SUMMER MULTICUTLURAL AND INTERDISCIPLINARY LEARNING FOR ENGINEERING (SMILE) IN TRANSPORTATION FOR CULTURALLY AND LINGUISTICALLY DIVERSE STUDENTS

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Abstract - This study was designed to offer an online professional development opportunity, "Summer Multicultural and Interdisciplinary Learning for Engineering (SMILE) in Transportation," for future elementary STEM teachers and measure its effects on their teaching. As the student population grows more diverse, schools face more significant challenges in delivering practical instructions on "transportation" to the diverse student population, including minority students who speak English as a second language. SMILE in Transportation provided future science teachers with an opportunity to interact with cultural professionals in Transportation who were experts in Transportation, had their cultural backgrounds, and presented transportation systems through their cultures. The cultural professionals in Transportation involved inter-disciplinarily professionals not only on the college campus but also from the communities. SMILE in Transportation was a novel approach to increase the knowledge of future science teachers in Transportation and to develop a unique teaching methodology that incorporates the backgrounds of culturally and linguistically diverse students into teaching engineering of Transportation. The data collected from the pre-and the post-surveys of the participants' science affinities & cultural competency (teaching efficacy, cultural competency, personal interest, & cultural IQ), science knowledge tests, and the qualitative survey at the end of the project were used to improve future teachers' understanding of Transportation and other cultures and their skills in developing culturally- responsive instructions to teach Transportation, as well as to update SMILE workshop for futuresessions.

Keywords - Transportation, Interdisciplinary, Minority Students, Multicultural, Professional Development

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).

II. LITERATURE REVIEW

2.1. 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).

2.2. 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-

lastingscienceidentities and mix them with theirself-concepts,increasing their possession ofTransportation (Herman, 2011).Self-efficacytheorypresents their confidenceintheirabilitiesthrough mastery, vicarious, modeling, and emotional and hands-on experiences (Chowdhury, 2016). Growth Mindsetresearch supports that future teachersbecome mature and foster mental resilience when they face challengingtasks (Dweck, 2015).Teacherswithstrongscienceidentitiesand self-efficacyweremorelikelytoseekoutpositiveexperiencesin science, which cultivates their mindsets. This SMILE studywas 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.

2.3. Purpose of the Study

This study soughttoexplorethe effects of the SMILE in Transportation using a CRI approach on future science teachers' knowledge of Transportation, science affinities, and cultural competency. Thestudywas 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?

III. METHOD

3.1. 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.

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)

Table1: Demographic Information of the Participants

3.2. 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.

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

Table2: Demographic Information of the Participants

IV. RESULTS

4.1. 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 theyparticipated in the program. Table 3 shows the results of 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				

Table3: Results of Knowledge in Transportation

4.2. Scientific Affinities

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 confidence in teachingTransportation after they participated in the program. Table 4 shows the 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				

Table4: Results of Teaching Efficacy

4.3. 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 showa significant increase in their cultural competency after participating in the program. Table 5 shows the results of the 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				

Table5: Results of Cultural Competency

4.4. Qualitative Survey

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

V. CONCLUSION

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.

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