Supporting High School Students and Teachers with a Digital, Localizable, Climate Education Experience: Quantitative Instruments to Measure Students' Environmental Science Agency

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Climate Education Pathways Context

Context and Purpose

As climate change will impact students' lives, students need to understand the science behind climate change and develop a sense of agency. Youth frame climate change using distant language, suggesting approaches that center people, local place and present time (Busch & Chávez, 2022). We are designing and testing a localized, storyline-based, NGSS climate learning unit that supports high school student's environmental science agency (ESA). Prior work has explored ESA outcomes using qualitative approaches (Ballard et. al 2017), yet few quantitative measures exist.

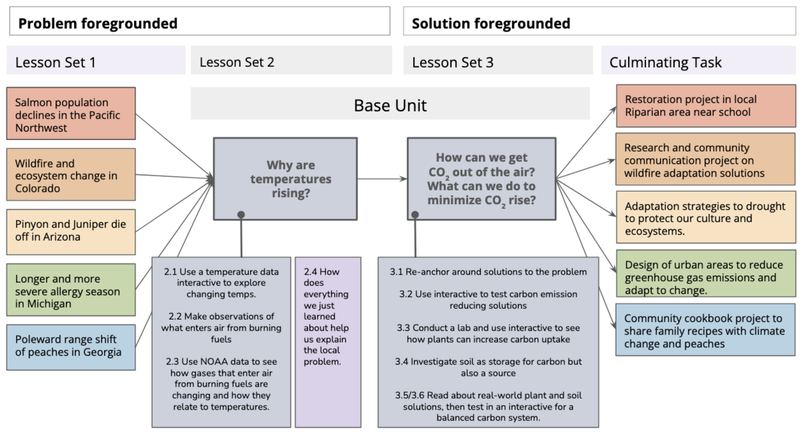
Project Research Questions

- To what extent do established practices (coherence and sensemaking), enacted in a climate change science unit, correlate with ESA?
- To what extent do innovative strategies for science learning "localization" influence students' ESA outcomes?

Poster Research Question:

- To what extent do the newly developed measures for Engaging in Science Roles, Science Identity, and Knowledge of Climate Change correlate with foundations for change, as measured by the Transformative Experience Questionnaire (TEQ)?

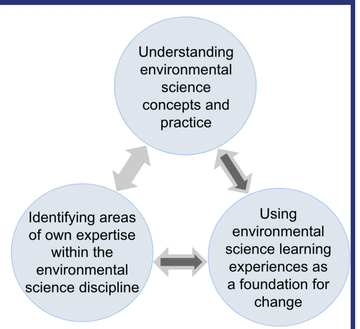
Localized pathways sharing a common base unit.



Theoretical Framework

Environmental Science Agency

Environmental science agency (ESA) (Ballard et al., 2017) focuses on how young people use their disciplinary science learning experiences to take action for environmental sustainability. It involves learners understanding science concepts and practices, identifying areas of expertise within the discipline, and using experiences as a foundation for change to act in one's life or community.



Methods

Quantifying Environmental Science Agency

ESA was measured quantitively through three newly developed instruments and two previously developed measures. The Transformational Experience Questionnaire (Littrell et al., 2022) was used to measure foundations for change while the Six Americas Super Short Survey (SASSY) was used to categorize different views of climate change (Chryst et al., 2018).

Newly Developed Instruments		
ESA Aspect	**Instrument**	**Questions**
Science concepts	Knowledge	Multiple choice and 3D questions about knowledge of climate change
Areas of expertise and engaging in science and social roles	Identity	Likert-style questions about experiences in science class
	Roles	Scenario-based Likert-style questions about enjoyment of taking on different role related tasks

Data Collection and Statistical Methods

Pre-instruction survey data was collected from 1,233 students. Rasch modeling was used to estimate person measures for each instrument except the SASSY. SASSY responses were used to categorize students into one of the six audience groups on their view of climate change.

These were then utilized in mixed-effects, multilevel regression analyses to examine the correlational validity of each measure with the TEQ, while controlling for the SASSY. We conducted a series of analyses examining the differences of effects within and between classrooms.

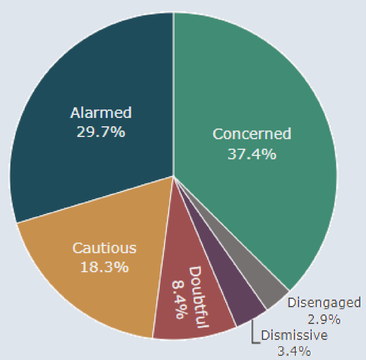
Results

Instrument Psychometrics

Instrument	Person Rel (Sep)	Item Rel (Sep)	Cronbach's Alpha	Variance Explained
Roles	0.90 (2.94)	0.99 (9.03)	0.88	34.8%
Identity	0.85 (2.35)	0.98 (6.98)	0.83	40.3%
Knowledge	0.79 (1.94)	1.00 (21.1)	0.74	38.3%
TEQ	0.89 (2.86)	0.99 (12.6)	0.95	65.3%

SASSY Results

The pie chart to the right illustrates the distribution of students across the six categories derived from the SASSY survey. Compared to national estimates our sample exhibits a higher percentage of students categorized as "Alarmed" or "Concerned", while displaying a lower percentage in the "Disengaged", "Doubtful", or "Dismissive" categories.



Results Continued

Mixed-effects multilevel regression analyses

Our first model examined raw correlations between our new variables and the TEQ. To reduce confounding, we iteratively added controls and adjusted variables to the model. Our final model included classroom centered average variables and scores of each student's deviance from their classroom mean, SASSY categorization and teacher fixed effects.

The positive correlational effect of roles shows that in classrooms, teachers can have an impact on positioning students to take on and engage in various roles that impacts students' environmental science agency. The coefficient of our roles measure, surpassing that of the SASSY, suggests that it captures a distinct facet of the domain that contributes to ESA.

Predictor	Coefficient	P Value
Roles	0.777	.000
Identity	0.212	.004
Knowledge	0.141	.009
SASSY	0.647	.000
Class Roles	0.412	.110
Class Identity	-0.112	.406
Class Know.	0.209	.174
Class SASSY	0.869	.000
Constant	-4.840	.000

Conclusions

Quantifying Environmental Science Agency

The findings indicate that the novel instruments demonstrate validity and exhibit correlations to foundations for change, providing evidence for the successful quantitative measurement of ESA.

Next Steps

Following post-test, and treatment year data collection and analysis we will assess the impact of our newly developed *Climate Education Pathways* materials on ESA.

While the measures are reliably correlated with the TEQ within the context of climate change, it would be intriguing to investigate the relationships between variables across new disciplinary contexts and age groups, all falling within the purview of ESA.

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