RICE UNIVERSITY
SCHOOL MATHEMATICS PROJECT

The Effects of a Culturally Relevant Intervention on Computer Science Motivation among Underrepresented Minority Students in High School Geometry

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Background

- Providing access to CS knowledge is an equity issue that must be addressed.
- African Americans, Hispanics, and females continue to be largely underrepresented in CS fields (Zweben & Bizot, 2014).
- Underrepresented minority (URM) students lack opportunities to enroll in CS high school courses and do not see themselves as “fitting in” CS fields (e.g., Goode, 2007).

Purpose

- To expose students to CS by infusing CS concepts into a required high school mathematics course—Geometry.
- To create culturally relevant curriculum that affirms URMs' cultural identities, elicits URMs' value for CS, and enhances URMs' confidence to pursue CS through:
  - computational visual art
  - videos of CS role models from diverse cultural backgrounds

Theoretical Frameworks

- Culturally Relevant Pedagogy (Ladson-Billings, 1995)
  - Cultural competency
  - Critical consciousness
  - High achievement expectations
- Motivation theories of academic and career identity development
  - Expectancy-Value Theory (Eccles, 2009)
    - Self-efficacy and task value for CS
  - Theory of Possible Selves (Markus & Nurius, 1986)
    - CS oriented possible selves

Research Questions

- To what extent does a culturally relevant intervention affect students' motivational beliefs about CS?

- In what ways do students connect with videos that spotlight computational scientists from diverse backgrounds?

Intervention

- Morning Star Quilt Designs

- Richard Tapia: Mexican-American CS role model, National Medal of Science recipient

Method

- Participants
  - 142 10th graders from 6 regular Geometry classes in a large urban school district (3 intervention & 3 control)
- Instruments to assess motivation
  - CS-oriented possible selves
  - CS self-efficacy and task value
- Open-ended: *"Describe how you connected with the Richard Tapia video."*

Hierarchical Linear Regressions Predicting CS Motivational Beliefs

Variable	Possible selves in CS[a]	Self-efficacy for CS[b]	Attainment value for CS[c]	Intrinsic value for CS[d]	Utility value for CS[e]
	β	β	β	β	β
Step 1					
Male	.04	.16*	.05	.04	.01
Hispanic	.12	-.04	.11	.03	.21*
Some CS experience	.30**	.40***	.31**	.36***	.37***
Step 2					
Male	.02	.15	.04	.04	.00
Hispanic	.12	-.04	.11	.03	.21*
Some CS experience	.30**	.40***	.30**	.36***	.37***
Intervention	.17*	.09	.13	.07	.09

Note. β indicates standardized regression coefficient. N = 142.
*p < .05. **p < .01. ***p < .001.
[a] R^2 = .09, p < .01 for Step 1; ΔR^2 = .03, p < .05 for Step 2. [b] R^2 = .19, p < .001 for Step 1; ΔR^2 = .01, p > .05 for Step 2. [c] R^2 = .09, p < .01 for Step 1; ΔR^2 = .02, p > .05 for Step 2.
[d] R^2 = .13, p < .001 for Step 1; ΔR^2 = .00, p > .05 for Step 2. [e] R^2 = .14, p < .001 for Step 1; ΔR^2 = .01, p > .05 for Step 2.

Hierarchical Linear Regressions Predicting CS Motivational Beliefs with Gender Interaction

Variable	Possible selves in CS[a]	Self-efficacy for CS[b]	Attainment value for CS[c]	Intrinsic value for CS[d]	Utility value for CS[e]
	β	β	β	β	β
Step 1					
Male	.02	.15	.04	.00	.03
Intervention	.18*	.10	.15	.10	.17
Step 2					
Male	.21	.42**	.21	.09	-.13
Intervention	.36**	.35**	.30	.18	-.13
Intervention X Gender	-.33*	-.46**	-.29	-.14	.36

Note. β indicates standardized regression coefficient. N = 142.
*p < .05. **p < .01. ***p < .001.
[a] R^2 = .03, p > .05 for Step 1; ΔR^2 = .03, p < .05 for Step 2. [b] R^2 = .04, p > .05 for Step 1; ΔR^2 = .06, p < .01 for Step 2. [c] R^2 = .03, p > .05 for Step 1; ΔR^2 = .02, p > .05 for Step 2.
[d] R^2 = .01, p > .05 for Step 1; ΔR^2 = .02, p > .05 for Step 2. [e] R^2 = .03, p > .05 for Step 1; ΔR^2 = .05, p > .05 for Step 2.

Hierarchical Linear Regressions Predicting CS Motivational Beliefs with Ethnicity Interaction

Variable	Possible selves in CS[a]	Self-efficacy for CS[b]	Attainment value for CS[c]	Intrinsic value for CS[d]	Utility value for CS[e]
	β	β	β	β	β
Step 1					
Hispanic	.03	-.15	.03	-.07	.10
Intervention	.17	.11	.13	.07	.09
Step 2					
Hispanic	-.13	-.36**	-.08	-.22	-.01
Intervention	-.13	-.26	-.06	-.20	-.12
Intervention X Hispanic	.36	.45*	.23	.33	.26

Note. β indicates standardized regression coefficient. N = 142.
*p < .05. **p < .01. ***p < .001.
[a] R^2 = .03, p > .05 for Step 1; ΔR^2 = .02, p > .05 for Step 2. [b] R^2 = .04, p > .05 for Step 1; ΔR^2 = .03, p < .05 for Step 2. [c] R^2 = .02, p > .05 for Step 1; ΔR^2 = .01, p > .05 for Step 2.
[d] R^2 = .01, p > .05 for Step 1; ΔR^2 = .02, p > .05 for Step 2. [e] R^2 = .02, p > .05 for Step 1; ΔR^2 = .01, p > .05 for Step 2.

Qualitative Results

- Ethnic background: *"I identify myself with Richard Tapia because like him, my parents are Mexican and I'm an American citizen."*
- Discrimination: *"It connects to me because of the race I am I get looked down upon."*
- Pride: *"Both my parents are Mexican and were often seen as bad people, but they always taught me to not be discouraged about my heredity and instead wear it proudly."*
- Overcoming adversity: *"It kind of connects to me because some people judge Hispanics and a lot of Hispanics can get to success … despite going through struggles."*

Conclusions

- The intervention had a positive effect on students' CS possible selves.
  - The intervention positively affected the CS self-efficacy and possible selves of female students.
  - The intervention positively affected the CS self-efficacy of Hispanic students.
- Students connected with the role model based on their shared experiences.
- Therefore, culturally relevant pedagogy may be a means to increase the representation of URMs in CS.

Future Studies

- Distinguish the effects of culturally relevant artwork and CS role models on various forms of motivation.
- Extend intervention to include additional videos of individuals working in CS representing other URM groups.
- Explore whether racial/ethnic congruence of role models telling a story of struggle has a stronger effect on CS motivation compared to stories told by models who are not racially/ethnically congruent.

Thank you!

Questions/Comments?

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