

Moving Beyond 'Covering' the Curriculum: Using sTc to Engage All Learners in Science/STEM Education

The University of Canterbury

Graham Nuthall Annual Lecture

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E nga waka

To the many canoes

E nga mana

To the stewards of this region

Tena koutou

Warm greetings

Thanks to Professor Graham

Nuthall's family and Foundation



Agenda

- * POE Demonstration: Sociotransformative constructivism (sTc) in practice
- * What is sTc and how can it be used to address issues of equity, diversity and social justice?
- * Highlights from an sTc research project
- * Recommendations
- * Q&A

Demonstration

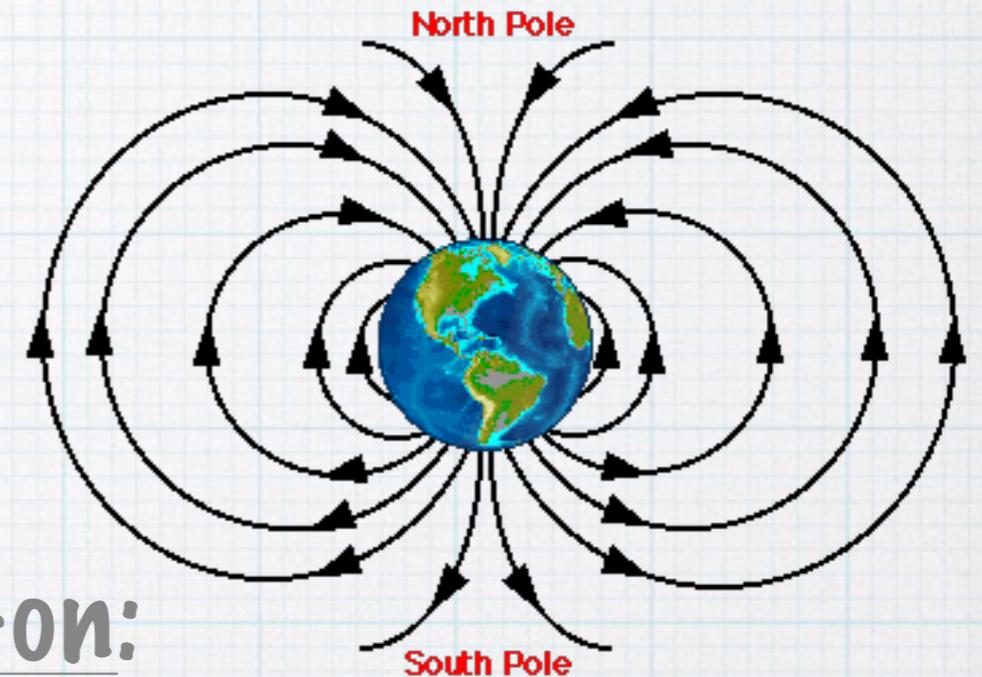
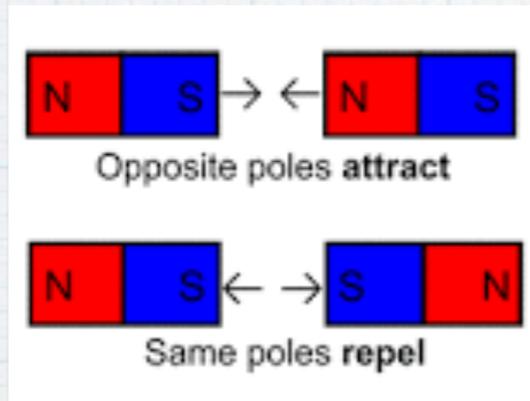
I. Use arrows to draw a model of what you think.
Share your ideas with your partner(s)

P Predict (Write down your prediction and explain)	O Observe (Write down your observations)	E Explain (Compare your prediction with your observation. Explain)

II. Another POE: Iron fillings + magnets

III. Revise models [Elements of engineering design process: Argumentation; construct models; test; revise; try again]

Teacher centered—>Magnetism: blah, blah, blah



Student-centered, minds-on, hands-on:

Create a **NEED TO KNOW** instead—activate scientific curiosity and connection to everyday life:

- +How was magnetism used in ancient times by different cultures? How is it used today?
- +In what ways different cultural groups use magnetism?
- +How is magnetism used in your culture?

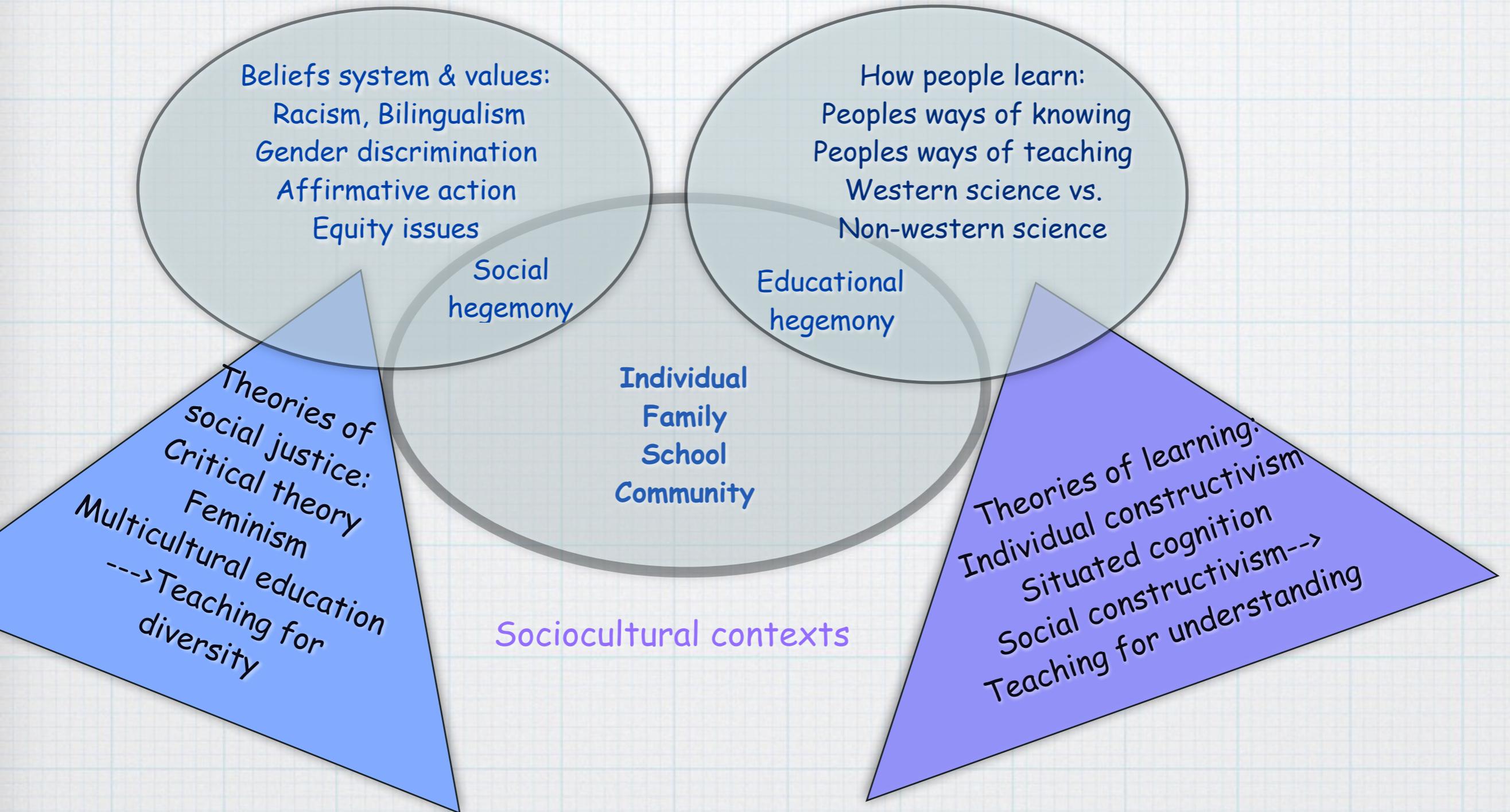


Research,
Read,
write,
STEM,
IT

The pervasive gap in student achievement and the disconnect between science/STEM education research and teacher practice

Ideological orientation

Epistemological orientation



Sociotransformative Constructivism

Ideological orientation:

Cross-cultural education as a theory of social justice

Social justice: Equal opportunities to learn and equal opportunities to succeed.

Empowerment:
Representation & equity

Epistemological orientation:

Social constructivism as a theory of learning

Socially/culturally relevant learning: Hands-on, minds-on, inquiry-based, student-centered.

Enlightenment: Knowledge is mediated and partial

Individual
Family
School
Neighborhood
Community

Sociocultural contexts

sTc

Critical Thinker

* **Sociotransformative constructivism:** An orientation to teaching and learning that takes into account how historical, institutional, and sociocultural codes mediate learning. In addition, power is a central construct in sTc because it is through the access to and use of power that individuals effect personal and social change [Agency] (Rodriguez, 1998, 2015).

* **Four interconnected components:**

* Dialogic Conversation (trust and intellectual and ideological honesty are central constructs)

* Metacognition: Knowing how we learn & why we learn

* Authentic Activity: Contextualizing learning

* Reflexivity awareness of the influence one's sociocultural, academic and ideological locations have on one's own [in]actions—Agency.

Kaupapa Maori Philosophy

(Savage et al, 2011; Bishop, 1992; G. Smith, 1990 and L. Smith, 1999)

1. Tino Rangatiratanga: self-determination
2. Collectivism: Research enterprise benefiting all participants and their collectively determined agendas;
3. Collaboratively defining and prioritizing Maori goals, and
4. Collaboratively designing and implementing theoretical and methodological preferences and practices for research—>stc: decolonizing collaboration + agency=common good



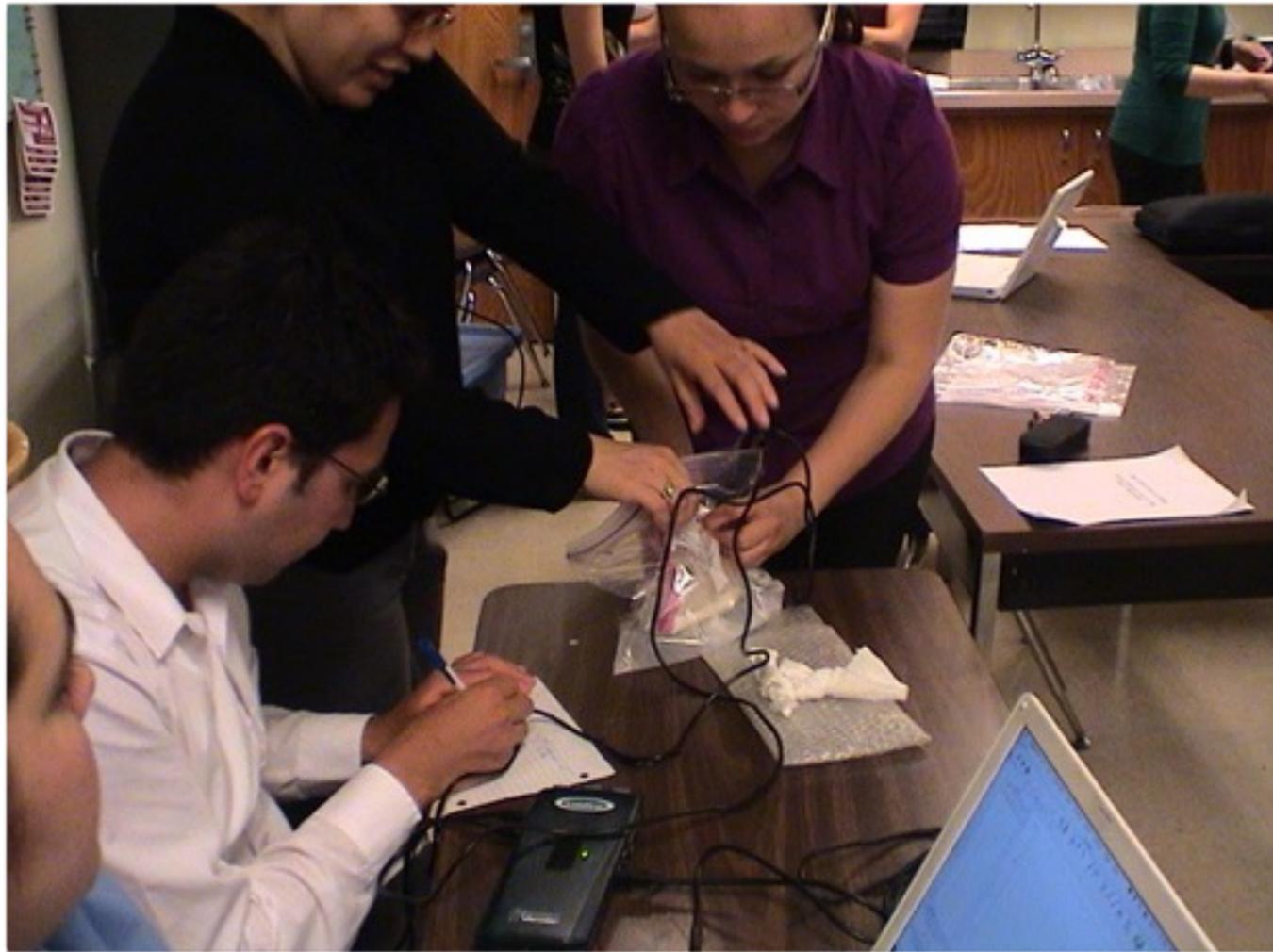
If we know so much about what “should work” and about what is not working, why don’t we conduct more studies about challenges to implementing innovations—“about what should work”?



“Meanwhile, of course, fashions in teaching methods came and went, without much evidence that they were more or less effective than the older methods. All we learned was that teachers inevitably reverted back to the methods that seemed to them to be tried and true.”

**Professor Graham Nuthall
(Inaugural address, Nuthall Classroom Research
Trust, 2004)**

Research Questions:



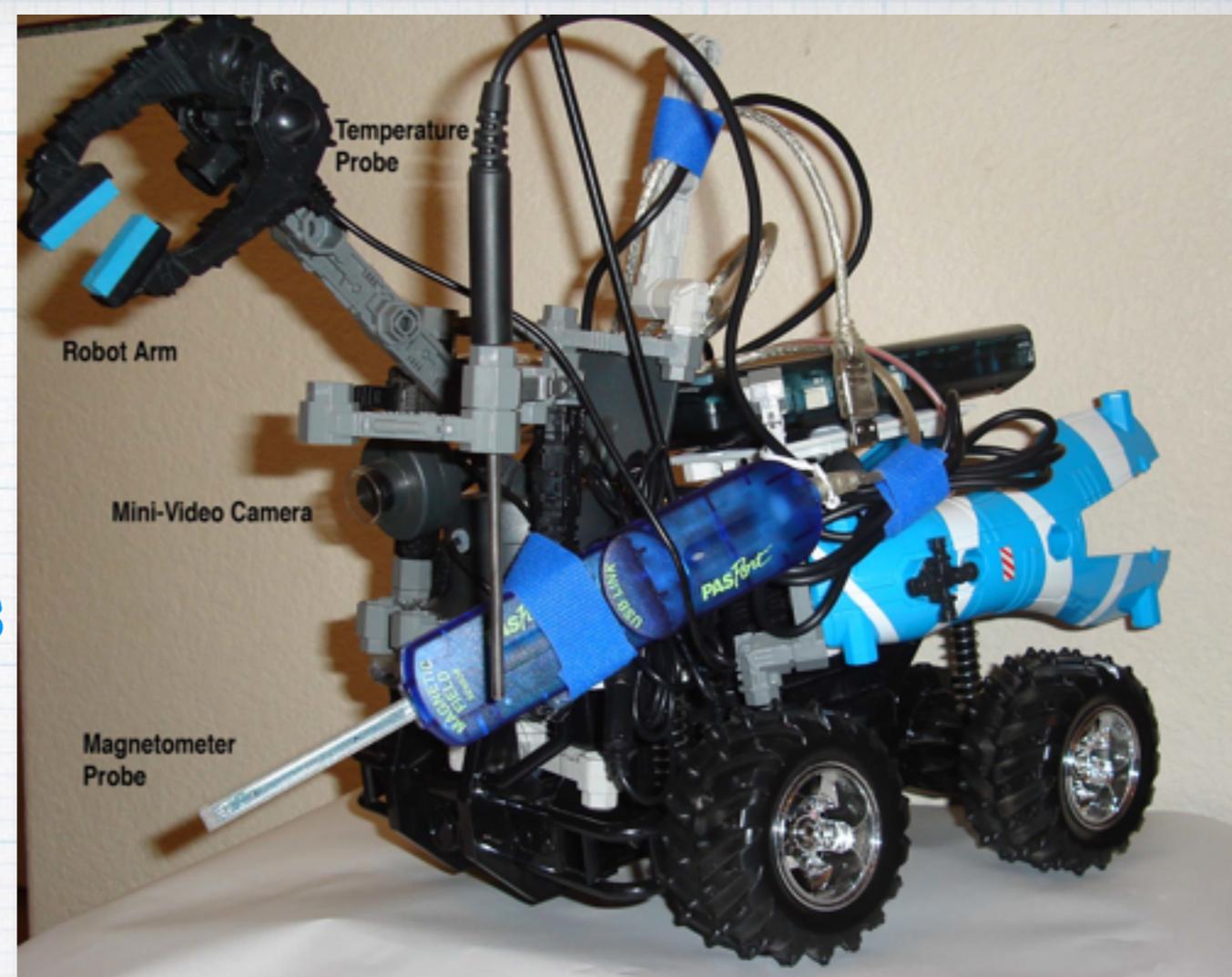
- * **What happens when you implement a project that enacts research-based recommendations and that directly involves teaching for diversity and for understanding?**
- * **What are the challenges to implementing innovation?**
- * **In what ways does a sociotransformative constructivist (sTc) framework impact novice teachers' practice and students' learning?**

Participants, Methodology & Analysis

- ❖ 10 pre-services teachers selected from sTc high school science methods course
- ❖ Placed with supportive cooperating teachers (attended 2-week summer PD institute on sTc)
- ❖ Followed up for two years after graduation in teaching jobs [n=4 -- some moved out of range; moved to elementary ed.]
- ❖ 2 Anglo males; 1 Anglo female and 1 Latina
- ❖ All found jobs in culturally diverse and impoverished schools
- ❖ PD summer institute offered every year
- ❖ Offered learning technologies (Vernier; educ. software, & other equip.)
- ❖ Weekly visits (videotape, field notes & support)
- ❖ Teacher Ethnographic interviews (2-3/year)
- ❖ Student focus group interviews (2/year)
- ❖ Iterative analysis. (Spradley, 1979; Patton, 1987).
- ❖ Impact on student achievement measured using CM's on Year III
- ❖ Paired t-tests calculated using pre & post instruction CM's
- ❖ CM's --two independent scorers (90+ inter-rater reliability).

Examples of sTc Activities

- * A scientist like me--digital quilt
- * Women in science--digital quilt
- * CR/SR problem-solving scenarios [sTc= action component]
- * Problem-solving scenarios in collaborative groups.
- * Group distribution (gender, ELL's, ability).
- * Transdisciplinary Integration (math, technology, engineering, social studies, literacy to promote science talk [argumentation], reading & writing [Spanish & English]).
- * Integration of IT's to support different learning modalities.
- * Promoting persuasive discourse & multiple modes of knowledge representations (modeling, graphics, animations).



Findings

⊕ CONCEPT MAP— Laura - The Cell - Grade 10 Biology

<u>sTc</u> Implementation Level	Students' Mean Scores %	Difference in mean scores	Paired sample <u>t</u> test	Percentage of students with score of = or > 70
DEVELOPING	Pre-test: 9.32 Post-test: 46.09	36.77	<u>t</u> = 11.798 <u>df</u> = 32 <u>n</u> = 33 <u>p</u> < 0.001	12.1%

Pearson's pre: .994 ($p < 0.001$); post: .988 ($p < 0.001$)

CONCEPT MAP— Barbara - Newton's Laws - Grade 9 Physical Sciences

<u>sTc</u> Implementation Level	Students' Mean Scores %	Difference in mean scores	Paired sample <u>t</u> test	Percentage of students with score of = or > 70
ACTIVE	Pre-test: 8.33 Post-test: 69.71	61.38	<u>t</u> = 11.483 <u>df</u> = 17 <u>n</u> = 18 <u>p</u> < 0.001	50%

Pearson's pre: .988 ($p < 0.001$); post: .951 ($p < 0.001$)

Three levels of sTc implementation: Emergent, Developing and Active

Findings

CONCEPT MAP— Gary - The Moon Astronomy - Grades 11-12

<u>sTc</u> Implementation Level	Students' Mean Scores %	Difference in mean scores	Paired sample <u>t</u> test	Percentage of students with score of = or > 70
ACTIVE	Pre-test: 12.86 Post-test: 65.18	52.33	<u>t</u> = 13.043 <u>df</u> = 34 <u>n</u> = 35 <u>p</u> < 0.001	45.7%

Pearson's pre: .982 ($p < 0.001$); post: .988 ($p < 0.001$)

⊕ CONCEPT MAP— Charles - STD - Grade 9 Health

<u>sTc</u> Implementation Level	Students' Mean Scores %	Difference in mean scores	Paired sample <u>t</u> test	Percentage of students with score of = or > 70
ACTIVE	Pre-test: 18.77 Post-test: 64.92	46.15	<u>t</u> = 16396 <u>df</u> = 25 <u>n</u> = 26 <u>p</u> < 0.001	30.8%

Pearson's pre: = .988 ($p < 0.001$); post: .951 ($p < 0.001$)

Three levels of sTc implementation: Emergent, Developing and Active

Case Study: Gary (published in JRST, 2015)

- * Gary, mature, Anglo male, former geologist
- * Two years followed up: Physics/Astr. ->98% Latin@ and 65% free & reduced lunch.
- * A. Giddens' (1984) structure—agency construct—> Gary's agency within/against existing structures.

Findings: Institutional & Sociocultural Challenges —> Agentic Responses

Institutional structural challenges (deeply entrenched policies)

- * Mono-cultural, content-heavy standardized curriculum and assessments
- * Lack of responsive professional development

Sociocultural structural challenges (deeply entrenched racialized interactions)

- * Teachers' low expectations of students
- * Students' low achievement & engagement in science

Sociocultural structural challenges (deeply entrenched racialized interactions) & Agentic Responses

- * Teachers' low expectations of students [Gary's words/his experience...]

- * Vicious cycle of low expectations & disengagement: Gary (1st year): "the teachers that struggle the most, even though they won't admit it, it's probably due to their prejudices. There are people who have been here for a while, that have a bad attitude. You could tell that they are prejudiced and they shouldn't be here"

- * Student Focus group interviews: "there are two kinds of teachers here, the ones that want to be here, and the ones that shouldn't be here."

- * Through sTc's reflexivity & dialogic conversations: "Caught in the cycle of low expectations" "giving in to students' complaints"

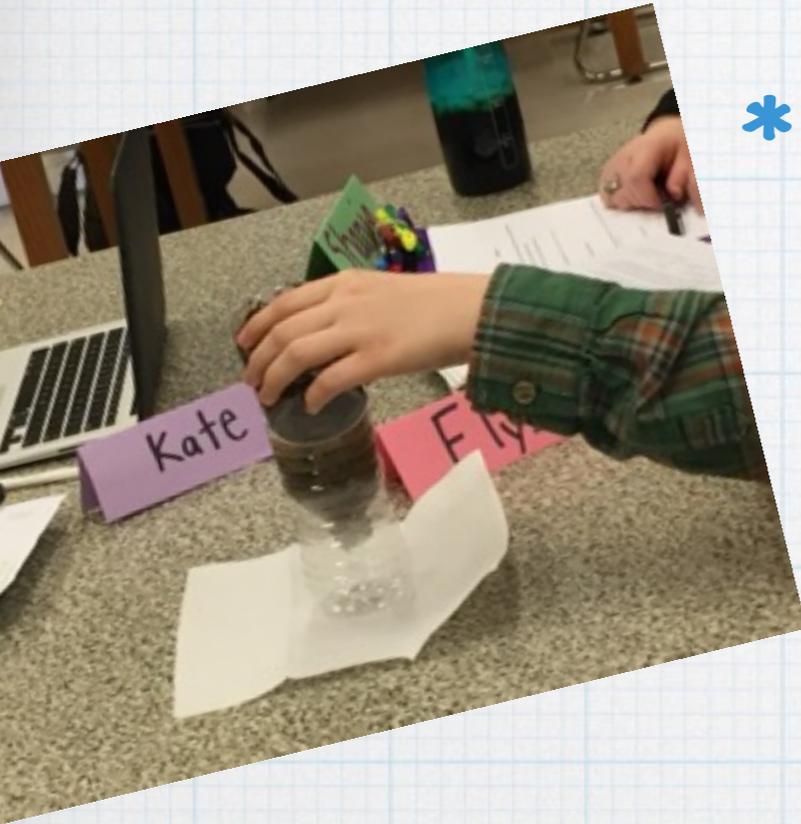


Sociocultural structural challenges (deeply entrenched racialized interactions) & Agentic Responses

* Teachers' low expectations of students (cont'd)

- * Agentic Response: "I think my main area of growth so far was reflecting on what I did my first year. And I think, the biggest mistake I made was giving in to the students a little too much. I think I was influenced by a lot of the existing teachers here. I gave them more and harder work, and I'm glad I did it. Students definitely rose up to the higher expectations level, and I've earned a lot more respect"
- * Agentic Response—High expectations=More support for success: Vocabulary bingo; definition trouble slips; guided reading with ELL's; note taking & study strategies; concept maps to summarize chapters; more bilingual resources; BrainPop.com, and more.
- * New Challenges: Enrollment and attendance increased (Astronomy class n=35+ students). More pressed for time and resources for s/c lessons: "I'm more efficient now and doing more and better activities. I'm covering more content, but now I'm struggling this semester 'cause I've never been this far along in either physics or astronomy, so I have to prepare new lessons every night and covering new stuff"

Sociocultural structural challenges (deeply entrenched racialized interactions) & Agentic Responses



- * **Students' low achievement & engagement in science:**
- * **In School Agentic Response:** Developed & implemented culturally/socially relevant, hands-on and minds-on, inquiry-based (sTc) activities (e.g. model of planet exploration rover; electricity audit)
- * **Out of School Agentic Response:** Fixed observatory & created Astronomy Club; Parents' Night; Science Olympiad
- * **New Challenges: Again—** More pressed for time and resources for sTc lessons: "It takes a lot more time than just copying worksheets out of a workbook. There is no doubt about it, but it's just very rewarding as a teacher to put the extra effort in because I definitely see the results every time I do"

Sociocultural Structural Challenge: Students' low achievement & engagement in science—>

* New Challenges (cont'd)

- * Higher enrollment & attendance: "It's much harder to do inquiry-based activities when you have 35 kids literally crammed into one classroom. I mean really, really tight"
- * Colleagues asking advice
- * Principal invited to do brown bag lunches
- * Piling it on: "My main disappointment this year has been all the additional responsibilities. I came here [this semester] with a fresh attitude after the sTc summer workshop. 'Boy, I'm going to have all this extra time this year, now that I have a basic curriculum to work with. I'm going to have all of this extra time to design new sTc lessons.' But, I'm extremely disappointed with these additional duties and how it really impacted my teaching"

Recommendations

- ✓ Suggestions about what “should work” --do seem to work. (on-going, on-site & responsive). More large-scale studies needed.
- ✓ Need to continue investigating challenges to innovation and best PD practices for teachers. (Move from narratives of despair or cheery narratives to narratives of engagement). -> Measure impact on st. learning! [Prof. Nuthall]
- ✓ sTc provides a useful theoretical framework to enhance research on teacher PD and student learning with a focus on cross-cultural education and social justice.
- ✓ sTc pedagogy has a significant impact on student achievement & engagement. Active sTc implementation level --> Higher achievement—>Next step develop sTc Observation protocol
- ✓ Administrators should provide more support to beginning teachers (e.g. less comm. duties; RT for conducting in-service; curriculum resources; Time to develop lessons & Responsive PD.



More on STC

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