

**JULY 14, 2022, EARTH EDUCATORS' RENDEZVOUS
TWIN CITIES, MN**



LEARNING AND IDENTITY WORK IN A FIELD- BASED INTRODUCTORY GEOLOGY COURSE

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The Team



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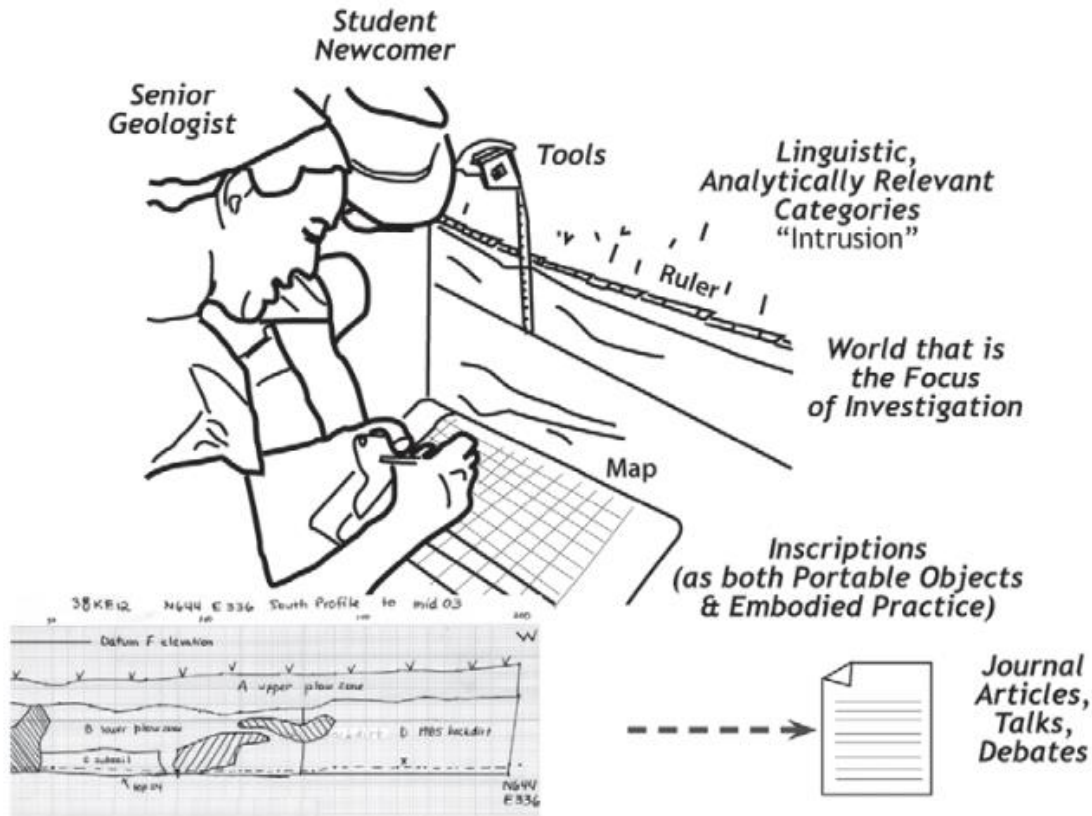
Teaching Assistant



Adam Papendieck

Ed. Researcher
(Backup Van Driver)

- In Field School the Senior GeoScientist can Observe both
- The Landscape that is the focus of Investigation
 - The Operations the Student is Performing on that Landscape



(Mogk & Goodwin, 2012)

A large, leafy green tree dominates the center of the image. To its right, a tall metal windmill stands against a bright blue sky filled with scattered white clouds. The scene is outdoors and appears to be a rural or park setting.

The White Family Outdoor Learning Center

Place- and Field-based Learning: Important and Imperfect

Place- and field-based learning experiences have been shown to contribute to students' understandings of the earth as a complex system and strengthen their scientific identities (Mogk and Goodwin, 2012; Semken et al., 2017).

Historically field-based sciences like geology are among the least diverse of all STEM disciplines (Bernard & Cooperdock, 2018; Dutt, 2020; Feig et al., 2019)

How can we design field- and place-based experiences that work better for a diversity of learners?

GEO 401: Physical Geology (Field-based)

People

- 3 Instructors + 1 TA
- N = 17 students
 - all first semester GEO majors
 - ~53% female, ~50% URM (n=13)
- Interactions with >10 experts

Semester Routine

- Classroom on Wednesdays
- Field trips on Fridays
 - In and around Austin
- Small group debriefs

Texts

- *Understanding Earth*, 8th edition by Grotziner & Jordan
- Field trip advanced organizers

Graded Activities

- Notes and drawings in field notebooks
- Textbook readings and quizzes
- Four written reflections/syntheses
- Participation

Design Conjectures (Sandoval, 2014)

1. **Conceptual conjecture:** Focusing on specific questions in specific local field sites will allow students to integrate geoscientific subdisciplines and develop complex conceptualizations of the earth as a system.
2. **Identity conjecture:** Forming an inclusive geoscientific community with students in local places that matter to them will contribute to the development of their discipline-based identities.

Design-based Research

(Barab & Squire, 2004)

Course Artifact Analysis

- *Reflections*
- *Field notebooks*

Semi-structured Interviews

- *Experience and reaction to course*
- *Pathway into and beyond course*

GOALS:

Inform Course Design and Solve Problems of Practice

Develop Theory

- *Disciplinary identity development*
- *Development of complexity and systems conceptualizations*

Identify & Share What Works and Scales

Surveys

- *Modified URSSA (Weston & Laursen, 2015)*
- *Standard institutional course evals*

Ethnographic Work

- *Participant observation: fieldnotes, photos, recordings*



What are we learning?

(image source: field observations)

CONCEPTUAL COMPLEXITY

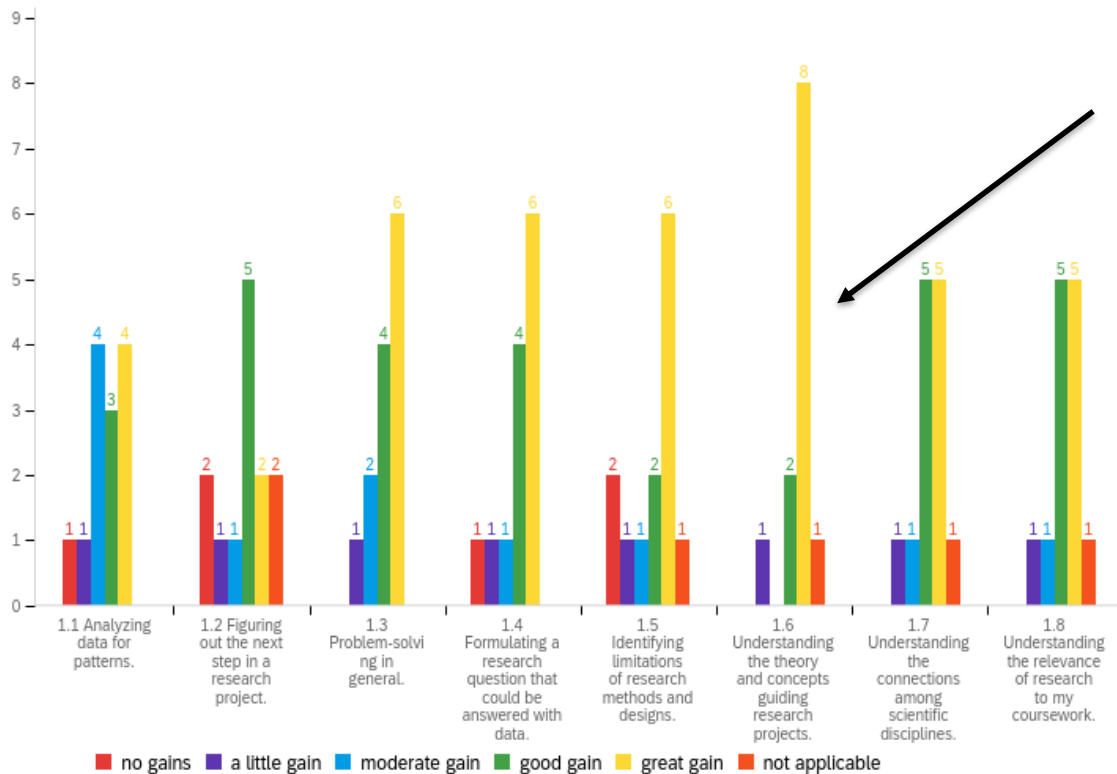
Complex Understanding of Earth and Discipline

- “I didn't realize just **how complex our earth really is**, I always knew it was complex but not on the scale I do now.”
- “I figured out that **everything in Earth is connected to one another**, rather than the different sciences being separate.”
- “I never realized how many different directions and subfields there are in geology.”
- “There were some concepts that I had previously learned in prior classes like Environmental Science, but **this class allowed me to tie those concepts to Geology/ understand their interconnection.**”

(source: post-course survey)

Knowledge Gains (source: modified URSSA)

How much did you GAIN in the following areas as a result of your recent course experience?



Understanding connections among disciplines

Earth System Interactions

Next step: Code student writing to evaluate *knowledge integration* (Liu, Lee & Linn, 2011) across earth spheres and disciplines.

Knowledge integration level (score)	Criteria	Examples
No answer (0)	Blank or random answer	<ul style="list-style-type: none"> I don't know
Off-task (1)	Irrelevant to the question	
No-Link: Non-normative ideas (2)	Elicited non-normative ideas or restated the multiple choice answer.	<ul style="list-style-type: none"> The elements go back to the environment <i>[restatement of the question and answer...no additional info is added]</i>.
Partial-Link: Normative ideas (3)	Elicited one of the ideas listed above.	<ul style="list-style-type: none"> I believe that the animals and plants go inside of the ground once they die and decomposers feed on them <i>[process idea]</i>. Because the elements go back in the earth. <i>[outcome idea]</i> When things die they decompose. <i>[outcome idea]</i> When they die they fertilize the soil. <i>[impact idea]</i>
Full-link: Single link between two normative ideas (4)	Used one of the links listed above.	<ul style="list-style-type: none"> They get decomposed by a decomposer <i>[process + outcome]</i>. The decomposers would put the nutrients back into the ground <i>[process + impact]</i>. When an animal or a plant dies, the worms eat it and make it into soil, which trees need to survive <i>[process + impact]</i>.
Complex-Link: Two or more links between normative ideas (5)	Used the Process-Outcome-Impact link	<ul style="list-style-type: none"> The dead animals and plants are decomposed (or change into elements) by decomposers and the elements are used by plants to grow <i>[process + outcome + impact]</i>

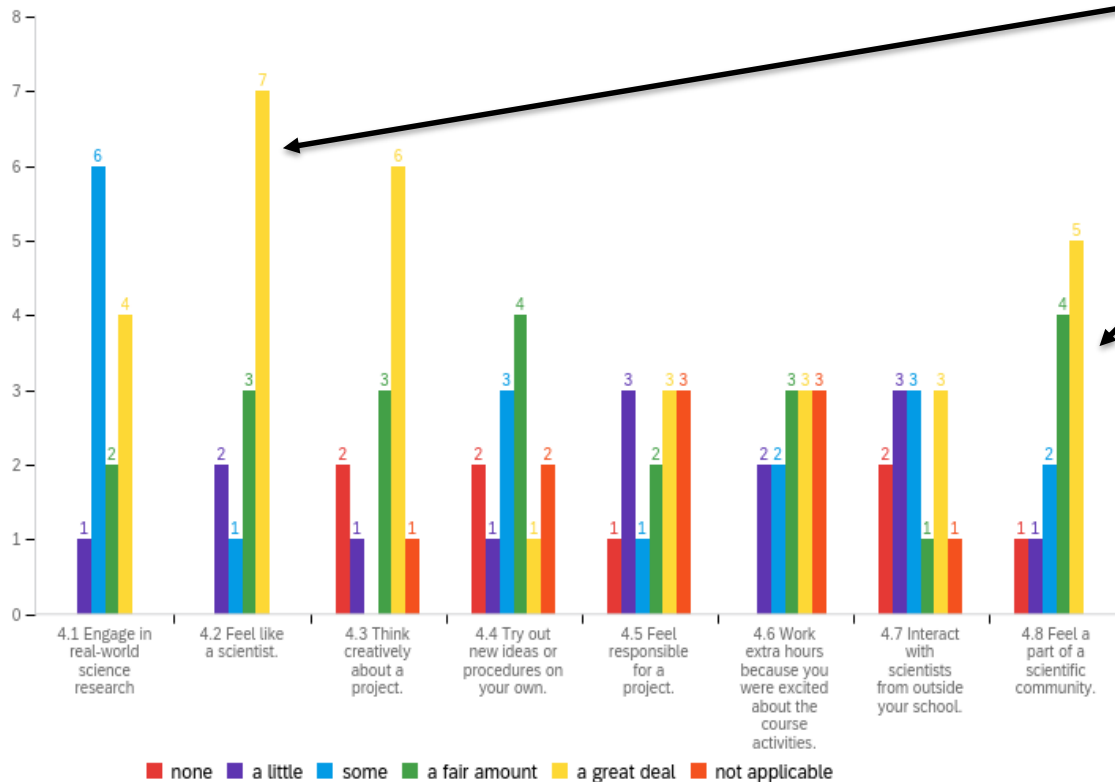


What are we learning?

(image source: field observations)

DISCIPLINARY IDENTITY

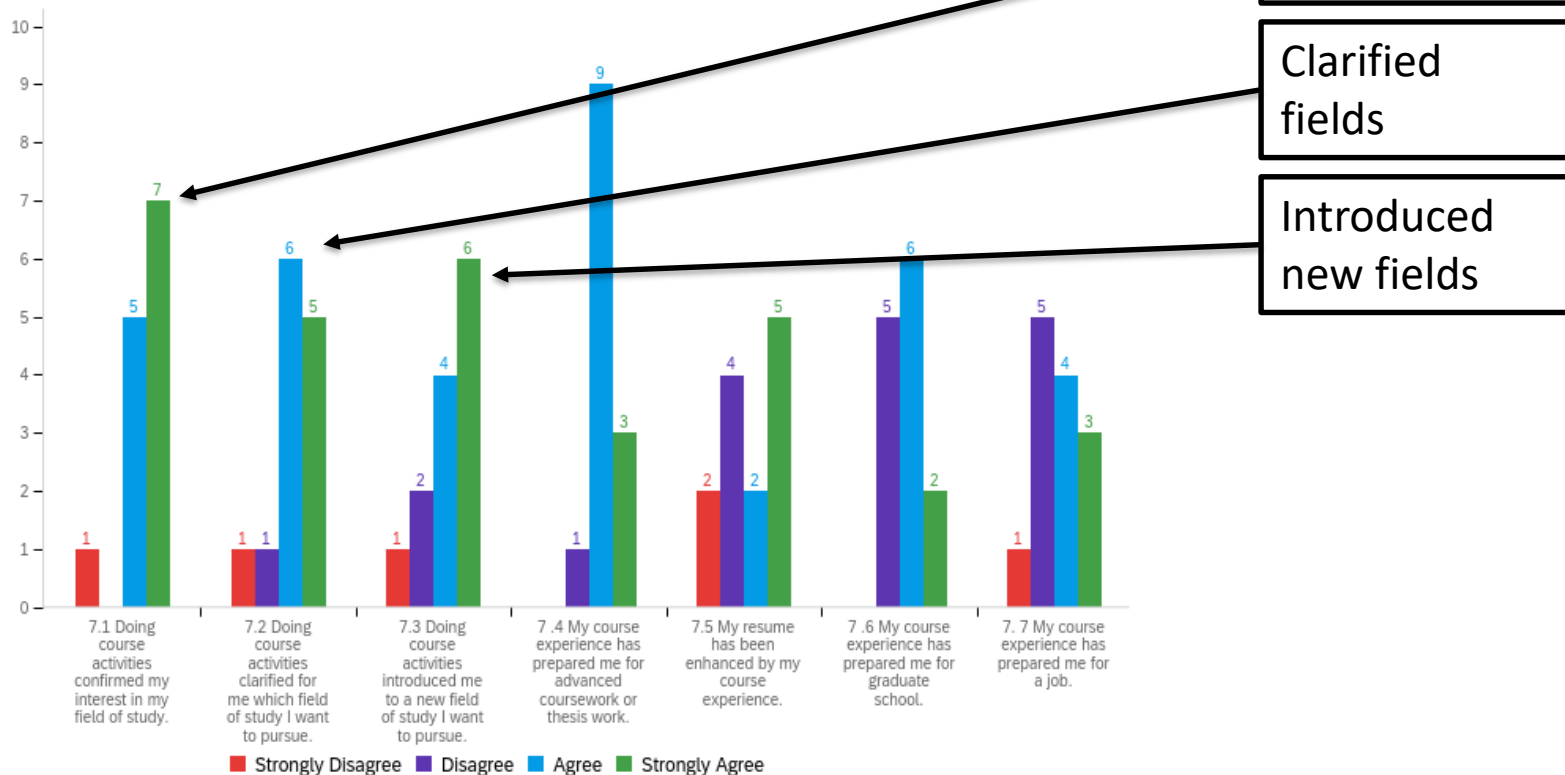
Attitudes: During your course experience HOW MUCH did you:



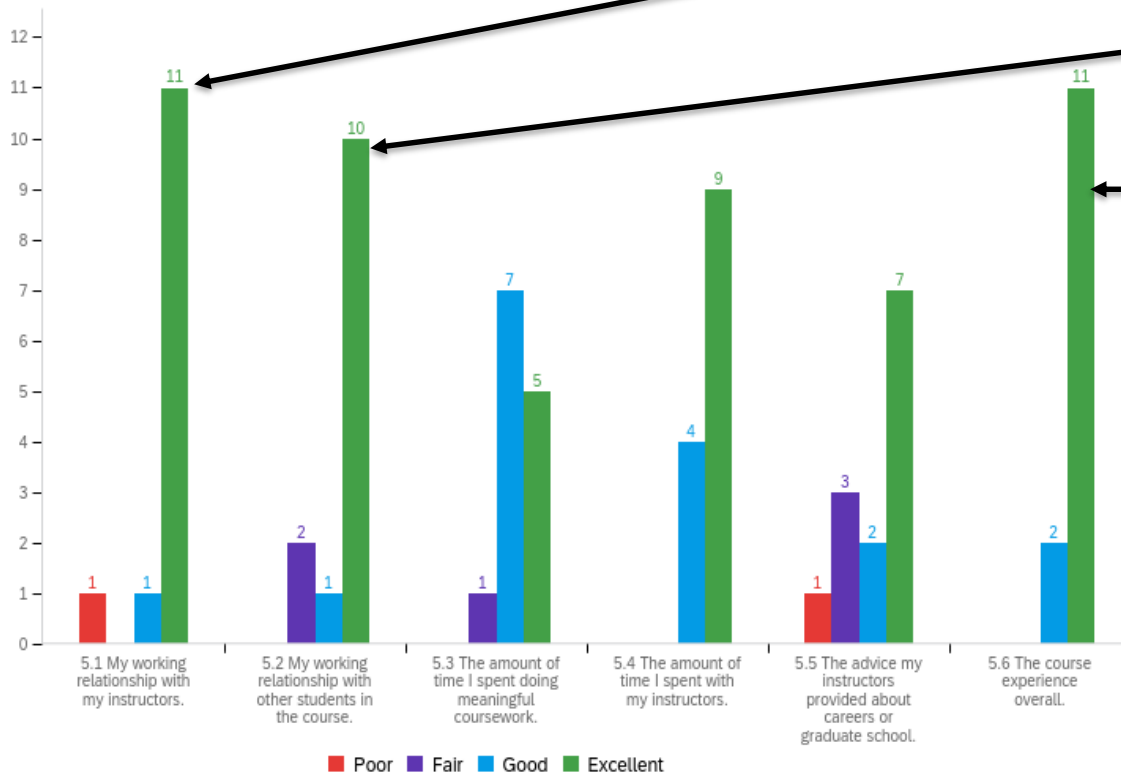
Feel like a scientist

Feel part of scientific community

Positioning: Rate how much you agree with the following statements.



Satisfaction: Please rate the following.

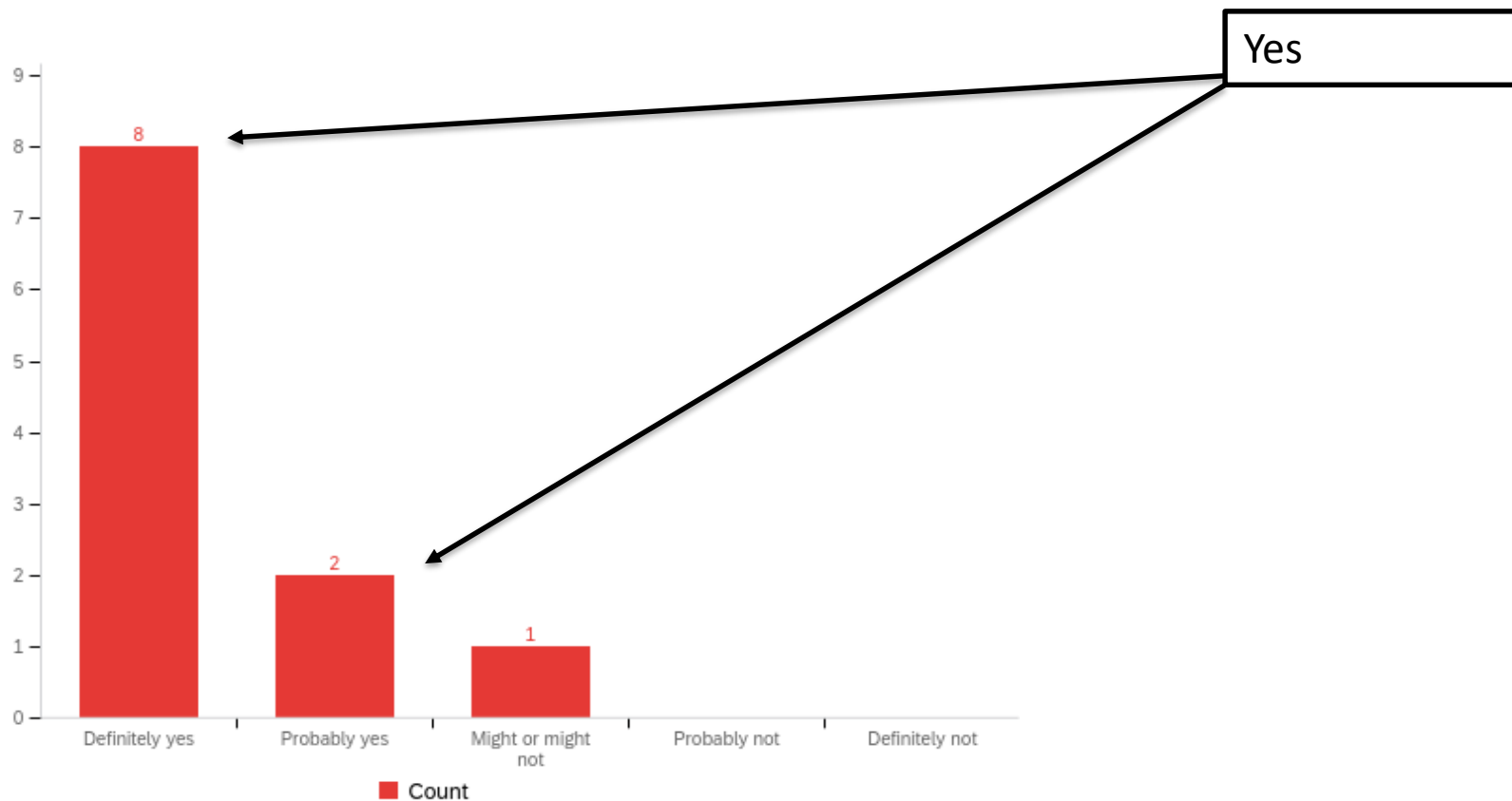


Instructor
relationship

Peer
relationship

Overall
satisfaction

Intentions: Do you intend to major in GEO?



Connection to Discipline, Place and Earth

- ***“Prior to this class I had [no] connection with geology, did not think I was going to stick with it, but this course made me do a 180 because I love geology now.** It was the involvement with nature that really changed my views.”*
- *“Given that I understand more about the relationship humans and the earth have and how this plays into geosciences, I think **I've become more conscious of my self and the impact my actions have** and what I can do to alter that should those impacts be negative.”*
- ***“I now feel the urge to tell my friends and family different things about what I have learned** because I feel as though it is something interesting to know and useful to know.”*

(source: post-course survey)

Who didn't connect?

- A female student with prior high school experience in the field and knowledge of the geosciences.
- She said struggles in other STEM courses (calculus and physics) impacted the way she related to her peers in the class, making her feel different and like she couldn't "compete" even in a field she liked and knew.

(source: post-course interview)



What are we learning?

(image source: field observations)

HOW LEARNING WORKS

Field, Place and Space Mattered

*“There was **a river we visited** and it was created by erosion, uplift, the tectonic plates, and other factors which was [sic] **opened my eyes** to the fact that the planet has undergone many changes due to those circumstances.”*

“I love geology now. It was the involvement with nature that really changed my views.”

Students also developed relationships to specific vans and to each other in vans-as-places!

(source: post-course survey)

Students Made Progress Through...

- Affective engagements with the earth and discipline
- Movements between learning contexts
 - Different contexts had different affordances
- ***Rich indexing of science, culture, identity and the earth through interpretation***

What is *Interpretation*?

- “aims to reveal *meanings* and *relationships* [italics added]. . . rather than simply to communicate factual information” (Tilden, 1957 via Semken, 2017)
- “Interpreters unabashedly strive to elicit personal emotional responses from visitors, and their methods may be adaptable to formal PBE settings” (Semken, 2017)
- Can involve contextualized storytelling, guided inquiry, narrated exploration, etc.

What Interpretation Looked Like

Case 1: Grappling with timescales: Linking lumber carts to erosion. Modeling a geological timeline at scale in the field.

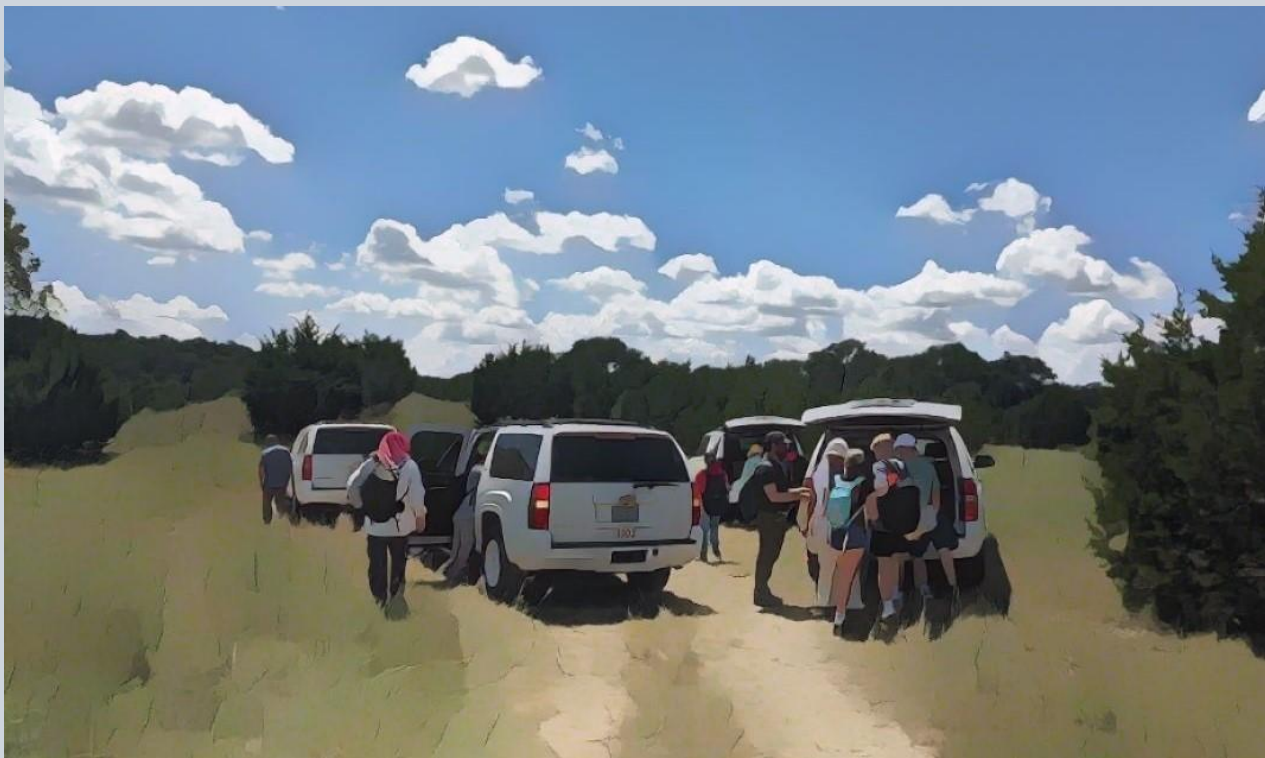
Case 2: Linking material to social: Tracing transformation of physical measurements of water level to reporting for conservation and policy.

Case 3: Understanding complexity: Demonstrate measurement of moisture in the vadose zone, adding layers of interacting variables that lead to profound complexity.

Case 4: Evaluating scientific practice: Attending to dress and gear in the field.

Rich Interpretation

- **Guided:** unfolds as a learning activity across a *zone of proximal development* (Vygotsky, 1978).
- **Proximal:** unfolds in spatial and/or temporal proximity to phenomena of interest.
- **Embodied** (Goodwin, 2013): involves a holistic engagement of physical and sensory ways of knowing and coming to know.
- **Logico-scientific** (Bruner, 1986): makes conceptual, logical, empirical connections and claims about what is true.
- **Narrative** (Bruner, 1986): ties into broader values-based discourses about meaning in the world (salient to construction and transformation of identity, discipline, society and culture).



What are we designing?

(image source: field observations)

ITERATION 2

Emergent Design Issues

- Van experiences were diverse and factored into group formation.
- **Inclusion: Confidence and isolation issues.**

Next Design Iteration

- Integrate (human) history of the Outdoor Learning Center
- Design van time for *learning on the move*
 - e.g. car games that play out over local landscapes
- Continued adjustments for better inclusion
 - Individual check-ins
 - Instructor personal narratives

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THANKS! We would love to hear your thoughts and insights.

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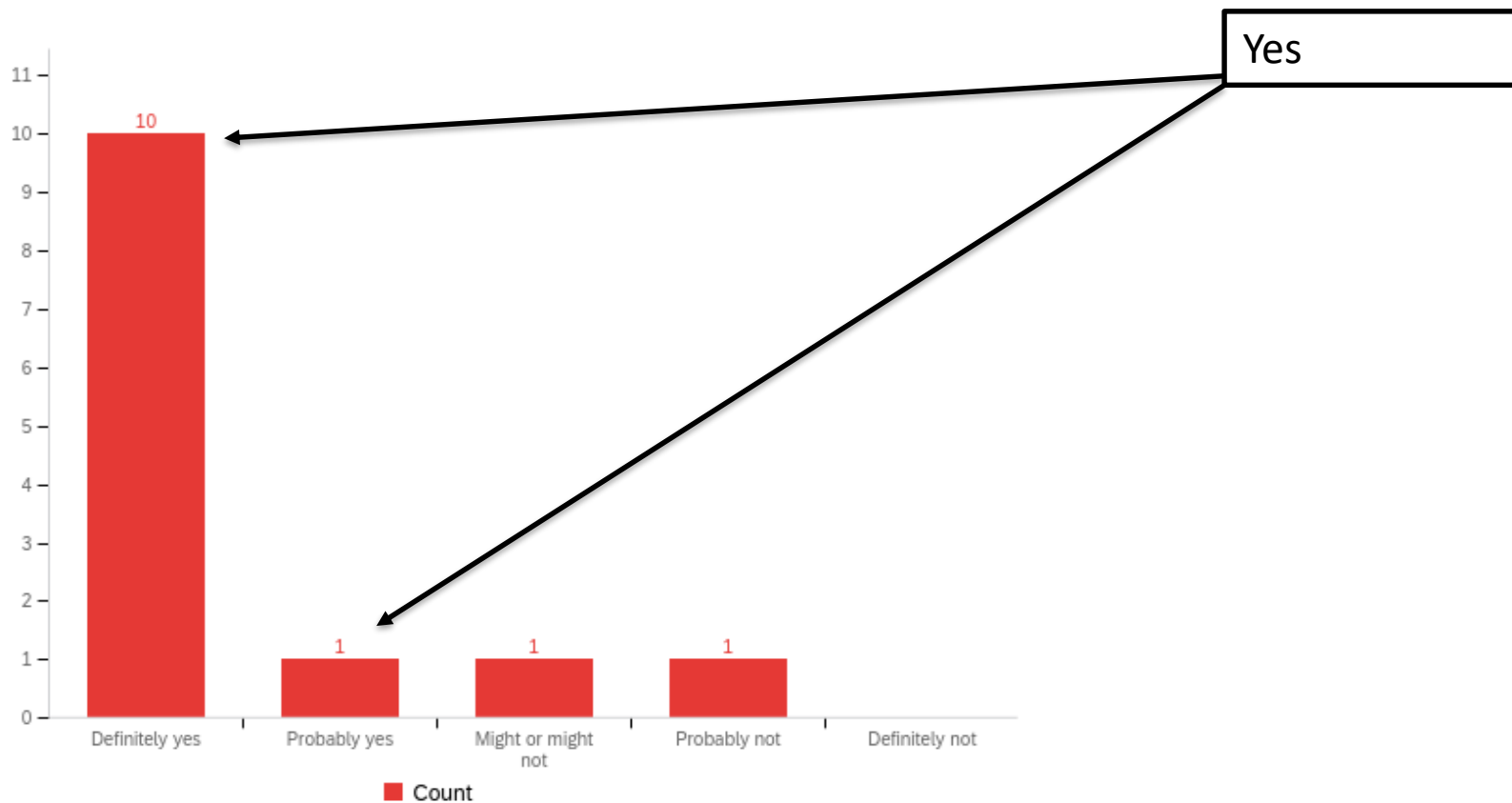
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REFERENCES

- Bruner, J. (1986). Narrative and Paradigmatic Modes of Thought. In *Actual Minds, Possible Worlds* (pp. 97–115). Harvard University Press.
- Dutt, K. (2020). Race and racism in the geosciences. *Nature Geoscience*, 13(1), 2–3. <https://doi.org/10.1038/s41561-019-0519-z>
- Feig, A. D., Atchison, C., Stokes, A., & Gilley, B. (2019). Achieving Inclusive Field-based Education: Results and Recommendations from an Accessible Geoscience Field Trip. *Journal of the Scholarship of Teaching and Learning*, 19(2), Article 2. <https://doi.org/10.14434/josotl.v19i1.23455>
- Goodwin, C. (2013). The co-operative, transformative organization of human action and knowledge. *Journal of Pragmatics*, 46(1), 8–23. <https://doi.org/10.1016/j.pragma.2012.09.003>
- Liu, O. L., Lee, H.-S., & Linn, M. C. (2011). Measuring knowledge integration: Validation of four-year assessments. *Journal of Research in Science Teaching*, 48(9), 1079–1107. <https://doi.org/10.1002/tea.20441>
- Mogk, D. W., & Goodwin, C. (2012). Learning in the field: Synthesis of research on thinking and learning in the geosciences. In K. A. Kastens & C. A. Manduca, *Earth and Mind II: A Synthesis of Research on Thinking and Learning in the Geosciences*. Geological Society of America. [https://doi.org/10.1130/2012.2486\(24\)](https://doi.org/10.1130/2012.2486(24))
- Sandoval, W. (2014). Conjecture Mapping: An Approach to Systematic Educational Design Research. *Journal of the Learning Sciences*, 23(1), 18–36. <https://doi.org/10.1080/10508406.2013.778204>
- Semken, S., Geraghty Ward, E. M., & Libarkin, J. C. (2020). *Design Elements for Place-Based Geoscience Teaching*. 2020, ED047-07.
- Semken, S., Ward, E. G., Moosavi, S., & Chinn, P. W. U. (2017). Place-Based Education in Geoscience: Theory, Research, Practice, and Assessment. *Journal of Geoscience Education*, 65(4), 542–562. <https://doi.org/10.5408/17-276.1>

Intentions: Do you want to take further GEO courses?



Complex Understanding of Discipline

- *“It has definitely opened my mind up to how large the parameters of geosciences and geoscientists actually are. **I never realized how many different directions and subfields there are in geology.**”*
- *“I went into this course as an undecided geoscience major and came out of it being on the hydro track. **I thought that learning about all sorts of fields really benefited me** into deciding what it is I truly want to pursue.”*

(source: post-course survey)

Identity: Connection to Earth, Place

- *"Before this course, my only connection to geoscience was an intro to geo course I took in high school. It was taught by an unenthusiastic teacher and filled with students that only wanted an easy science credit. **After this course, I am proud to say I am majoring in the Geosciences and feel like I can actually pursue this field, and do something meaningful.** A great learning environment makes a world of difference."*
- *"I believe this course just reaffirmed my love for geosciences, especially being out in the field. **It all reminded me of why I picked Geology.**"*
- *"**I now have a much deeper connection with our earth, this sounds cheesy but I really do feel that this class has opened my eyes and heart to the earth in a way that is hard to describe. I feel much more connected to this planet and at peace in a way, happier** knowing how little we are in this Giant earth."*
- *"[My relationship to the earth was influenced] especially on this last trip (11/19) when the experts were explaining the "spiritual connection" they felt with the environment when they would study and take data from their instruments. **When we get to understand the Earth, we build a connection with it that we couldn't have if we had no idea how it worked** or the amazing things it has done to sustain life for so long."*
- *"Given that I understand more about the relationship humans and the earth have and how this plays into geosciences, I think **I've become more conscious of my self and the impact my actions have** and what I can do to alter that should those impacts be negative."*
- *"It influenced me to feel more connected to geology in my everyday life. **Anywhere new I go I look at the geology and think about the things we learned** in class to keep an eye out for and to think about."*
- *"**I now feel the urge to tell my friends and family different things about what I have learned** because I feel as though it is something interesting to know and useful to know."*

(source: post-course survey)