

Exploring Changes in Teachers' Engineering Design Self-Efficacy and Practice Through Collaborative and Culturally Relevant Professional Development

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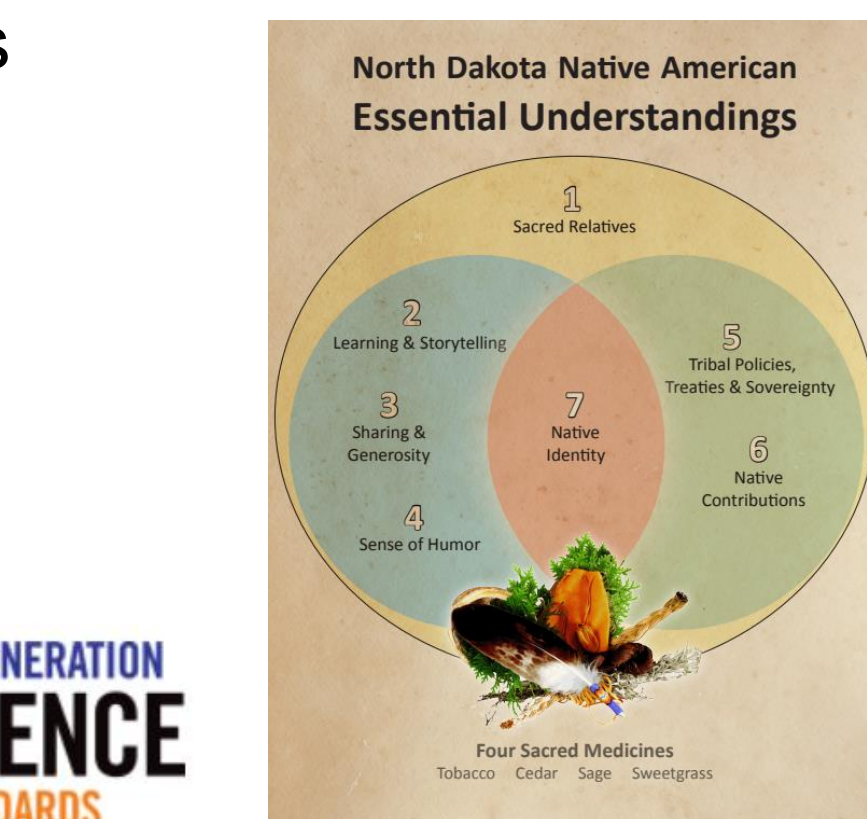
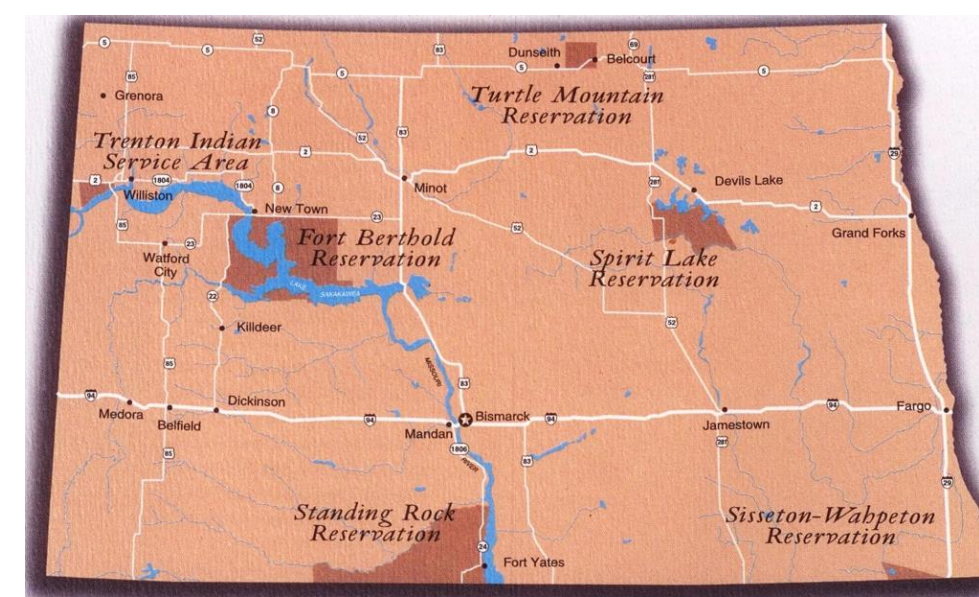
Project Overview

Project ExCEED goals:

- Address need for improved elementary and middle school teacher training in engineering education
- Develop on-going, collaborative professional development program designed to include culturally relevant pedagogy

Project Structure:

- 15 teachers from 4 school districts in or near tribal communities
 - Grades 5-8 in Science, Math, ELA classrooms
- 5 days of summer professional development
- 3 PD days within the academic year
- Classroom implementation of 3 culturally relevant engineering design tasks



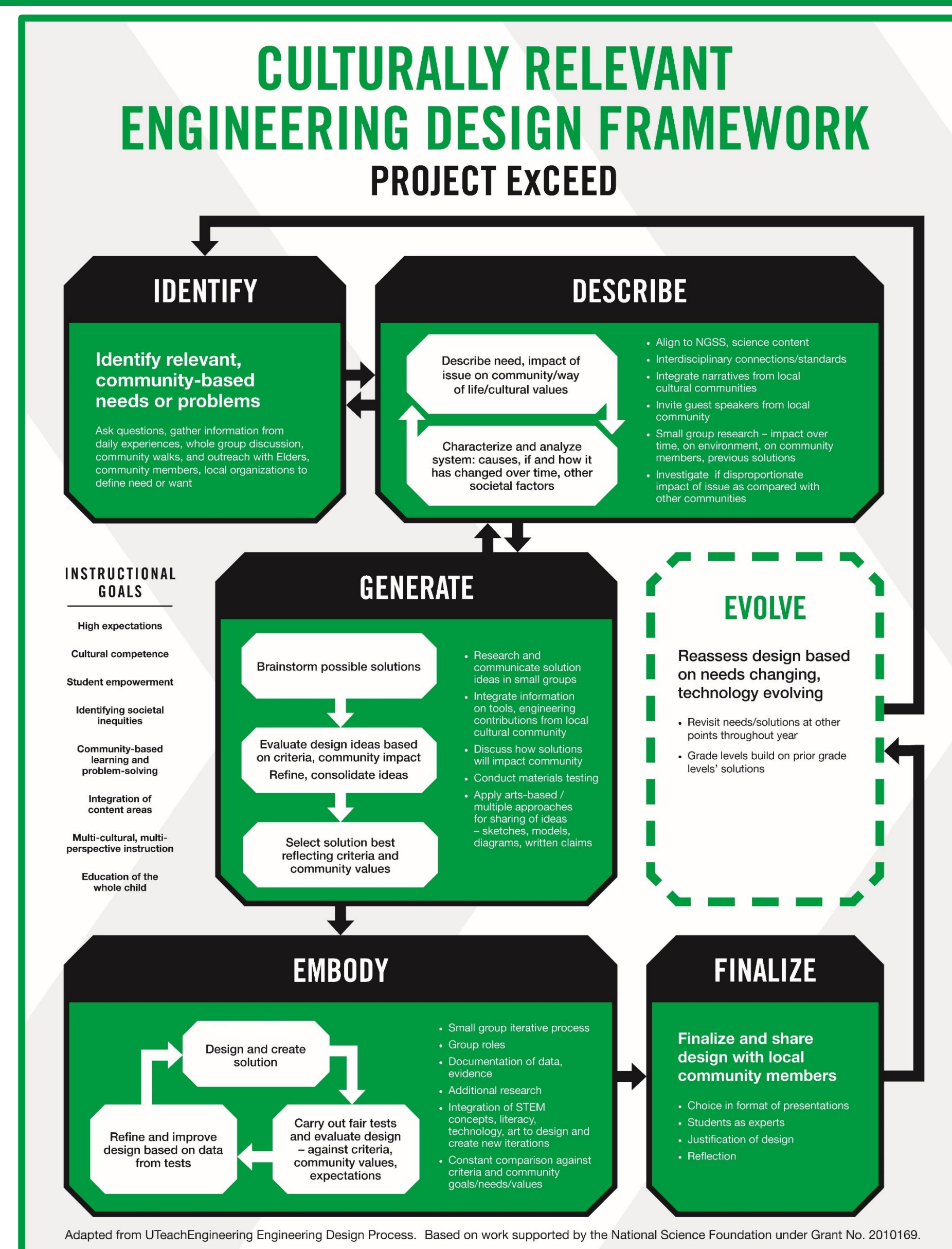
Approach

- Adapted engineering design framework from UTeachEngineering to incorporate culturally responsive teaching principles from Ladson-Billings and Gay
- Culturally responsive practices using "Teaching of our Elders" and "North Dakota Native American Essential Understandings"
- Expertise from TIE's Scott Simpson and Sharla Steever who helped develop the Essential Understandings
- Integration of NGSS



CRED Framework

- Engineering design steps oriented around community needs and cultural values
- Teacher guidance provided for each design step/stage
- Culturally relevant / responsive pedagogy principles highlighted
- Simplified version (without teacher guidance) for classroom use with students



Professional Development Model

Theories, Needs, and Aims

- Theories of adult learning integrate the characteristics of **1) self-concept, 2) learner experience, 3) readiness to learn, 4) immediate applications, 5) internal motivation, and 6) need to know**
- There is a lack of opportunity for professional learning in:
 - Engineering education and pedagogy
 - Culturally relevant (STEM) pedagogy,
 - Rural and Indigenous educational communities and epistemologies

Our aim

Provide PD training in a culturally relevant approach to engineering education, situated with rural and Native communities, and job-embedded and on-going.

Key elements:

- Fostering connections to local community and Indigenous cultural contexts
- Developing teachers' collective efficacy through a cohort model, mentorship, and on-going collaboration
- Teachers have autonomy in how they integrate engineering into their instruction and curriculum across content areas
- Highlighting the breadth of engineering, the design cycle, and creativity in engineering to enhance student engagement
- Providing opportunities for teachers to directly apply new learning to their lesson design and classroom instruction
- Allowing teachers time to reflect on their experiences to consider next steps
- Teachers have input into PD design and content

Research Design

A mixture of quantitative and qualitative data target both research questions (teacher self-efficacy and classroom pedagogy) and both focus areas (cultural relevance and engineering design)

		Focus Area	
		Cultural Relevance	Engineering Design
Research Question	Impact of PD on Teacher Self-Efficacy in CRED instruction	CRTSES interviews	TESS interviews
	Changes in Classroom Pedagogy around CRED	CCIS interviews	interviews

Pre/Post Surveys

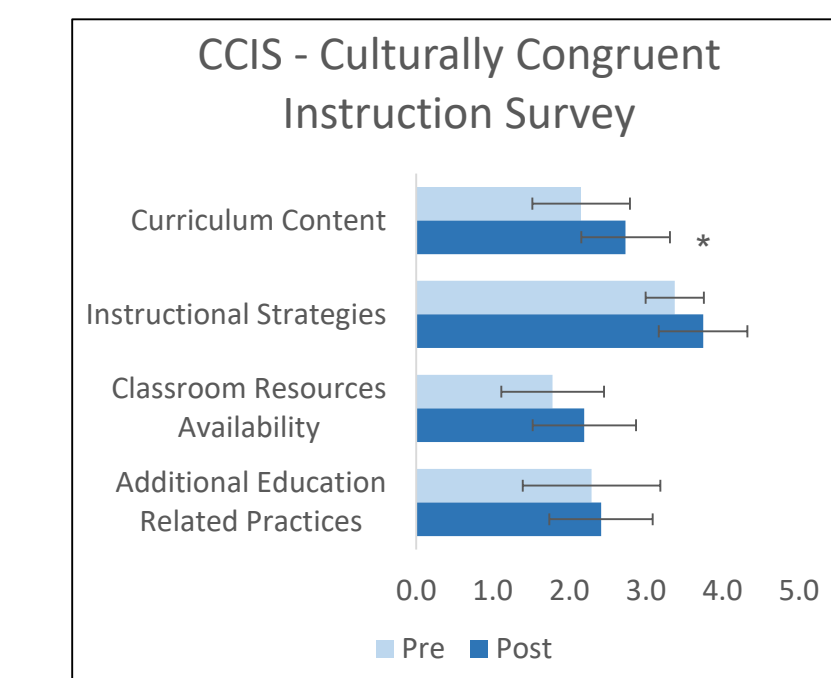
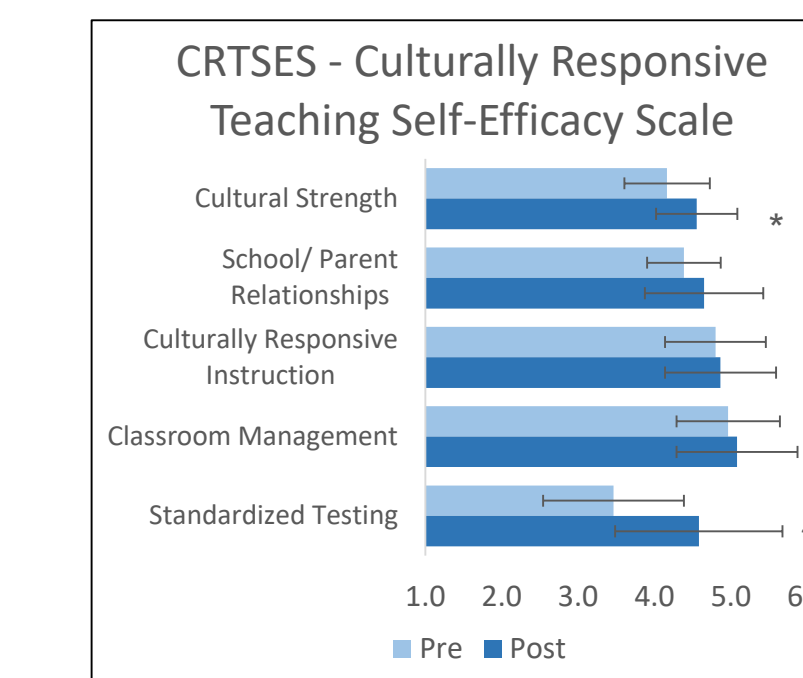
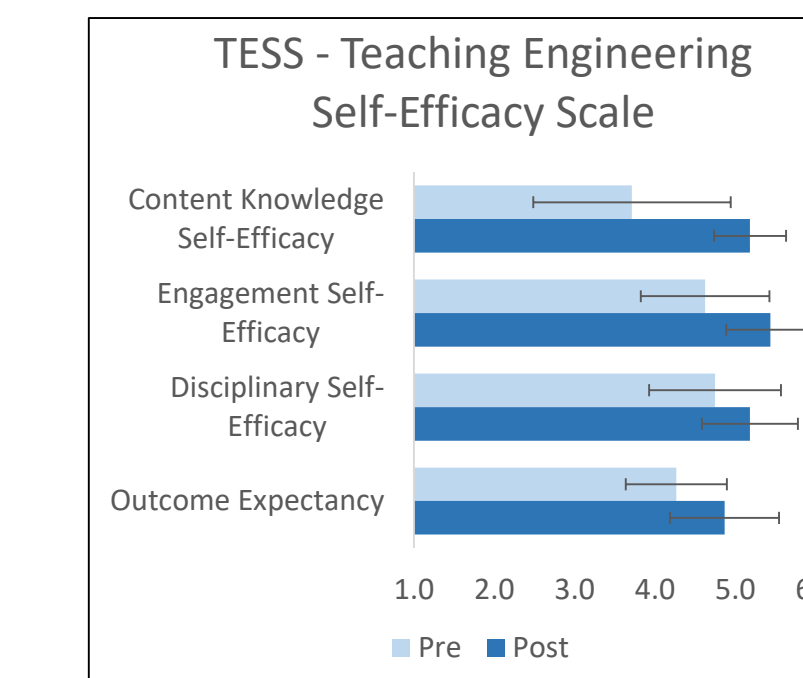
- TESS – Teaching Engineering Self-Efficacy Scale
- CRTSES – Culturally Responsive Teaching Self-Efficacy Scale
- CCIS – Culturally Congruent Instruction Scale

Interviews, Reflections, Observations

- Written Reflections
- Focus Group Interviews
- Classroom Observations
- Analysis of Engineering Lesson Plans

Initial Findings

Teacher Pre/Post Surveys



After one year in the program (summer PD + full school year with PD and classroom implementation) teachers showed statistically significant increases in the following areas:

TESS

- Recognize and appreciate the engineering concepts in all subject areas
- Employ engineering activities in my classroom effectively
- Guide my students' solution development with the engineering design process

CRTSES

- Use examples that are familiar to students from diverse cultural backgrounds

CCIS

- Used traditional stories and STEM knowledge from ND tribes
- Used science activities in which students designed solutions to problems relevant to their community
- Used alternative forms of assessment
- Websites about ND Indian cultures

Teacher Interviews, Reflections & Observations

- Increased engagement from **all** students.
 - Previously struggling/disengaged students taking leadership
 - Changes in girls' confidence and engagement
- Changes to student approaches to learning
 - Better creative problem-solving skills and independent learning
 - Increased confidence on standardized tests
- Changes to teacher practice
 - Culturally relevant pedagogies being embedded throughout their teaching
- Improved teacher self-efficacy
 - confidence, excitement, enthusiasm for implementing engineering tasks
 - Greater awareness of their own communities
- Positive impact of collaboration – among both teachers and students

References

- G. Ladson-Billings, "Toward a theory of culturally relevant pedagogy," *American Educational Research Journal*, vol. 32, no. 3, pp. 465-491, 1995.
- G. Gay, "Preparing for culturally responsive teaching," *Journal of Teacher Education*, vol. 53, no. 2, pp. 106-116, 2001
- L. Guerra, D.T. Allen, R.H. Crawford, and C. Farmer, "A unique approach to characterizing the engineering design process" in *119th ASEE Annual Conference and Exposition, San Antonio, TX, USA, June 10-13, 2012*, American Society for Engineering Education, 2012. Available: <https://peer.asee.org/20878>



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