Becoming Theoretical: Our Approach to Understanding How Geologists Experience Learning to Map

Peggy McNeal, Heather Petcovic, Samuel Nyarko, and Megan Doorlag
Purpose: Share our decision-making process during analysis of qualitative interview data.
Purpose: Share our decision-making process during analysis of qualitative interview data.

Encourage others to pursue qualitative inquiry in geoscience education research with confidence and to generate impactful findings that move the community forward.
Five-year project in which N=67 novice (undergraduate) through expert (professional) geologists completed a suite of lab and field tasks.

HOW DID YOU LEARN TO MAKE A GEOLOGIC MAP?
Five-year project in which N=67 novice (undergraduate) through expert (professional) geologists completed a suite of lab and field tasks.

Our purpose was to describe the range of experiences that student through professional geologists report when asked how they learned to make geologic maps.
Research Design*

1. We used a basic qualitative research design to understand how geologists interpret experiences learning to map and what meaning they derive from these experiences.

2. We adopted an inductive stance to build toward theory from observations.

3. We began with open coding of the transcripts, i.e., open to anything possible at that point... because we didn’t know what we were looking for.

* (Merriam & Tisdell 2016)
1. Responses to mapping and experience questions in the interview were isolated for analysis.

2a. Each author independently read a random sample of 10 interviews and generated a list of potential codes.

2b. Codes were compared across authors and common codes were consolidated. We organized the preliminary coding scheme using ideas presented in Mogk and Goodwin (2012).

2c. We iteratively applied codes to a sample of 5 transcripts, compared results across all authors, and used the resulting discussion to refine the coding scheme until a final coding scheme was agreed upon.

3a. Transcripts were divided for coding among all authors. One author identified relevant text passages to code. This author and a second author independently coded each passage.

3b. Across all 67 transcripts, a mean inter-coder agreement of 76.5% agreement was achieved. All disagreements were discussed and resolved to reach 100% agreement for all coded passages.

4a. Text segments for each code were compiled using NVivo 11.0.

4b. Coded segments were reviewed by all authors and an independent peer group to interpret key ideas within each code and flag illustrative quotes.

4c. Attendees at the 2018 Geological Society of America (GSA) national meeting were invited to comment on our poster by placing stickers or written notes on codes or participant quotes that they found particularly compelling.

5. Using the lens of the theoretical framework, we organized findings into three major categories (Table 2). This allowed us to make sense of the findings, generate interpretations, develop our model (Figure 3), and draw conclusions.
INTERVIEWER: Okay. So that's great. Now we'd like to just ask a few questions about your prior mapping experience.

VACHOT: Okay.

INTERVIEWER: So, can you tell me, where did you learn to make geologic maps?

VACHOT: I took a structural geology class. And we learned the basics of structural geology in the course and lectures. And then we had a one-week field trip down into the Appalachian area and down into, I think we went as far as Tennessee. I don't believe we went all the way to the Carolinas (0:29:00.5).

But there we did some mapping with some outcrops, probably four or five different areas. We spent most of our times working on faults and folds was the focus kind of that. And then I also had the two-week field course. And the second week of that was in the Upper Peninsula of Michigan where there are a lot of those structural geology features. So, there we also spent a fair amount of time mapping out. And that's really, I credit that field camp as where I really learned the importance of mapping and the meaning of it and what you can really infer from bedrock mapping, you know, surface bedrock outcrops and things like that.

INTERVIEWER: So, you actually led straight into the next question; you credited the two-week field camp. And I'm wondering can you tell me a little bit more about the type of instruction you received and how you were taught to develop a map (0:30:07.2)?
2a. Each author independently read a random sample of 10 interviews and generated a list of potential codes.

2b. Codes were compared across authors and common codes were consolidated. We organized the preliminary coding scheme using ideas presented in Mogk and Goodwin (2012).

2c. We iteratively applied codes to a sample of 5 transcripts, compared results across all authors, and used the resulting discussion to refine the coding scheme until a final coding scheme was agreed upon.
3a. Transcripts were divided for coding among all authors. One author identified relevant text passages to code. This author and a second author independently coded each passage.

3b. Across all 67 transcripts, a mean inter-coder agreement of 76.5% agreement was achieved. All disagreements were discussed and resolved to reach 100% agreement for all coded passages.
4a. Text segments for each code were compiled using NVivo 11.0.

4b. Coded segments were reviewed by all authors and an independent peer group to interpret key ideas within each code and flag illustrative quotes.

4c. Attendees at the 2018 Geological Society of America (GSA) national meeting were invited to comment on our poster by placing stickers or written notes on codes or participant quotes that they found particularly compelling.
4a. Text segments for each code were compiled using NVivo 11.0.

4b. Coded segments were reviewed by all authors and an independent peer group to interpret key ideas within each code and flag illustrative quotes.

4c. Attendees at the 2018 Geological Society of America (GSA) national meeting were invited to comment on our poster by placing stickers or written notes on codes or participant quotes that they found particularly compelling.

Image source: https://www.interaction-design.org/literature/article/how-to-do-a-thematic-analysis-of-user-interviews
We Were Stuck

• Merriam and Tisdell (2016) recognize this as being:

“too close to the data, unable to articulate how the study is significant, and unable to shift into a speculative mode of thinking...hindered by thinking that is linear rather than contextual” (p. 216)
Becoming Theoretical

- a higher level of analysis that Miles, Huberman, & Saldana (2014) describe as moving:

“from the empirical trenches to a more conceptual overview of the landscape. We’re no longer just dealing with observables, but also with unobservable, and are connecting the two with successive layers of inferential glue” (p. 292).
Engaging in Theorizing (Merriam and Tisdale 2016)

- Data beg for continued analysis, past formation of categories
- The researcher knows that the coding scheme does not tell the whole story - there is more to be understood
- This may lead to development of a model of interrelationships or a theory
Our Approach to Theorizing

• Back to the literature, especially on learning theory
• Thinking and discussion
• More thinking and discussion
• We decided to re-interpret our findings through the lens of Situated Learning Theory (Lave and Wenger 1991) because it conceptualized and connected what we initially saw as disparate themes
Uncharted Territory
• Can we add a theoretical framework this late in the game?
• What do we do now with the Mogk and Goodwin (2012) framework?
• Is Situated Learning Theory a good fit?
• Are we going to just find what we go looking for?
5. Using the lens of the theoretical framework, we organized findings into three major categories (Table 2). This allowed us to make sense of the findings, generate interpretations, develop our model (Figure 3), and draw conclusions.

**Theoretical Framework: Situated Learning (Lave & Wenger, 1991)**

**Content:** The learner acquires skill through engaging in the authentic practice of experts.

*Example:* Feedback provided by an expert during field work helps the learner identify if they are right or wrong.

**Participation:** The learner develops as a full participant by interacting with experiences and understanding.

*Example:* Immersion in physical and cultural environments facilitates learning and construction of identity.

**Community:** The learner develops relationships that shift perspectives on what is known and how things are done.

*Example:* Interacting with peers provides opportunity to compare work, question thinking and discuss possibilities.
5. Using the lens of the theoretical framework, we organized findings into three major categories (Table 2). This allowed us to make sense of the findings, generate interpretations, develop our model (Figure 3), and draw conclusions.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1A. Immersion</td>
<td>2A. Imagery</td>
<td>3A. Peer group work-teamwork</td>
<td>4A. Ill-structured instruction</td>
<td></td>
</tr>
<tr>
<td>1B. Purpose</td>
<td>2B. Data sets</td>
<td>3B. Apprenticeship</td>
<td>4B. Structured instruction</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2C. Tools and technology</td>
<td>3C. Teaching others</td>
<td>4C. Practice and repetition</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>3D. Independent work</td>
<td>4D. Metacognitive approach</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>3E. Rite of passage</td>
<td>4E. Struggle</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>4F. High stakes</td>
<td></td>
</tr>
</tbody>
</table>
Theoretical Framework: Situated Learning (Lave & Wenger, 1991)

- **Content:** The learner acquires skill through engaging in the authentic practice of experts.
  - Example: Feedback provided by an expert during field work helps the learner identify if they are right or wrong.

- **Participation:** The learner develops as a full participant by interacting with experiences and understanding.
  - Example: Immersion in physical and cultural environments facilitates learning and construction of identity.

- **Community:** The learner develops relationships that shift perspectives on what is known and how things are done.
  - Example: Interacting with peers provides opportunity to compare work, question thinking and discuss possibilities.

5. Using the lens of the theoretical framework, we organized findings into three major categories (Table 2). This allowed us to make sense of the findings, generate interpretations, develop our model (Figure 3), and draw conclusions.
Lessons Learned while going from this

To this

Image source: https://www.interaction-design.org/literature/article/how-to-do-a-thematic-analysis-of-user-interviews
Lessons Learned

• Our findings are deeply contextualized by the theoretical framework...

• and that’s OK

• “Becoming theoretical” required sustained, purposeful, and lengthy effort to develop the familiarity and vision necessary for finding meaning in the data

• Our circuitous and messy process ultimately generated novel findings about how geologists learn to map*