Differences between students and teachers in the perceived relevance of a localized climate change unit

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Introduction to the Problem

NGSS calls for using real-world phenomena that matter to students to motivate sensemaking and create equitable learning experiences (NGSS Lead States, 2013). Creating equitable science learning experiences also necessitates the need to attend to students' interests, experiences, and identities (NRC, 2012; Suárez & Bell, 2019). This presents a challenge for curriculum designers and teachers. For curriculum designers, there is a challenge around knowing what matters or is meaningful because that differs across individuals and communities. Some projects like OpenSciEd or NextGenStorylines use surveys to broadly identify what is important or interesting to students (e.g., Penuel et al., 2022). However, research also shows that anchoring student learning to locally relevant phenomena of personal or community consequence is a particularly productive way to make learning meaningful for students (Adah Miller et al., 2022; DeBarger et al., 2013, 2017). Further, creating materials that are locally relevant and/or that are anchored in phenomena that matter to students is a resource-intensive and time-consuming process, making it inaccessible for many teachers.

Within climate education, the challenges of attending to NGSS while also creating meaningful learning are further compounded because climate change phenomena and impacts can vary within and across communities. And, while student learning is important, what is needed are locally consequential materials that draw attention to actions students can take and that can support agency and hope (Lee & Grapin, 2022; Monroe et al., 2019). Thus, climate change learning is a fruitful context to explore the influence of localization of phenomena given

the varied impacts of it on communities. We also argue that it is a productive context for supporting teachers to customize instructional materials (e.g., McNeill et al., 2024), to support rigorous instruction and meaningful learning (Penuel & Gallagher, 2009; Penuel et al., 2009), improve science learning (Penuel et al., 2011), and to foster agency and hope in students (e.g., L. Mohan et al., 2024).

In this roundtable proposal, we report on the results of a cohort-controlled quasi-experimental study that was part of a larger design-based implementation project focused on revealing the impacts of a localizable climate change unit on developing students' environmental science agency (Ballard, Dixon, & Harris, 2017). The larger project supported teachers in adapting a climate change unit to anchor learning in local climate problems and solutions, and that leveraged teachers' knowledge of their community, students, and local phenomena to create meaningful learning. We also developed a professional learning program to support teacher design and adaptation. In this smaller study that we will discuss in a roundtable, we examined data collected from student exit ticket surveys and teacher implementation surveys to examine how students and teachers perceived the relevance of the localized unit. Our research question is: *How do teachers and students perceive the relevance of a localized, phenomenon-driven climate change unit in comparison to teachers' business-as-usual approach for teaching about climate change?*

Design/Procedure

We report on quasi-experimental data collected during the 2022-23 and 2023-24 school years from 25 high school science teachers in the United States and 2,065 of their students. During the spring of the 2022-23 school year, participating teachers taught about climate change using their existing materials ("business as usual" [BAU unit]) and in spring of the 2023-24 school year taught a phenomenon-driven and localized climate change unit ("localized unit")

developed in collaboration with the research team. Students and teachers came from diverse communities concerning race, economics, geography, climate change impacts, and support for teaching about climate change. Table 1 provides a brief overview of the distribution of students across the BAU and localized samples.

Table 1. *Overall BAU and Localized Unit sample sizes.*

Total Sample	**BAU Sample**	**Localized Unit Sample**
2065	1123	945
Total Classes	**BAU Classes**	**Localized Classes**
143	77	66

During both the BAU and localized units, students and teachers completed a survey at three different time points: (0) at the beginning of their units, (1) approximately halfway through the units, and (2) when the units were completed. The student exit ticket survey consisted of 12 items, and teachers completed a comprehensive implementation log that asked a series of questions that varied based on where they were in both their BAU and Localized Units. Multiple items were similar across both the student exit tickets and teacher implementation logs concerning perceptions of relevance, coherence, and sensemaking; however, for this roundtable, we are only focusing on the results of three relevance items. The three Likert-scale items were created to measure the perceived relevance of localized climate lessons to students and as perceived by teachers. The items were based on items used in other projects to measure the relevance of lessons and phenomena (e.g. Penuel et al., 2022). It is important to note that while students were responding individually, teachers were responding to the items at the end of their instructional day and were asked to respond by how they perceived the relevance of the instructional materials for all of the classes they taught on that particular day. See Table 3 for a list of the items used in the survey.

Table 3. *Likert-scale questions used to measure the perceived relevance of localized climate lessons to students and as perceived by teachers (1 – Not true at all for me, 2, 3 – Somewhat true for me, 4, 5 – Very true for me).*

Item	Question
1	Today's science lesson was personally meaningful (to me/to my students).
2	Today's lesson relates to a problem we have in our city/town/community that needs to be solved.
3	If people in my city or town understood the science (we learned/I taught) in today's lesson, they would do something that could help make our city or town a better place.

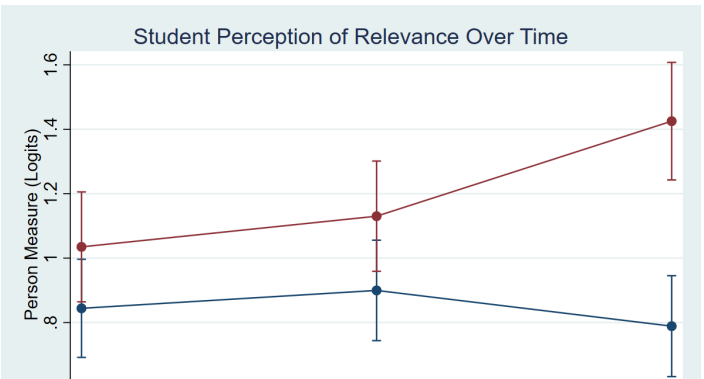
To examine changes in teachers' and students' perception of relevance over time, we transformed raw scores from each survey to Rasch person measures, or logits, which were then used in mixed-effects regression models. These models included time, treatment condition, and their interaction as fixed effects, with random intercepts for individual students or teachers to account for repeated measures. We also report on an additional qualitative data source that comes from teacher implementation logs. Teachers were asked to reflect on the localization and relevance of their Localized Unit. Table 4 provides an overview of the open-ended survey items. Their responses are used to understand and elaborate on the findings from the relevance measures.

Table 4. *Open-ended localization and relevance items were asked on teacher implementation logs at three-time points while teaching their Localized Unit (beginning, middle, and end).*

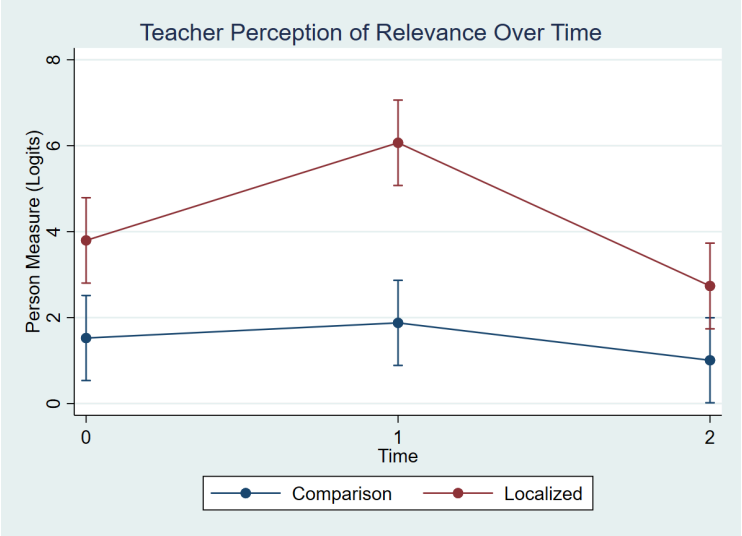
Item	Question
1	What local connections did you include in your unit?
2	What local connections did your students bring to your unit?
3	What other methods did you use to tap into personal relevance for your students during your new unit?
4	About what percent of your unit was spent on local connections or topics that students found relevant to them?

Analysis and Findings

Students' perception of relevance over time. Analysis revealed that the



localized unit did not have a significant effect on students' perception of relevance over time in comparison to the BAU ($\beta = 0.19$, $p = 0.102$). Students' perceptions tended to remain relatively stable across both units with no significant changes at either Time 1 ($\beta = 0.06$, $p = 0.488$) or Time 2 ($\beta = -0.06$, $p = 0.491$). However, a significant interaction effect between treatment and time emerged at Time 2 for the localized unit ($\beta = 0.45$, $p < .001$), indicating that students in the localized unit reported higher relevance at the end of the unit compared to those in the BAU condition. There was no significant interaction at Time 1 ($\beta = 0.04$, $p = 0.743$). Figure 1 illustrates the results of our analysis of the effects of the BAU and localized units on students' perceptions of relevance over time.



When teachers were asked to report on how they were tapping into the personal relevance of their students, they reported a variety of ways that they were trying to do so; however, one teacher did report that "I don't know if I did a good job of this, I am struggling to think of ways I did this." Others reported that they asked students to consider the immediate impacts of climate change on themselves, their families, and their communities. For example, one teacher who localized around the expansion of Lyme disease and climate change stated, "We talked a lot about hunting and seeing ticks on the deer they hunt, and how when they butcher the deer, they have changed where they do the initial prep from inside sheds to outside."

Teachers' perception of relevance over time. Analysis revealed there was a large, significant, and positive effect of the localized unit on teachers' perceived relevance of the unit

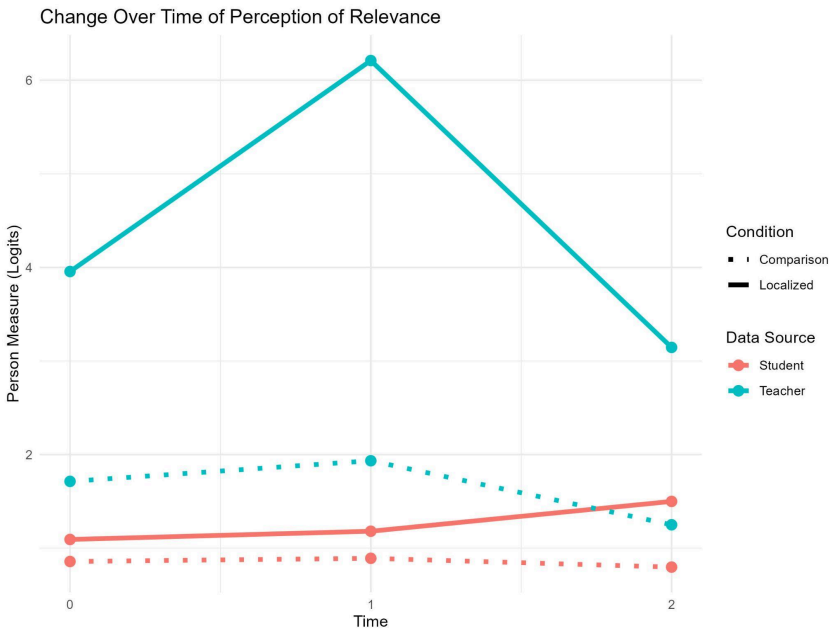
to students ($\beta = 2.27$, $p < 0.001$). Teachers' perceptions of relevance changed significantly over time in both units, with an increase at Time 1 ($\beta = 0.35$, $p = 0.005$) and a decrease at Time 2 ($\beta = -0.52$, $p < 0.001$). Significant interaction effects between treatment and time were observed, with a large positive interaction at Time 1 ($\beta = 1.92$, $p < 0.001$) and a negative interaction at Time 2 ($\beta = -0.54$, $p = 0.005$). Figure 2 illustrates the results of our analysis of teachers' perceptions of relevance over time in both the localized and BAU units.

When teachers were asked to report on the local connections their students were bringing to the unit, they indicated a range of ways their students identified connections between what they were learning in the classroom and the local impacts of climate change on their communities. For example, students were reporting connections they had to climate-related wildfires and agricultural-related impacts. Teachers' responses also indicated an increased level of engagement for some of their students. One teacher who created a localized unit focused on the local decline in brook trout noted that "I had a handful of students who were very interested in fly fishing and contributed a lot to understanding. One in particular is not very interested in school, but has been thoroughly engaged in the unit, so that was a plus!"

Discussion

Our findings indicate that the localized unit influenced both students' and teachers' perceptions of relevance but with different patterns. Teachers in the localized unit condition showed significantly higher perceptions of relevance overall compared to their perceptions in the BAU condition. In contrast, there were small but insignificant changes in students' perceptions of relevance until the localized unit was completed, at which point students in the localized condition showed a significantly higher perception of relevance compared to those in the BAU condition. The slight increase we saw at the end of the localized unit could be because the unit

also was designed for students to apply their understanding in a culminating task that could include implementing a localized solution and/or communicating their knowledge in some way to an authentic audience. It is possible that the culminating task served as an opportunity for students to come to see how classroom science can help them understand and explain problems in their own communities (e.g., Calabrese Barton & Tan, 2010), thus fostering some sense of relevance for them (Stuckey et al., 2013).



Interestingly, teachers started with a higher overall perceived relevance of both the BAU and localized units than did students but did not perceive the localized unit to be as relevant as it was to students in the end. Figure 3 illustrates the comparison between teachers' and students' perceived relevance following both the BAU and localized units. Some of these differences could be explained by the teachers' own experiences in designing the localized student for student relevance. They had designed the unit to be relevant for their students, so we can imagine that they would perceive it to be relevant for their students in the beginning. Some of the measured differences in perception also could be explained by the average perceived measure scores for students and teachers on the first survey item, "Today's science lesson was personally meaningful (to me/to my students)." In Table 2, we can see that teachers and students had very different average scores across all time points in both

treatments for Item 1, while their responses were relatively similar for the other two items. Wright maps from the Rasch analysis also indicated that the item itself was more difficult to respond to, for both teachers and students, than the other perceived relevance items.

Table 2. Average perceived relevance scores for teachers and students on perceived relevance items.

		Item 1		Item 2		Item 3	
	Time	Student	Teacher	Student	Teacher	Student	Teacher
BAU	0	2.96	4.20	3.72	3.80	3.48	4.24
	1	4.20	3.96	3.80	3.80	3.43	3.92
	2	3.06	4.44	3.48	4.28	3.38	4.52
Localized Unit	0	3.96	4.68	4.24	4.96	3.56	4.84
	1	3.02	4.80	3.57	4.96	3.58	4.80
	2	4.44	4.68	3.80	5.42	3.75	5.08

While we have some ideas for why the differences in perception are present, we believe this warrants further discussion with peers, particularly with respect to the diminishing perception that teachers had over time in comparison to students' increasing perception over time. In the roundtable, we plan to present a brief overview of the study, provide a handout detailing the findings of the study, and engage participants in discussion around three primary questions:

1. What could be causing teachers to perceive the relevance of the localized unit to be decreasing, while their students' perceived relevance is increasing?
2. What are the broader implications of these findings for customizing curriculum to attend to local relevance?
3. What are the broader implications of these findings for phenomenon-driven instruction intended to be relevant to students?

This roundtable discussion will be of interest to NARST members given the need for impactful climate change education (Project Drawdown, 2023) and the large number of sessions focused on curriculum adaptation and localization seen at the 2024 NARST Annual Conference.

Additionally, this proposal is related to the 2025 theme, “In Praise of Science Teachers: Essential Partners in Researching, Reframing, and Reforming Science Learning” as this project would not have been possible without our partner teachers who collaborated with us to reimagine what climate education could look like in their classrooms.

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