classrooms and link this knowledge to their teaching, which helps them to transform their own cultural biases and preferences for communicating with ethnic minority students and their learning. Therefore, culturally responsive teaching engages and sustains student participation and achievement in science classrooms.

A. Culturally Responsive Instruction

Culturally responsive Instruction (CRI) gets students from non-dominant cultures engaged in demonstrating their proficiencies in their languages and culture from their everyday lives. CRI translates the logical structures of their culture and languages onto the school curriculum, which helps the students experience intellectual growth as a result of an interaction. The students successfully achieve when their strengths are nurtured and connected to new knowledge. It is essential to recognize the minority students' culture and their home languages for minority students' learning (Ladson-Billings, 2014).

B. Scientific Affinities

This study utilized scientific affinities, including identity formation theory, self-efficacy theory, and growth mindset theory, to measure the effects of CRI on future science teachers. Identity theory explains how future teachers develop long-lasting science identities and mix them with their self-concepts, increasing their possession of Transportation (Herman, 2011). Self-efficacy theory presents their confidence in their abilities through mastery, vicarious, modeling, and emotional and hands-on experiences (Chowdhury, 2016). Growth Mindset research supports that future teachers become mature and foster mental resilience when they face challenging tasks (Dweck, 2015). Teachers with strong science identities and self-efficacy were more likely to seek out positive experiences in science, which cultivates their mindsets. This SMILE study was designed to get future teachers involved in building their identities, improving self-efficacy, and thus growing their mindsets in Transportation by integrating cultures in teaching Transportation.

C. Integration of Culture for Scientific Affinities

Education research strongly indicates that combining culture and science motivates and engages students in learning complex concepts and closing their achievement gaps in science areas (Gay, 2000). The culture in this proposal means all the ways for living, including food, arts, music, traditional games, dance, housing, geography, politics, education, and so on. CRI is a pedagogy that allows teachers to close the cultural gap in classrooms and have their students from non-dominant cultures leverage their proficiencies in their languages and culture from their everyday lives and translate the logical structures of their personal identity into the school curriculum (Kozleski, 2010). This cultural interaction forms essential factors in their mental growth, including identity, self-efficacy, and mindset (Ladson-Billings, 2014). Therefore, teachers must have the ability to connect minority students' cultures to academic knowledge for minority students' learning opportunities. This enables the students to become successful when their strengths are nurtured and connected to new knowledge. Their culture and home languages must be recognized as essential instructional elements.

D. Purpose of the Study

This study sought to explore the effects of the SMILE in Transportation using a CRI approach on future science teachers' knowledge of Transportation, science affinities, and cultural competency. The study was conducted based on the following research questions:

1) *Does the SMILE in Transportation help future science teachers to increase their knowledge in Transportation?*
2) *Does the SMILE in Transportation improve their affinities in Transportation?*
3) *Does the SMILE in Transportation promote their cultural competency?*

METHODS

A. Participants

The Participants of the project are nine future science teachers with the age range of 18 to 24 years old (56%), 25 to 34 years old (33%), and 35 years and older (11%), mostly female (89%), and the ethnicity of White (44%), Asian (22%), and Black (11%). They are the juniors enrolled in a science method course in the teacher license program. Half of the participants had been enrolled in the current teacher license program for one year (44%), 2 years (22%), 3 years (22%),

and more than 3 years (11%). Table 1 summarizes the demographic information of the participants.

TABLE 1
DEMOGRAPHIC INFORMATION OF THE PARTICIPANTS

Demographic Components	Sub-categories	Percentages
Age	18-24 Years Old	56% (5)
	25-34 Years Old	33% (3)
	35 Years and Older	11% (1)
Gender	Male	11% (1)
	Female	89% (8)
Ethnicity	Hispanic or Latino	22% (2)
	Asian	22% (2)
	Black or African American	11% (1)
	Caucasian or White	44% (4)
Race	Hispanic or Latino	22% (2)
	Not Hispanic or Latino	78% (7)
Numbers of years enrolled in the current program	1 year	44% (4)
	2 years	22% (2)
	3 years	22% (2)
	3 years and more	11% (1)

[a]Number of participants % (N=9).

B. Procedure of the Study

This study lasted for one academic year. The project team composed of two research scholars (one from science education and the other from the transportation engineering) proceeded the study following the five objectives:

1) “collaborate” by recruiting cultural professionals from the campus, city halls, local communities (cultural centers and international museums and schools) for three months, The cultural professionals were the experts in Transportation, had strong cultural knowledge, and presented transportation systems through their cultures. Korean teacher and Bangladeshi Engineers voluntarily joined this study as the cultural professionals.
2) “design” by holding a meeting with the cultural professionals and creating culturally responsive science activities based on the cultural professionals’ transportation literacy and cultures for two months,
3) “perform” by communicating between the future science teachers and the cultural professionals at the SMILE in Transportation (online workshop) for a week,
4) "produce" a representative transportation curriculum for the ethnic minority students that is integrated into the participants' school curriculums for one months, and
5) "contribute" to the advancement of knowledge in multicultural education and the subject areas of Transportation by disseminating the research and curriculum products generated through SMILE in Transportation to a broad audience of educators for six months.

C. Data Collection

Data collected for this project included both quantitative (a) science affinities: science teaching efficacy, cultural competency, personal interest, & cultural intelligence and b) modified standardized tests in Transportation) and qualitative measures (the online interview at the end of the project). Before and after the participants experienced the SMILE in Transportation with the cultural professionals, they were asked to take the pre-and the post-survey tests (quantitative measures) and an online interview at the end (qualitative measure). Table 2 shows the evaluation tools.

TABLE 2
EVALUATION TOOLS FOR DATA COLLECTION

Quantitative Data	Qualitative Data
Pre- and post-survey of science affinities & cultural competency (science teaching efficacy, cultural competency, personal interest, & cultural intelligence) Pre-and post-modified Texas standardized test in Transportation (STAAR test: State of Texas Assessment of Academic Readiness)	Interview at the end

During the workshop online sessions, the future teachers participated in multicultural and interdisciplinary discussions and activities to learn about general knowledge of transportation systems in two different countries (Korea and Bangladesh) and to experience the immigrant histories and culture, including topics in language, politics, housing, geography, and education. In the online workshop, the participants experienced mostly transportation systems and other cultures with the cultural professionals and then explored interactive and outdoor activities beyond in-class learning. The two cultural professionals who willingly collaborated for this study were 1) an elementary teacher in social studies & science from a local school and 2) a civil engineer from a university engineering lab. After the workshop, the participants reserved their times for online reading, research, or personal consultation with the project team and the cultural/transportation professionals to develop culturally- responsive instructions. At the end of the workshop, the participants created their own culturally responsive instructions and presented them at the Cultural Science Night. The learning outcomes of the workshop are: Students are able to: 1) understand Hispanic culture/history, 2) know Korean culture/history, 3) learn how to develop CRI, 4) develop CRI, and 5) perform CRI to students. Table 3 includes the workshop schedule and learning outcomes.

RESULTS

The findings are discussed in three sections: knowledge of Transportation (pre-and post-test), scientific affinities & cultural competency (pre-and post-test), and a qualitative survey at the end of the study. Nine participants completed the tests for knowledge of Transportation, scientific affinities, and cultural competency.

A. Knowledge of Transportation

The results from the modified Texas standardized test in Transportation (pre-test: M= 6.00, SD =1.32 & post-test: M =9.33, SD =0.71) indicated that the online interactions with the cultural professionals resulted in an extremely significant improvement in participants' knowledge in transportation (t=8.9443, p< 0.0001). Only nine participants took this pre-and post-knowledge test. Most of the participants increased their knowledge of Transportation after they participated in the program. Table 4 shows the results of knowledge in Transportation.

TABLE 4
RESULTS OF THE KNOWLEDGE IN TRANSPORTATION

	N	Mean	SD	Std. Error of D	t	df	P
Pre-test	9	6.00	1.32	0.373	8.94	8	0.0001[a]
Post-test	9	9.33	0.71				

[a]P<0.0001

B. Scientific Affinities & Cultural Competency

1) Teaching Efficacy

The results from the pre-test (M= 3.87, SD =0.43) and post-test (M =4.09, SD =0.47) of teaching efficacy indicated that the online interactions with the cultural professionals were not statistically significant in improving participants' teaching efficacy (t=0.917, p>0.01). Most of the participants did not show a significant increase in their

TABLE 5
RESULTS OF TEACHING EFFICACY

	N	Mean	SD	Std. Error of D	t	df	P
Pre-test	9	3.87	0.43	0.243	0.917	8	0.3858[a]
Post-test	9	4.09	0.47				

[a]P>0.01

confidence in teaching Transportation after they participated in the program. Table 5 shows the results of teaching efficacy.

2) Cultural Competency

The results from the pre-test (M= 4.00, SD =0.403) and post-test (M =4.24, SD =0.49) of cultural competency indicated that the online interactions with the cultural professionals were not statistically significant in improving participants' cultural competency (t=1.014, p>0.01). Most participants did not show a significant increase in their cultural competency after participating in the program. Table 6 shows the results of cultural competency.

TABLE 6
RESULTS OF CULTURAL COMPETENCY

	N	Mean	SD	Std. Error of D	t	df	P
Pre-test	9	4.00	0.43	0.241	1.0142	8	0.3402[a]
Post-test	9	4.24	0.49				

[a]P>0.01

3) Personal interest

The results from the pre-test (M= 3.41, SD =0.72) and post-test (M =3.76, SD =0.96) of personal interest indicated that the online interactions with the cultural professionals were not statistically significant in improving participants' personal interest (t=1.0446, p>0.01). Most participants did not show a significant increase in their Personal Interest in Transportation after participating in the program. Table 7 shows the results of personal interest.

TABLE 7
RESULTS OF PERSONAL INTEREST

	N	Mean	SD	Std. Error of D	t	df	P
Pre-test	9	3.41	0.72	0.340	1.0446	8	0.3268[a]
Post-test	9	3.76	0.96				

[a]P>0.01

4) Cultural Intelligence

The results from the pre-test (M= 3.90, SD =0.36) and post-test (M =4.05, SD =0.63) of cultural intelligence indicated that the online interactions with the cultural professionals were not statistically significant in improving participants' cultural intelligence (t=0.5283, p>0.01). Most participants did not show a significant increase in their cultural intelligence after participating in the program. Table 8 shows the results of cultural intelligence.

TABLE 8
RESULTS OF CULTURAL INTELLIGENCE

	N	Mean	SD	Std. Error of D	t	df	P
Pre-test	9	3.90	0.36	0.224	0.6591	8	0.5283[a]
Post-test	9	4.05	0.63				

[a]P>0.01

C. Qualitative Survey at the end

Eight participants in the survey shared various viewpoints on culturally responsive teaching in STEM education and transportation curriculum. Here's an analysis of their responses:

Participant 1: This participant believes that current STEM education lacks diversity and inclusivity. They highlight the need for culturally responsive science teaching and express concern that many teachers are unaware of how to include minorities, women, and people with special needs. They emphasize the importance of integrating students' cultures into science education: “In my opinion, current STEM education is not diverse and inclusive. According to some research studies, many STEM education still focuses on boys and girls didn't like to do STEM areas, so

that's why we're still encouraging culturally responsive science teaching. Many teachers, they don't know how to include, especially minorities, women, and people with special needs. They don't know their culture… So how to integrate their culture in teaching science? ... (I have) a feeling they're failing."

Participant 2: This participant acknowledges the importance of incorporating different cultures into the curriculum, considering the growing diversity of the nation. They emphasize the role of educators in this process: "I think it's important because, the diversity of our nation is growing. So, we as educators need to know how to incorporate different cultures into our curriculum."

Participant 3: This participant emphasizes the importance of creating a welcoming environment for students and eliminating bias. They highlight the need for students to feel included and comfortable in the learning environment: "I was just saying that it's important to help make sure students feel welcome and don't have any feel like they have any bias going on."

Participant 4: This participant suggests that teachers could include lessons on the contributions of women of color and other cultures in STEM fields, such as NASA. They believe that highlighting diverse role models can help attract more students to STEM subjects: "I think teachers could do more lessons on the different cultures and how Women of color or other cultures have played a big part like in NASA. For instance, they can teach lessons on that kind of diversity to draw more people towards it."

Participant 5: This participant agrees with a previous comment and suggests making lessons more realistic to help students relate and see themselves in the subject matter. They believe this would contribute to inclusivity in STEM education: "I definitely agreed with the other participant, make the lesson more realistic so all the students in the class can relate and visibly see themselves in that position."

Participant 6: This participant discusses the issue of girls feeling intimidated by STEM subjects and suggests promoting a growth mindset among students. They propose encouraging students to believe in their ability to tackle STEM activities and reinforcing the idea that they can succeed: "So, we were talking about how women are kind of women and girls, some girls in school they are kind of intimidated by STEM and you know, science engineering. And they think that they're not able to do the activities or the lessons that are provided to them. So maybe as educators we could push for, like a growth mindset, you know, tell them that they can do these things that are being presented to them."

Participant 7: This participant suggests an alternative approach in the transportation curriculum by allowing students to share their preferred modes of transportation rather than their actual experiences. This way, students can engage in a more imaginative and inclusive activity, reducing the chance of embarrassment or discomfort related to personal circumstances: "Maybe say how they would like to get to school instead of how they get to school. Because they can make something up like they could say, 'oh I would like to go in rocket ship, or I would like to go to school and a limo or an hour monster truck'. So, they don't have to share their actual personal experience and feel like if they're put on the spot or embarrassed by their current situation. It makes it more fun, and I guess more inclusive because it's more like an imaginary thing and it's a literal form of it."

Participant 8: This participant suggests asking simple questions about different modes of transportation to engage students in the discussion. By focusing on shared experiences, they believe this approach can contribute to inclusivity in the transportation curriculum: "I think you could also just ask you know who's been on a bus before, who's been in a car, who's ridden a bike? Stuff like that."

Overall, the participants express concerns about the lack of diversity and inclusivity in STEM education, particularly in relation to gender, ethnicity, and students with special needs. They highlight the importance of incorporating different cultures, diverse role models, and realistic examples to make STEM subjects more relatable and inclusive. They also emphasize the need to create a supportive and welcoming environment for all students, addressing biases and promoting growth mindsets.

DISCUSSION & CONCLUSIONS

The aim of this study was to investigate the impact of online professional development called SMILE in Transportation, which utilized a culturally responsive teaching approach, on the knowledge of future science teachers in Transportation, their science affinities, and their cultural competency. Pre- and post-surveys were conducted with nine participants, revealing that the study effectively enhanced the participants' knowledge of Transportation. However, statistically significant effects on their science affinities and cultural competency were not observed. Nevertheless, qualitative survey responses indicated that the study successfully raised participants' awareness of cultural diversity and facilitated the creation of high-quality educational materials through the use of a culturally responsive teaching approach. The participants also highlighted potential challenges in implementing culturally responsive instruction, including the difficulty of incorporating multiple cultural components, privacy concerns, and potential legal issues.

Based on the statistical analyses conducted with the participants, it was found that SMILE in Transportation was valuable in providing a condensed knowledge of Transportation within a short period of time. However, it could have had a positive impact on supporting participants' interests and confidence in teaching Transportation to culturally diverse students. Although the future science teachers acquired new teaching strategies and materials through SMILE in Transportation, they expressed a need for more confidence and comfort in delivering the newfound information to students (Rollison, Ludlow, & Wallingford, 2012). Given the relatively brief duration of the project (five days), teacher candidates were required to simultaneously learn and implement culturally responsive instruction, resulting in limited opportunities to practice and present it effectively to diverse students.

However, the qualitative survey findings indicated that the implementation of SMILE in Transportation with a culturally responsive teaching approach had a positive impact on the participants' understanding and preparation for culturally responsive instruction in classrooms. The online interaction with cultural professionals through SMILE in Transportation stimulated cognitive engagement among the participants (McLoughlin & Lee, 2010), inspiring them to delve deeper into transportation concepts by leveraging visual and audio multimedia in cultural presentations. This culturally responsive approach facilitated broader participation in transportation learning, including underrepresented student groups, thereby fostering their interest in transportation literacy and enhancing their appreciation and understanding of our living environments through the lens of transportation and cultural adaptation.

By employing the culturally responsive teaching approach, future teachers were able to better recognize the needs of ethnic minority students in classrooms and felt empowered to provide informed and responsible instruction (Aronson & Laughter, 2016; Hammond, 2014; Paris & Alim, 2014). The implementation of SMILE in Transportation also played a role in enhancing the participants' confidence in teaching, contributing to their positive outlook on teaching science (Maypole & Davies, 2001; Yager & Akcay, 2008; Yager et al., 2008; Yager et al., 2009).

Overall, the culturally responsive teaching approach adopted in SMILE in Transportation resulted in improvements in teachers' scientific knowledge, confidence in teaching science to culturally diverse students, and cultural competency within the classroom setting.

SMILE in Transportation is an innovative approach that aims to foster future science teachers' interest and literacy in Transportation by integrating transportation concepts with diverse cultures. The project focuses on meeting the needs of ethnically diverse students, thereby enhancing future science teachers' knowledge and understanding of multicultural education in the context of transportation. Throughout the study, cultural professionals in Transportation provided valuable assistance to the participating future science teachers, helping them broaden their understanding of different cultures and improve their instructional knowledge and skills in Transportation. The project also aimed to ensure equal learning opportunities for all learners by actively involving future science teachers in interactive and hands-on activities through the SMILE in Transportation initiative.

The culturally responsive transportation curriculum was developed collaboratively by the participating future science teachers and cultural professionals during the SMILE in Transportation workshop. Through deep online conversations, each future science teacher was able to construct their own transportation curriculum, tailored to their specific teaching context and incorporating cultural perspectives. This study also holds significant insights for educators and administrators in the field of Transportation, offering guidance on how to effectively support the achievement of ethnic minority students in Transportation education.

By facilitating interactions between future teachers and cultural professionals with expertise in transportation and diverse cultural backgrounds, this study sought to bridge scientific affinities and transportation literacy. The project recognized the value of allowing future teachers to engage with experts who possess both transportation knowledge and cultural insights, creating a rich learning experience that connects the two domains.

Chapter II:

This chapter describes awareness, knowledge, and strategies of culturally responsive teaching in transportation curriculum development. The findings are obtained through educational workshops and discussions with pre-service teachers and transportation professionals at UT Arlington. This work is designed and conducted by the Civil Engineering research team (Hyun, Naz and Saha) and the findings can serve as an independent and standalone product of the research project. This chapter consists of several subsections similar to a journal article including the introduction, methodology, result, and conclusion.

Introduction

Students enrolled in K-12 public schools in the United States have various cultural backgrounds based on their race and ethnicity. A study showed that 45.8% of the K-12 students in the US are White, 15% Black, 28% Hispanic, 5.4% Asian, and 5.8% other races (Duffin, 2022). As teachers have more students with diverse social and cultural backgrounds today (Childers-McKee, 2020), it is important to develop a more inclusive curriculum in K-12 education. Literature shows that a lack of diversity could cause psychological isolation or discouragement in learning for them, which in turn leads to reduced graduation and retention rates (Washington, Boone, Kim, Shakya, & Roberts, 2021).

To develop an inclusive curriculum, teachers must promote a student-centered environment in the classroom. Culturally Responsive Teaching (CRT) is one of the key techniques to connect students' cultures, languages, and life experiences with their learning (Breiseth, García, & Butler, 2022). CRT recognizes the importance of centering students' cultural references in all aspects of learning to be able to help them gain meaningful and relatable knowledge from their classroom materials (Vavrus, 2008). For successful implementations on a constructivist approach of learning, teachers are required to train themselves to enhance sociocultural consciousness and a positive attitude to the students of different backgrounds (Villegas, 2002).

Despite these known benefits of the CRT, literature indicated that CRT strategies had not been adequately implemented in transportation education because of limited awareness and knowledge of teachers. The lack of understanding on how to translate CRT theories to practice, however, can be improved with proper CRT training of teachers (Brown, 2019). Professional development training allows teachers to become more cognitive of the differences in how their students perceive educational materials based on their cultural backgrounds and learned how to construct lesson plans and hands on activities (Brown, 2019).

Many researchers agree on the importance of introducing transportation education at an early age for successful recruitment of the workforce in practice. Therefore, universities, agencies, and professional organizations provide efforts in creating transportation education materials for K-12 students. For example, the University of Minnesota Center for Transportation Studies (CITE) developed K-12 programs, events, and web-based tools to encourage students in exploring transportation components. They used various lesson plans covering several topics of fundamental transportation engineering including traffic control, bridge structure, and transportation safety, which all enrich students' knowledge of transportation systems. However, transportation engineering education tends to lack social or cultural elements differed by region.

This could create unintentional bias in learning since most transportation topics address complex social and human interactions between users and the systems. A lack of awareness and knowledge of different cultural and social elements around transportation also contributes the field to being more of a 'technical' domain rather than 'social engineering' incorporating human elements.

To the best of the authors' knowledge, there is a significant absence of empirical or theoretical evidence on why there is limited cultural diversity in the K-12 transportation curriculum and how the curriculum could integrate cultural or social components of transportation planning and engineering to enhance inclusiveness and diversity in learning processes. This research contributes to the literature by investigating the current practice of CRT in STEM education and finding the current state of knowledge, awareness, and resources present in transportation pedagogy. This study also investigates the feasibility of transportation as a suitable topic to incorporate culturally responsive pedagogy through workshops with pre-service science teachers and transportation professionals.

Methodology

This study conducted two workshops with pre-service science teachers and transportation professionals to understand their knowledge, awareness, and perception of the transportation curriculum and its incorporation of CRT. The workshops included 19 participants from diverse background including science education, civil engineering, and transportation/urban planning. At the beginning of the workshops, a pre-assessment survey was conducted to understand their knowledge and awareness of STEM education and transportation curriculum, which compare with a post-assessment survey that collects the level of improvements in participants' awareness of CRT. A total of 19 participants including pre-service teachers and transportation engineers/urban planners participated in the workshops on November 17, 2021, and November 30, 2021 via Teams online meeting platform. The workshops were constructed with a short lecture discussing inclusion and diversity in STEM education for K-12 through transportation concepts. All of the discussions were led by two trained research assistants and audio-recorded for transcription. The audio files were transcribed verbatim.

This study used a mixed-method approach to analyze surveys and workshop discussions. Pre- and post-survey findings were quantitively analyzed while workshop transcripts were analyzed using thematic analysis. Two trained researchers familiarized themselves with the data, developed the initial idea for potential themes, and finally defined the final themes.

Result

Students enrolled in K-12 public schools in the United States have various cultural backgrounds based on their race and ethnicity. A study showed that 45.8% of the K-12 students in the US are White, 15% Black, 28% Hispanic, 5.4% Asian, and 5.8% other races (Duffin, 2022). As teachers have more students with diverse social and cultural backgrounds today (Childers-McKee, 2020), it is important to develop a more inclusive curriculum in K-12 education. Literature shows that a lack of diversity could cause psychological isolation or discouragement in learning for them, which in turn leads to reduced graduation and retention rates (Washington, Boone, Kim, Shakya, & Roberts, 2021).

A. Participants

Majority of the participants are within the age range of 17 to 34 years old (86%) and mostly female (70%), Asian (37%) or White (32%). Participants' educational backgrounds include civil engineering – transportation specializing (37%), urban planning and public policy (15%), and education (47%). Half of the participants had been enrolled in the current program for two-year or less (52%), and rest of them had been enrolled for three or more years. Table 1 summarizes the demographic information of the participants.

TABLE 9: DEMOGRAPHIC INFORMATION OF THE PARTICIPANTS

Demographic Components	Sub-categories	Percentages (Number of participants % (N = 19)
Age	Less than 17 Years Old	5% (1)
	17-24 Years Old	37% (7)
	25-34 Years Old	47% (9)
	35 Years and Older	11% (2)
Gender	Male	25% (5)
	Female	70% (14)
	Not Listed	5% (1)
Ethnicity	Hispanic or Latino	16% (3)
	Asian	37% (7)
	Black or African American	5% (1)
	Caucasian or White	32% (6)
	Multiracial	11% (2)
Race	Hispanic or Latino	26% (5)
	Not Hispanic or Latino	74% (14)
Field of Study	Civil engineering	37% (7)
	Urban planning and public policy	15% (3)
		47% (9)
	Science Education	26% (5)
Number of years enrolled in current program	1 year	26% (5)
	2 years	38% (7)
	3 years	5% (1)
	4 years	5% (1)
	5 years and more	

B. Integrated findings from quantitative and qualitative analysis

The findings are discussed in three sections: (1) initial awareness and knowledge before the workshops; (2) assessments and findings from the workshops; and (3) post workshops evaluation.

(1) Initial awareness and knowledge before the workshops:

Given the fact that K-12 students have various cultural backgrounds based on their race and ethnicity, several researchers pointed out the importance of incorporating cultural components in their curriculum or class modules through hands-on experiences (Fink, 2018). This study starts with documenting participants' awareness and knowledge about CRT before the workshops.

TABLE 10
FAMILIARITY OF PARTICIPANTS WITH THE CONCEPT OF CRT

Familiarity with the concept of Culturally Responsive Teaching	Percent (Number) of Participants
Not at all familiar	47% (9)
Slightly familiar	11% (2)
Moderately familiar	21% (4)
Very familiar	11% (2)
Extremely familiar	11% (2)

Participants were asked about their familiarity with the concept of CRT. About half of the participants (47%) are "Not at all familiar" with the concept. About one-third of the participants (33%) are moderate to slightly familiar and about one-fourth of the participants (22%) have higher familiarity (very to extremely familiar) with the CRT concept. The results align with the educational background of the participants since more than half of the participants (53%) are outside the education background.

Less than half of the workshop participants (42%) had experienced CRT as a student but only one participant used CRT as an instructor. More than half of the participants (53%) had either no experience or were not at all familiar with the concept of CRT. In terms of the frequency of

using CRT in past, among three instructors, one of them has never used, one used it monthly or quarterly, and one used it weekly in their classroom.

TABLE 11
EXPERIENCE AND FREQUENCY OF PARTICIPANTS OF USING CRT

Experience of Culturally Responsive Teaching as a student/instructor	Percent (Number) of Participants
Yes, as a student or an instructor	47% (9)
No	21% (4)
I am not familiar with Culturally Responsive Teaching	32% (6)
Frequency of using Culturally Responsive Teaching as an instructor	
I am not an instructor	85% (16)
I am an instructor however never used Culturally Responsive Teaching	5% (1)
I have used it somewhat frequently (Monthly or Quarterly)	5% (1)
I have used it frequently (Weekly)	5% (1)

In addition, participants were asked about their familiarity with the concept of transportation engineering in the pre-survey. Even though familiarity is a crucial requirement in research design, its effects have not been sufficiently acknowledged in transportation research (Harms, Burdett, & Charlton, 2021). The result also provides a comparison of participants' knowledge before and after the workshops to evaluate how much their awareness changed after the workshops. About one-third (36%) of the participants indicated that they are "Not at all familiar" with the transportation concept; however, almost half (47%) of these participants were education major students. One-third of the participants (27%) are moderate to slightly familiar, where all the students are from civil engineering, and urban planning and public policy major. The other one-third (36%) of the participants are very to extremely familiar with transportation engineering, whereas 75% of respondents in these two categories are from civil engineering and urban planning and public policy major.

TABLE 12
FAMILIARITY WITH THE CONCEPT OF TRANSPORTATION ENGINEERING

	Total	**Pre-service teachers**	**Civil and transportation engineering professionals**
Extremely familiar	11% (2)	-	11% (2)
Very familiar	11% (2)	5% (1)	5% (1)
Moderately familiar	39% (7)	32% (6)	5% (1)
Slightly familiar	22% (4)	5% (1)	16% (3)
Not at all familiar	17% (3)	5% (1)	11% (2)
Grand Total	95% (18)	47% (9)	47% (9)

Next, they were asked if they have used transportation concepts in their classroom as a teacher or a student. More than half (64%) of the participants mentioned they used the concept as a student and there was no one who used the concept as a teacher.

(2) Qualitative assessments and Findings from the workshops:

After the survey, the workshops focused on explaining the meaning and importance of CRT in STEM education. Participants shared their viewpoints on CRT in STEM education and transportation curriculum. Some shared that they feel a lack of diversity in STEM education. They emphasized teacher's awareness on cultural components to adequately prepare lesson plans incorporating culturally diverse examples. On the topic of transportation and diversity, participants shared that transportation can be a good topic for K-12 curriculum to encourage inclusion at all levels. All qualitative findings are elaborated below under the five key themes (Naz, Saha, & Hyun, 2023):

i) Current STEM curriculum lacks diversity however it started to change to be inclusive:

Several studies confirmed that curriculum models of K-12 incorporating cultural components likely enhance early understanding of social equity in science and engineering fields. The absence of diversity in STEM education limits students' early understanding on social inclusion and justice, which could lead to a marginalization of women and individuals with a particular racial and ethnic backgrounds in STEM fields by treating them unequally (MILLS, 2021). Prior to the discussion around transportation engineering, participants were asked a broader question to understand if STEM education includes a culturally and socially diverse curriculum and ultimately is diverse and inclusive. We found mixed opinions among the participants. Some expressed that STEM educators have been making an effort to incorporate cultural components through different STEM activities; however, the level and the degree of incorporation depend on the educator.

"So, I've done some STEM activities with some students at an after-school program, and whenever I'm trying to decide which activities to do, I would try to incorporate, you know, different things, different activities from different time periods. For example, one time I had my student's make-up a windmill, and I guess that would be inclusive for different cultures and different time periods. Then it's on the teacher or how much knowledge they have about STEM education and different cultures." (Sasha)

Some participants felt that STEM education has been unintentionally designed toward and promoted to racial majorities (e.g., White) or male students. This bias in creating educational materials could cause many female or racially minority students to drive away from STEM fields, which ultimately makes the field less diverse in problem development and solving processes. Many participants also believed that educators lack expertise in creating curricula to include various cultural and social components because they were not well trained to equip such skills. Fortunately, they felt that the situation has gradually started to change, and more women and people of color has started joining the STEM fields.

"Well, I don't think it (the current STEM education) is very inclusive because I feel like every time I've come in contact with STEM education, it's been more directed towards one group of people, mostly boys, and it's mostly just I feel like it's towards more of race like in my personal opinion. I think it's more stereotypical, like the science and technology (you know) geared towards one set of people, … and I feel like they're trying to make it more inclusive, but it's just a very intimidating education system to me. That's what I've experienced in schools." (Betty)
"It's predominantly an area men draw towards, and I hardly see any woman in that field. And I also do see it being towards one race more. But nowadays into 2021, I see more women and people of color joining the STEM fields. " (Jill)

ii) Teacher's awareness and preparation plays an important role in creating quality educational materials:

TABLE 13
IMPORTANCE OF USING CRT IN K-12 CLASSROOM

How important do you think to use culturally responsive teaching in your K-12 classroom?	percentage (%)
Not at all important	-
Slightly important	7%
Moderately important	14%
Very important	43%
Extremely important	36%

One of the most challenging but important goals in education is to ensure an educator's quality before they stand in front of students (Jordan, Kuriloff, Sutherland, Ponnock, & Hoffman, 2018). Some good qualities of an educator include communication abilities and classroom presence that engages with students with strong teamwork, adaptability, compassion, and perseverance, since these features make the classroom lecture more into real world learning (Gagnon, 2019). The literature emphasizes that teachers' quality strongly influences student achievement compared to other in-school factors such as resources, curriculum, school leadership and environment (National Commission on Teaching and America's Future, 1996). Our workshops found similar results. Many participants agreed that it is important for educators to prepare themselves to reduce or remove cultural or societal gaps among students. As shown in Table 5, most of the participants (79%) expressed that CRT is very and extremely important for K-12 classrooms.

Among many required skills, our workshops participants specifically emphasized the technical abilities of teachers to integrate different cultural components into the STEM curriculum to make students feel welcome and connected to each other.
"It is very helpful for students to connect, open their horizons, and it can help students recall information more easily."(Eve)
"I think culture helps the student relate to the topic." (Perry)

iii) Curriculum topics that can relate to cultural components in daily living enhance social diversity in transportation education:

Early exposure to encourage women and minorities to pursue STEM and transportation studies appears to be important for introduction and retention of them to the field (Center for Online education, 2022). In order to understand educators' preparedness to reduce cultural and societal gaps in their classroom, we asked their own strategies that can be incorporated in transportation lesson plans. A few themes emerged including a) increasing familiarity with different cultures and ethnicities, b) using lived experiences and examples from different cultures, and c) promoting communications with students and their families.
Participants mentioned that educators must equip with a solid understanding of different cultures to allow them to be more accepting, open, and tolerant to other communities. Knowledge of how people solve transportation issues or problems in different geographic locations, especially the ones of their own students, facilitates a broader understanding of the possibility that different perspectives could exist on the same engineering problems and reduces negative conventions and biases. A few quotes of the participants describe how they would develop curriculum to improve students' understanding on racial and gender diversities.
"Maybe being familiar with the different cultures and ethnicities. Ethnicities that are in your community or the area that you work in. " (Sasha)

“Include lessons or examples of other cultures within the school. “ (Jill)
“Taking the time to get to know where your students are from and the culture. “ (Jill)
“Educate yourself on the cultures of your students through research and communication with them and their family.” (Jill)
“Learning about the different cultures and implementing it into lesson so everyone in your class can understand from different viewpoints.” (Amy)

Participants also shared the importance of exposure to real-life examples either by visiting schools in different socio-demographic neighborhoods or listening experiences from a professional relevant to the field. This would enhance students’ first-hand knowledge of diversity in their communities.
“Exposure to STEM careers from people of diverse backgrounds (for example, having class speakers for career day).” (Eve)

In addition, participants shared that engaging with students using a class discussion on specific cultures of communities could be helpful to enhance awareness of the general topic of equity and diversity. Frequent and in-depth interaction with students in a classroom will enhance students’ performances and understanding of education materials. Students might feel disconnected from learning when they cannot relate the school to themselves and their living environment (Howard, 2020). Teachers can provide real-life examples and allow students to share their ideas related to their cultural diversity.
“Giving them enough opportunities to share their experiences and ideas. Providing them with examples and engaging them in new experiences.” (Amy)
Participants were also asked to talk about pedagogical techniques that they think can be implemented to encourage participation from students with diverse races and background. As a well-designed pedagogy helps students learn successfully and develop high-order thinking skills (Main, 2022), the following techniques emerged from the discussion with participants: a) Including realistic examples into lessons, b) encouraging a growth mindset among underrepresented groups of students. Early exposure to this type of pedagogical technique can help students reach their desired career path.

The workshop participants also shared that the current education systems may not be well equipped with resources to implement hands-on activities to cover various cultural and social components in transportation and one of the most efficient strategies is to systematically prioritize minority areas to allocate more resources.
“I feel like we could include more culturally diverse and stem education by providing (more resources for), I guess, lower scoring schools where there is more minorities typically.. than higher end schools.” (Merry)
“(those underrepresented) schools should be provided with more resources and technology (because) we would never be able to include all students and diverse groups of students.
“ (Sasha)

iv) Transportation can be a good curriculum for increasing diversity and inclusion:

Participants largely agreed with that transportation components are not sufficiently addressed in K-12 STEM curriculum although transportation addresses varying societal topics of mobility,

access, and infrastructure which could add a more cultural component to pre-engineering, math, and physics materials. Potential lesson plans may include public transit and ride hailing systems in different countries, transportation technologies in different time horizons, the impact of socio-economic characteristics on land use and transportation mode choice.
"Yes, I think you can use transportation to teach many different things that like from how Steam engine works to how gasoline motor works. You can talk about other countries and how they use different kinds of taxi systems or different kinds of bus systems. Or go to the bullet train for instance." (Bob)
"Yeah, it's very much related to diversity. Diversity of population and their socioeconomic characteristics affect the place of their living location and how far or close they are to job opportunities and therefore their transportation needs could be different based on where they live." (Rick)
"Everything could be a good topic to talk about. They discuss diversity and inclusion and transportation…From government state, when they have such a big topic with a lot of money behind it in this country of course, and definitely it, it is a topic that leads to more and inclusion leads to." (Amy)

In addition, the participants expressed that the importance of a sustainable green transportation system can be explained as educational materials on sustainability could naturally provide lesson plans on environmental equity and transportation justice.
"Maybe for K-12, you can explain that going more green is a good idea, especially in countries over high populations. " (Jill)
"When we have this inclusion and diversity in teaching, students can understand everybody, So it promote equity in our society not only in the classroom but also the whole society." (Jill)

Some participants believe that cultural lessons using various transportation examples around the world would ultimately have synergetic impacts on the transportation engineering/planning fields eventually improving overall transportation systems. If a student exposed to diverse perspectives on transportation becomes a transportation engineer in the future, they would be more open and have inclusive and diverse solutions for transportation problems.

"Well, I think the more we know about all the transportation options around the world, you know all the countries, and the more ideas we can get for bettering our own transportation systems and everything. Then we can get ideas from everyone around. I think that would just be really helpful for an engineer's perspective. Because they've seen other transportation issues and they've you know, thought about it. And seeing other ways that work. And I think that would just be very helpful." (Bella)

However, some participants pointed out that discussion on students' own cultural background might be a sensitive topic for younger students who could feel confused or uncomfortable with talking about their culture. For example, students whose families do not own a private vehicle might feel comfortable talking about various transportation modes including passenger vehicles. The participants emphasized that personal questions should be handled carefully and there are always options to ask more indirect questions that do not require any private information.
"I think that we could add transportation to and culture together by explaining how different cultures use different methods of transportation. It's an inclusive activity because you can ask in

their home countries if they use different types of transportation like public transportation or carpooling. But I also feel that it's kind of like a sensitive matter, just because, what if, like the student's family doesn't have a vehicle or they'd transport like through carpooling or they walk. Maybe some students could be embarrassed to say how they get to school or how they do things. " (Merry)

v) A variety of transportation topics could serve although barriers persist:

Participants were asked which transportation concepts they are interested in including to culturally responsive K-12 STEM education. Majority (42%) selected "General transportation knowledge" and "Transportation issues and problems" while some (16% each) selected "Transportation goals and objectives", "Transportation and communities" and "Transportation user".

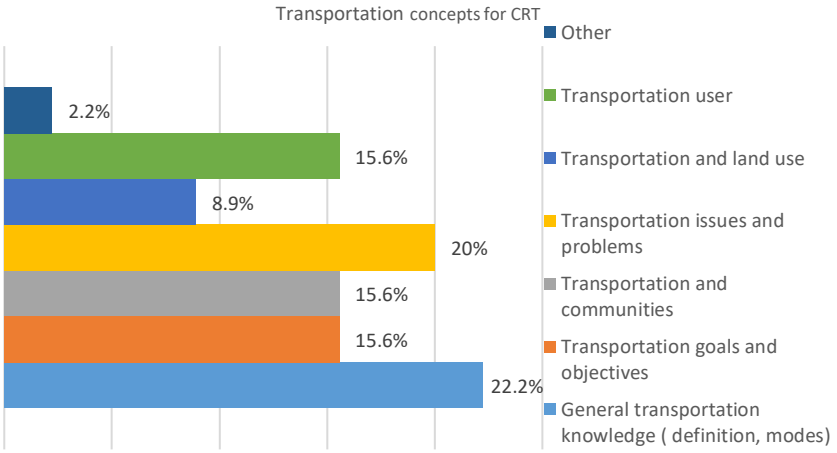

FIGURE 1: VARITY OF TRANSPORTATION TOPIC TO INCLUDE IN CRT

Besides the above-mentioned concepts, they also were interested in including additional transportation concepts in K-12 STEM curricula such as environmental impacts (e.g., emissions), land use difference between rural and city, safety, infrastructure, equity, and transportation options/modes. However, participants highlighted possible challenges of CRT implementation regarding the difficulty of incorporating many cultural components, privacy, or even legal issues.

"Some challenges I expect to face while implementing CRT is trying to incorporate all cultures that are present in my classroom since there are so many different ethnicities. I also expect to face gender-related issues. So many people are very gender-sensitive in today's society so it is important to be aware of this while teaching." (Sasha)

"Trying to adhere it to the different cultures without offending anyone else." (Nancy)

"I would assume that there is a chance of making the kids feel judged. If you are going to use culture teaching maybe make it as an open conversation and don't assume anything." (Perry)

"If the reasons and goals of this method are not clear and well-defined, it might create confusion and even some might refuse it. When working with kids we should be very careful not to put them in spot or to give them the sense of discrimination!" (Amy)

"a college setting versus you know K through 12 setting is very different and you know topics might have to be approached little bit more carefully….. Because kids are a little bit more shy, you can't just straight up ask a question. Maybe they need some like exposure 1st and that can lead to further discussions." (Eve)

Participants expressed that students from other cultures might get offended, or feel judged, thus the content or discussion should be carefully conducted. Besides, the cultural challenges, resources such as time and costs to develop interactive programs could also be another challenge for a successful application of culturally responsive teaching.

(3) Post Workshops Evaluation:

Sufi et al. (2018) mentioned ten simple rules for measuring the impact of workshops (Sufi, et al., 2018). Two of those rules includes asking about the change in confidence in participants regarding the concept they were present at the workshops and/or building new skill (Sufi, et al., 2018). To assess the impact of our workshops on the participant's confidence, the research team asked about their anticipated frequency of using CRT in a classroom with the concept we presented with. The majority of participants mentioned their confidence in using CRT either weekly (31%) and monthly or quarterly (38%). Participants were asked whether the lecture will help them implement CRT in the future when they teach K-12 students. About half of

TABLE 14
POST WORKSHOPS EVALUATION

Frequency attributes	Percent of Participants (Number of participants)
Anticipated frequency of using culturally responsive teaching in your K-12 classroom	
Not frequently (annually or bi-annually)	8% (1)
Somewhat frequently (Monthly or Quarterly)	38% (5)
Frequently (Weekly)	31% (4)
Other	23% (3)
Today's lecture will help me implement Culturally Responsive teaching (CRT)	
Strongly disagree	-
Disagree	-
Neither agree or disagree	29% (4)
Agree	21% (3)
Strongly agree	50% (7)
Today's lecture will help me implement CRT in the science and engineering education	
Strongly disagree	-
Disagree	-
Neither agree or disagree	15% (2)
Agree	46% (6)
Strongly agree	38% (5)

the participants strongly agree and none of the participants disagree that the lecture will help them implement CRT. About one third of the participants neither agree nor disagree. As can be seen from the above (Table 2), even though about half of the participants were not at all knowledgeable about CRT before the workshops, however, about three fourth of the participants agree that the workshops will help them implement CRT.

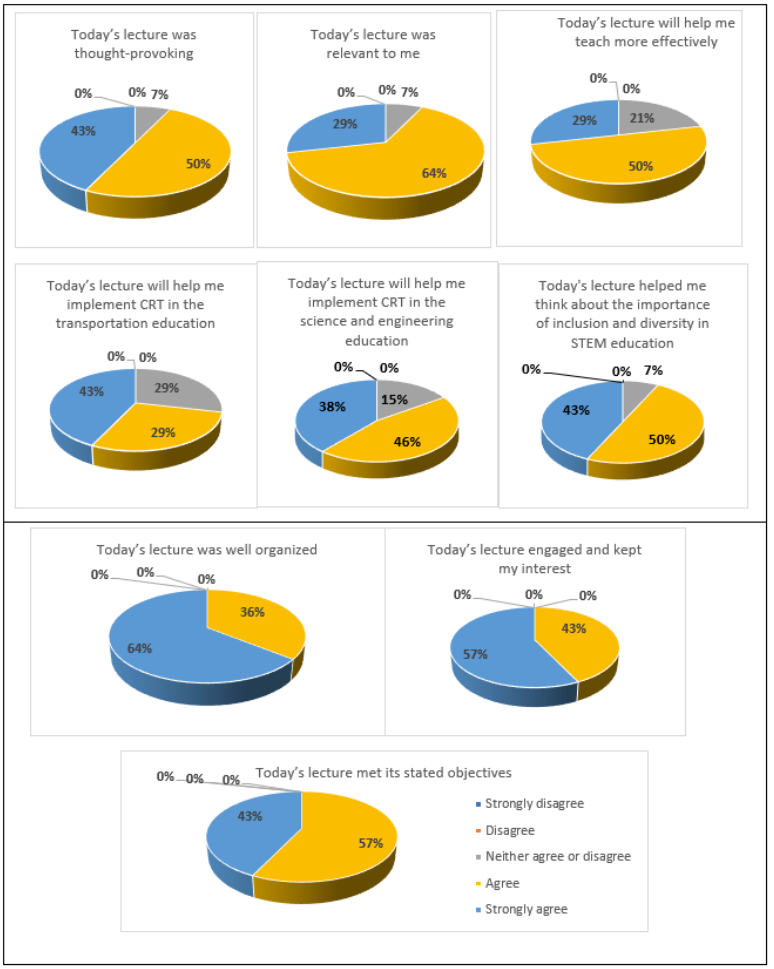

FIGURE 2: POST WORKSHOPS ASSESSMENTS

Participants were asked about the impact of the workshops and the participants commented on whether the workshops i) was thought-provoking, ii) relevant, iii) well organized, iv) engaged and kept participants' interest, v) met its stated objective, vi) will help participants teach more effectively, vii) will help participants implement CRT in the transportation education, viii) will help me participants CRT in the science and engineering education ix) helped participants think about the importance of inclusion and diversity in STEM education. Figure 2 summarizes the responses to each of the questions.

Conclusion

We conducted two workshops with two student groups representing pre-service science teachers and transportation engineers/urban planners to understand the potential of including the transportation engineering concepts in the CRT curriculum for K-12 students. A pre-survey conducted before the workshops was compared to a post-survey implemented after the workshops to evaluate the changes in knowledge on the CRT. Both the quantitative and qualitative data show the current awareness and resources in CRT practice focusing on the transportation curriculum in K-12 classrooms. The result shows participants agreed that transportation could be an appropriate topic to incorporate culturally responsive pedagogy to the K-12 students, if the existing gaps between students and teachers in an understanding of cultural diversity are reduced and necessary resources are systematically secured in the education systems.

References

Chapter 1

Aronson, B., & Laughter, J. (2016). The Theory and Practice of Culturally Relevant Education: A Synthesis of Research Across Content Areas. *Review of Educational Research*, 86(1).

Baurhoo, N & Asghar, A (2014) Using universal design for learning to construct inclusive science classrooms for diverse learners, *Learning Landscapes,* 7(2), 59-81.

Cloby, S., & Ortman, J. (2015). Projections of the Size and Composition of the U.S. Population: 2014 to 2060, *U.S. Census Bureau: Department of Commerce*, 25-1143.

Chapin, J. R. (2006). The achievement gap in social studies and science starts early: Evidence from the early childhood longitudinal study, *The Social Studies, 97(6), 231–238.*

Chowdhury, M. A. (2016). The integration of science-technology-society/science-technology-society-environment and socio-scientific-issues for effective science education and science teaching. *Electronic Journal of Science Education*, *20*(5), 19-38.

Dweck, C. (2015). Carol Dweck revisits the growth mindset. *Education Week*. Retrieved from: https://www.edweek.org/leadership/opinion-carol-dweck-revisits-the-growth-mindset/2015/09

Flanklin, S. L., Slate, J. R., & Sheila, A. (2014). Ethnic Disparities in Graduate Education: A Selective Review of Quantitative Research, Social Theory, and Quality Initiatives, Journal of Faculty Development, 28(3), 63-79.

Gay, G. (2000). Culturally responsive teaching: theory, research, and practice. New York: Teachers College Press.

Gonzales, P., Williams, T., Jocelyn, L., Roey, S., Kastberg, D., & Brenwald, S. (2009). Highlights from TIMSS 2007: Mathematics and science achievement of U.S. fourth- and eighth-grade students in an international context. Retrieved from http://nces.ed.gov/pubs2009/2009001.pdf

Hammond, Z. (2014). Culturally Responsive Teaching and the Brain: Promoting Authentic Engagement and Rigor Among Culturally and Linguistically Diverse Students, Corwin Press.

Herman, W. E. (2011). Identity formation. In S. Goldstein & J. A. Naglieri (eds.), *Encyclopedia of child behavior and development*. Springer. https://doi.org/10.1007/978-0-387-79061-9_1443

Kozleski, E. B. (2010). Culturally Responsive Teaching Matters!, Equity Alliance, Retrieved from https://files.eric.ed.gov/fulltext/ED520957.pdf Ladson-Billings, G. (2014). Culturally Relevant Pedagogy 2.0: a.k.a. the Remix , Harvard Educational Review, 84(1), 74-85.

Ladson-Billings, G. (2014). Culturally Relevant Pedagogy 2.0: a.k.a. the Remix, Harvard Educational Review, 84(1), 74-85.

National Center for Educational Statistics. (2020). Racial/Ethnic Enrollment in Public Schools, *The Condition of Education*, Retrieved from https://nces.ed.gov/programs/coe/indicator_cge.asp

Maypole, J., & Davies, T. G. (2001). Students' perceptions of constructivist learning in a community college American History II. *Community College Review*, *29*(2), 54-80. https://doi.org/10.1177/009155210102900205

McLoughlin, C. E., & Lee, M. J. W. (2010). Developing an online community to promote engagement and professional learning for pre-service teachers using social software tools,

Journal of Cases on Information Technology, 12(1), 17-30. DOI:10.4018/jcit.2010010102.
Paris, D. (2012). Culturally Sustaining Pedagogy: A Needed Change in Stance, Terminology, and Practice, *Educational Researcher*, 41(3).
Paris, D., & Alim, S. H. (2014). What Are We Seeking to Sustain Through Culturally Sustaining Pedagogy? A Loving Critique Forward, Harvard Educational Review, 84(1).
Rollison, J. M., Ludlow, L. H., & Wallingford, T. W. (2012). Assessing content knowledge and changes in confidence and anxiety related to economic literacy in a Professional development program for history teachers, *Journal of Education al Research and Practice*, *2*(1), 15-30.
Theobald, E. J., Hill, M. J., Tan, E., Agrawal, S. E., Arroyo, N., Behling, S., Chambwe, N., Cintrón, L., Cooper, J. D., Dunster, G., Grummer, J. A., Hennessey, K., Hsiao, J., Iranon, N., Jones II, L., Jordt, H., Keller, M., Lacey, M. E., Littlefield, C. E., Lowe, A., Newman, S., Okolo, V., Olroyd, S., Peecook, S., Pickett, S. B., Slager, D. L., Caviedes-Solis, I. W., Stanchak, K. E., Sundaravardan, V., Valdebenito, C., Williams, C. R., Zinsli, K., & Freeman, S. (2020). Active learning narrows achievement gaps for underrepresented students in undergraduate science, technology, engineering, and math, *Proceedings of the National Academy of Sciences of the United States of America (PNAS)*, 117(12), https://DOI.org/10.1073/pnas.1916903117
Qian, X, Nandakumar, R., Glutting, J., Ford, D., & Fifield, S. (2017). Gender and Minority Achievement Gaps in Science in Eighth Grade: Item Analyses of Nationally Representative Data, *ETS Research Report,*2017(1), 1-19. https://DOI.org/10.1002/ets2.12164
Williams, A. (2011). A call for change: Narrowing the Achievement gap between white and monitory students, *the Clearing House*, 84(2), 65-71. https://www.jstor.org/stable/41149869
Yager, R. E., & Akcay, H. (2008). Comparison of learning outcomes in middle school science with an STS approach and a typical textbook dominated approach. *Research in Middle Level Education*, *31*(7), 1-16. https://doi.org/10.1080/19404476.2008.11462050
Yager, R. E., Choi, A, Yager, S. O. & Akcay, H. (2009). Comparing science learning among 4th, 5th, and 6thgrade students: STS versus textbook-based instruction. *Journal of Elementary Science Education*, *21*(2), 15-24. https://doi.org/10.1007/BF03173681

Chapter 2

Breiseth, L., García, S., & Butler, S. (2022). What is culturally responsive teaching? Retrieved from https://www.understood.org/en/articles/what-is-culturally-responsive-teaching.
Brown, B. A. (2019). Moving culturally relevant pedagogy from theory to practice: Exploring teachers' application of culturally relevant education in science and mathematics. Urban Education 54, no. 6 .
Center for Online education. (2022). STEM Opportunities for Women and Minorities. Retrieved from https://www.onlinecolleges.net/for-students/women-and-minorities-stem/.
Childers-McKee. (2020, July 31). 5 Culturally Responsive Teaching Strategies. Retrieved from https://www.northeastern.edu/graduate/blog/culturally-responsive-teaching-strategies/.
Coleman, A. a. (2020). Creating a Culturally Responsive STEM Classroom.
Duffin, E. (2022, February 21). Share of students enrolled in K-12 public schools in the United States in 2020, by ethnicity and state. Retrieved March 8, 2022, from

https://www.statista.com/statistics/236244/enrollment-in-public-schools-by-ethnicity-and-us-state/#:~:text=In%20the%20U.S.%20as%20a,and%2028%20percent%20were%20Hispanic.

Fink, L. (2018, January 08). Culturally Responsive Teaching in Today's Classrooms. Retrieved March 08, 2022, from https://ncte.org/blog/2018/01/culturally-responsive-teaching-todays-classrooms/.

Gagnon, D. (2019). 10 Qualities of a Good Teacher. Retrieved from Southern New Hampshire University: https://www.snhu.edu/about-us/newsroom/education/qualities-of-a-good-teacher#:~:text=Some%20qualities%20of%20a%20good,a%20lifelong%20love%20of%20learning.

Harms, I. M., Burdett, B., & Charlton, S. (2021, March). The role of route familiarity in traffic participants' behaviour and transport psychology research: A systematic review. Transportation Research Interdisciplinary Perspectives, 9. doi:10.1016/j.trip.2021.100331

Howard, T. C. (2020, November 19). 7 Culturally Responsive Teaching Strategies and Instructional Practices. Retrieved from https://www.hmhco.com/blog/culturally-responsive-teaching-strategies-instruction-practices.

Jordan, W. J., Kuriloff, P., Sutherland, D., Ponnock, A., & Hoffman, B. (2018, August). William Penn Foundation. Retrieved from https://williampennfoundation.org/what-we-are-learning/teacher-preparation-and-quality.

Main, P. (2022). Pedagogy For Teaching: A Classroom Guide. Retrieved from https://www.structural-learning.com/post/pedagogy-for-teaching-a-classroom-guide.

MILLS. (2021, April 21). Retrieved from https://online.mills.edu/blog/diversity-in-stem/.

Naz, F., Saha T., & Hyun, K. (2023). Transportation Curriculum with Culturally Responsive Teaching: Lesson Learned from Pre-Service Teachers and Future Transportation Workforce. Transportation Research Record, Journal of Transportation Research Board (In Print).

Peel, E. A. (2020). pedagogy. Retrieved from https://www.britannica.com/science/pedagogy.

Sufi, S., Duckles, B., Simera, I., Nurmikko-Fuller, T., Bellis, L., Miah, W., . . . Higgins, V. (2018). Ten simple rules for measuring the impact of workshops. PLOS Computational Biology. doi:10.1371/journal.pcbi.1006191.

Vavrus, M. (2008). Culturally responsive teaching. 21st century education: A reference handbook, 2: 49-57.

Villegas, A. M. (2002). Preparing culturally responsive teachers: Rethinking the curriculum. . Journal of teacher education, 53.1: 20-32.

Washington, M., Boone, J., Kim, D., Shakya, T., & Roberts, D. (2021, July 26). Lack of diversity in higher learning can be a problem for diverse student bodies. Retrieved from abcNews: https://abcnews.go.com/US/lack-diversity-higher-learning-problem-diverse-student-bodies/story?id=7901917

Appendix A: Technology Transfer

During the project term, the SMILE project team conducted several Technology Transfer (T2) activities to facilitate the adoption and implementation of innovative transportation solutions by relevant stakeholders. These activities aimed to disseminate research findings, best practices, and technological advancements to the transportation community, policymakers, practitioners, and the general public. The following is a documentation of the T2 activities conducted, accomplishments achieved, and post-project T2 plans of the project team:

1. Knowledge Sharing Workshops: the project team organized a series of workshops throughout the project term to share research outcomes, case studies, and practical insights with transportation professionals. These workshops covered various topics such as transportation equity, finance, and development. Presentations, interactive sessions, and networking opportunities were provided to encourage dialogue and knowledge exchange.
2. Webinars and Online Resources: the project team developed a repository of webinars, online tutorials, and resources to disseminate research findings and promote T2 adoption. These resources were made accessible to stakeholders, allowing them to access valuable information remotely and at their convenience. The webinars covered topics such as innovative financing models, transportation planning strategies, and inclusive community development.
3. Collaboration with Stakeholders: the project team actively engaged with relevant stakeholders, including transportation agencies, community organizations, and policymakers, to promote T2 adoption. Collaborative partnerships were established to facilitate the implementation of research outcomes and recommendations. This involved sharing technical expertise, providing guidance, and supporting stakeholders in implementing innovative transportation solutions.
4. Policy Briefs and Reports: the project team produced policy briefs and reports summarizing key research findings and recommendations for policymakers. These concise and accessible documents highlighted the potential impacts of implementing innovative transportation approaches and provided evidence-based policy recommendations. The briefs and reports were widely distributed among relevant stakeholders to support informed decision-making and policy development.

Accomplishments towards T2 adoption and implementation by relevant stakeholders:

- Increased Awareness: the project team's T2 activities contributed to an increased awareness and understanding of innovative transportation solutions among stakeholders. Through workshops, webinars, and collaborations, stakeholders gained knowledge about the benefits and practical applications of new approaches in transportation planning, financing, and equitable development.
- Implementation Projects: As a result of the project team's T2 efforts, several stakeholders successfully implemented research outcomes and recommendations in their projects. This includes the adoption of innovative financing mechanisms, integration of equity

considerations in transportation planning, and the implementation of community-centered transportation initiatives.

- Policy Changes: The project team's policy briefs and reports influenced policy changes at various levels. Policymakers incorporated research findings and recommendations into transportation plans, funding strategies, and policies, resulting in more equitable and sustainable transportation systems.

Post-project T2 plans:

The SMILE project team recognizes the importance of sustaining T2 efforts beyond the project term. To ensure continued impact and knowledge dissemination, the following post-project T2 plans are underway:

- Continued Knowledge Dissemination: The project team will maintain an online presence, sharing research outcomes, webinars, and resources through its website and other digital platforms. This will enable stakeholders to access up-to-date information and foster ongoing knowledge exchange.
- Capacity Building: The project team plans to conduct capacity-building activities, including training programs and technical assistance, to further support stakeholders in implementing innovative transportation solutions. These activities will enhance the skills and expertise of transportation professionals and empower them to address emerging challenges.
- Policy Advocacy: The project team will continue to engage with policymakers to advocate for evidence-based transportation policies and strategies. By providing research-based recommendations and insights, the project team aims to influence policy decisions that promote transportation equity, finance, and development.
- Research and Collaboration: The project team will continue to collaborate with transportation agencies, community organizations, and industry stakeholders to foster implementation of research outcomes and promote knowledge sharing. Through partnerships, CTEDD aims to support stakeholders in implementing innovative transportation practices and facilitate cross-sector collaboration for effective and equitable transportation.

CENTER FOR TRANSPORTATION EQUITY, DECISIONS & DOLLARS

The **Center for Transportation, Equity, Decisions and Dollars (CTEDD)** is a USDOT University Transportation Center, leading **transportation policy research** that aids in **decision making** and **improves economic development** through **more efficient, and cost-effective use of existing transportation systems,** and offers **better access to jobs and opportunities.** We are leading a larger consortium of universities focused on **providing outreach** and **research to policy makers**, through **innovative methods** and **educating future leaders of the transportation field.**

UNIVERSITY OF TEXAS ARLINGTON

CAL POLY SAN LUIS OBISPO

Georgia Tech

USF UNIVERSITY OF SOUTH FLORIDA

WISCONSIN UNIVERSITY OF WISCONSIN–MADISON

C-TEDD@UTA.EDU CTEDD.UTA.EDU @UTACTEDD @ C__TEDD @ CENTER FOR TRANSPORTATION, EQUITY, DECISIONS AND DOLLARS 817.272.5138