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Board 242: Connecting Classroom Curriculum to Local Contexts to Enhance Engineering Awareness In Elementary Youth

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Connecting Classroom Curriculum to Local Contexts to Enhance Engineering Awareness in Elementary Youth

Project Overview

This paper reports on the year three findings of a National Science Foundation Research in the Formation of Engineers project focused on increasing rural and indigenous youth's awareness of engineering and engineering related careers. To reach this goal, we worked with elementary teachers to connect the engineering activities taught in the classroom with local funds of knowledge and local engineering opportunities (Hammack et al., 2022; Hammack et al., 2021). Each of the four participating teachers developed an engineering learning sequence that connected to a design opportunity within their local context (see Hammack et al., 2022 for additional curriculum detail). After developing the lessons, participating teachers enacted the lessons with their elementary students. Participants included 43 4th and 5th grade students divided into two groups, those who attended school on a Native American reservation (n=23) and those who attended a small town school not located on a reservation (n=20). To measure the impacts of the program, students completed the Students Attitudes towards STEM survey ([S-STEM], Friday Institute, 2012) and the Engineering Identity Develop Scale ([EIDS], Capobianco et al., 2017) before and after engaging in the community-focused engineering lessons.

Student Attitudes Towards STEM (S-STEM)

The first portion of the MISO survey measures Students Attitudes towards STEM. This portion consists of four sections: attitudes toward mathematics (8 items), attitudes toward science (9 items), attitudes toward engineering & technology (9 items), and a fourth section measures the extent to which students feel that schools provide a safe, caring, and engaging 21st century learning environment (11 items). Each item is measured on a 1-to-5 Likert type scale (1 = strongly disagree, 2 = disagree, 3 = neither agree or disagree, 4 = agree, and 5 = strongly agree). For this paper, we are only reporting on the attitudes towards engineering & technology subscale.

All of the analyses that were conducted for this report were conducted with the intent to determine whether there were differences between Reservation students and Non-Reservation students. The between subjects variable was comprised of two groups: Students from reservation (n = 23) and non-reservation students (n = 20).

A mixed, univariate repeated measures analysis of variance (ANOVA) was conducted. Reservation students versus Non-Reservation students comprised the between subjects variable, and Time1/Time2 was the repeated measure. The dependent variables were students' mean pre-test and post-test scores from the engineering and technology section of the Student Attitudes Towards STEM.

There was no within-subjects main effect for Time, Wilks' Lambda = .872, $F(4, 38) = 1.397$, $p = .253$; however, there was a significant interaction between Time and Reservation/Non-Reservation with a large effect size, Wilks' Lambda = .720, $F(4, 38) = 3.699$, $p = .012$, $\eta^2_p = .280$. Descriptive statistics are provided in Table 1.

Table 1

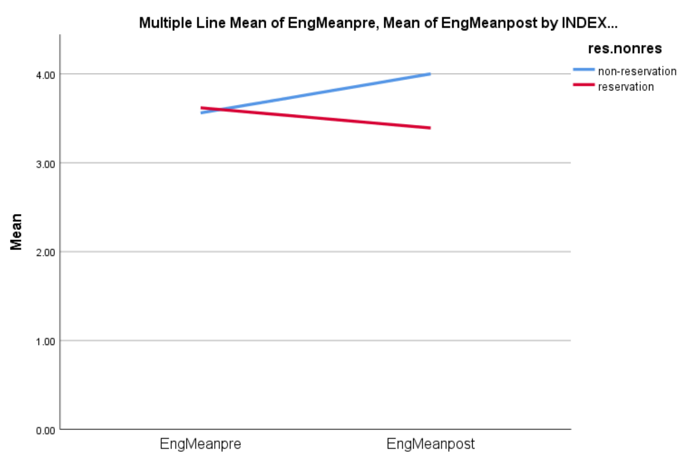
Pre-Test and Post-Test Means and Standard Deviations for Engineering & Technology by Reservation/Non-Reservation Students

Descriptive Statistics

	Reservation/ Non-Reservation	Mean	Std. Deviation	*n*
Eng Mean Pre-Test	non-reservation	3.56	.82	20
	reservation	3.62	.58	23
	Total	3.59	.69	43
Eng Mean Post-Test	non-reservation	4.00	.77	20
	reservation	3.39	.54	23
	Total	3.67	.72	43

Engineering & Technology

The univariate ANOVA using the Greenhouse Geisser correction for unequal variances indicated that for engineering & technology the interaction between Time X Reservation/Non-Reservation was significant with a large effect size, $F(1, 41) = 15.151$, $p < .001$, $\eta^2_p = .270$. At pretest, there was little difference between Reservation students and Non-Reservation Students; however, at posttest Non-Reservation Students had higher attitudes toward engineering & technology than Reservation students.



Engineering Identity Development Scale (EIDS)

The Engineering Identity Develop Scale is a 20-item assessment to identify how elementary school children conceive their early conceptions of engineering and potential career aspirations and how they may interrelate with their identity development (Capobianco, Deemer, & Lin, 2017). Originally, the assessment consisted of a four-factor model (academic, school, occupational, and engineering aspirations; (Capobianco, French, & Diefes-Dux, 2012) but was later modified into a two-factor model (academic and engineering career) by Capobianco et al. (2012). The factor structure of the assessment has again been modified to consist of three factors that tap into (a) feelings that students are valued and belong academically and socially in their school environment, (b) conceptual understanding of the engineering profession and what engineers do, and (c) goals aimed at following a career path involving engineering (Capobianco et al., 2017). Items 1, 5, 6, 7, 8, and 9 tap into students' feelings of being valued and belonging in a school environment and is labeled Academic Identity. Items 10, 11, 13, 14, 15, and 16 tap into students' conceptual understanding of engineers and is labeled Occupational Identity. Last, items 17, 18, 19, and 20 tap into students' goals in following an engineering career path and is labeled Engineering Aspirations. The items of the EIDS are rated on a three-point scale: 1 = no, 2 = not sure, and 3 = yes. Mean scores for each of the three factors were calculated for each student for the pre-test and the post-test.

When the pre-EIDS and post-EIDS were administered, item #17 was omitted from the surveys given to the students on the reservation but was included for the students off the reservation. Therefore, Engineering Aspirations was calculated using four items for non-reservation students but only three items for reservation students. To solve this problem, item #17 was eliminated from non-reservation, and a new Engineering Aspirations variable was calculated using only three items, putting all three school districts on an equal basis. To measure what influence this had on this variable for non-reservation students, Pearson correlations were calculated for no-reservation students between the pre-EIDS with 4 items and the pre-EIDS with 3 items, and between the post-EIDS with 4 items and the post-EIDS with 3 items. The correlation between the two versions of the pre-EIDS was .98 and the correlation between the two versions of the post-EIDS was .97. These correlations indicate that the pre- and post EIDS are virtually the same regardless of whether it was calculated with three or four items. Therefore, the values reported for Engineering Aspirations were calculated using items 18, 19, and 20 for all school districts, and item 17 was eliminated for all school districts.

A mixed, multivariate repeated measures analysis of variance (ANOVA) was conducted. Reservation students versus Non-Reservation students comprised the between subjects variable, and Time1/Time2 was the repeated measure. The dependent variables were students' mean pre-test and post-test scores from the three sections of the EIDS: Academic Identity, Occupational Identify, and Engineering Aspirations. The descriptive statistics are shown in Table 2.

Table 2

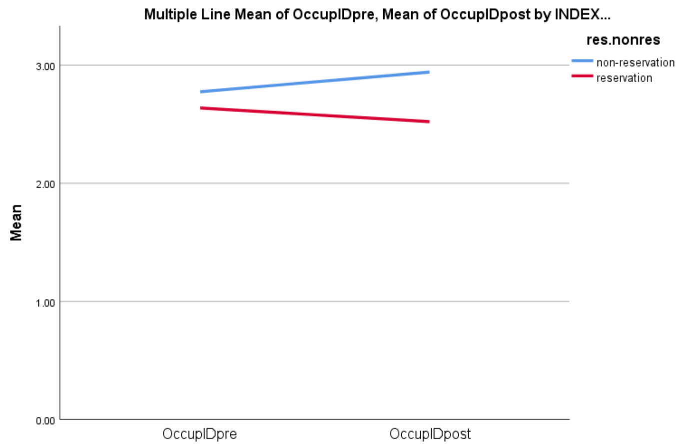
Means and Standard Deviations for Pretest and Posttest Means for Academic Identity, Occupational Identity, and Engineering Aspirations for Reservation and Non-Reservation Students

Descriptive Statistics

	Reservation/ Non-reservation	Mean	Std. Deviation	*n*
Academ ID Pre-Test	non-reservation	2.48	.41	20
	reservation	2.61	.378	23
	Total	2.55	.39	43
Academ ID Post-Test	non-reservation	2.54	.46	20
	reservation	2.54	.42	23
	Total	2.54	.43	43
Occup ID Pre-Test	non-reservation	2.78	.26	20
	reservation	2.64	.39	23
	Total	2.70	.34	43
Occup ID Post-Test	non-reservation	2.94	.16	20
	reservation	2.52	.55	23
	Total	2.72	.46	43
Eng Aspire Pre-Test	non-reservation	2.05	.52	20
	reservation	2.43	.49	23
	Total	2.26	.53	43
Eng Aspire Post-Test	non-reservation	1.96	.45	20
	reservation	2.23	.65	23
	Total	2.11	.57	43

Only the Time x Reservation/Non-Reservation interaction approached significance, Wilks' Lambda =.837, $F(3, 39) = 2.535$, $p = .071$.

A univariate ANOVA using the Greenhouse Geisser correction for unequal variances indicated that there was a significant Time X Reservation/Non-Reservation interaction with a moderate effect size for Occupational Identity, $F(1, 41) = 5.108$, $p = .029$, $\eta^2_p = .111$. Non-Reservation and Reservation students differed little at pretest; however, at posttest, Non-Reservation students tended to have a stronger Occupational Identity than Reservation students.



Conclusions and Next Steps

The lack of significant increases in scores for the reservation students was both surprising and discouraging. The research team witnessed great enthusiasm for the project activities during our visits and the teachers and school administrator shared how valuable the project was on multiple occasions. Students talked about how if they were engineers, they would make sure that all people had enough food to eat and housing. Students were thinking about how engineering could address the problems on their reservation, and this connection to engineering in the local context was one of the goals of the project. This led the research team to question how to adjust our data collection to better determine the impacts of the programming on participating students. Traditional westernized approaches to program assessment may not detect programmatic impacts in Indigenous communities (Maunakea, 2022). As white researchers implementing NSF programming in Indigenous communities, we need to think carefully about the ways we are assessing community research projects. Who decides what counts as success in these programs? Shouldn't success be defined by the communities? According to Maunakea (2022), measures of success in Indigenous communities would not be found in pre/post assessments but would be intergenerational impacts based on the interactions participants have after the programming and the choices they make about the stories they share with family. Moving forward, our research team is engaging in conversations without community partners about how we can work together to define program assessment and how we can stress the importance of using community defined and co-constructed assessment rather than relying on western approaches of using Likert surveys with large sample sizes to produce generalizable data sets.

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