Assessing Conceptual Change in Place-based Geoscience Education: Theories and Methods

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The Project: Design Place-based Geoscience Assessments

Key Question Elements:
Conceptual, Multiple-choice format, and Place-specific content
Previous Work

• Past presentations
  • VALIDATING EXISTING INSTRUMENTS
    • 2011-GSA: Collaborative development of place-based, culturally informed geoscience assessment
  • INSTRUMENT DESIGN
    • 2014-RMS-GSA: Designing place-based, culturally informed geoscience assessment: Geological Society of America
    • 2014-GSA: Cultural Validation in Practice: Valuing and Leveraging Place and Culture in Geoscience Assessment
  • METHODS FOR ASSESSMENT VALIDATION
    • 2016-GSA: A mixed-methods approach to assessment design that incorporates culture and place
Theoretical Frameworks in Placed-Based Education (PBE)
Conceptual Understanding

1) Student conceptions and knowledge construction (e.g. Driver)

“Students’ everyday knowledge of natural phenomena are a coherent framework of ideas, based on a commonsense interpretation of their experience in living in the world rather than “misunderstandings” or “mistakes” ” (Osborne et al., 1997)

• Identify student conceptions before and after PBE intervention
Sociocultural Theories

2) Learning as a social process (e.g. Vygotsky)
   • Importance of language and culture
   • Knowledge is co-constructed
   • Learning is collaborative

3) Situated cognition & learning (e.g. Brown et al., Lave and Wenger)
   • Knowledge is embedded in the activity, context, and culture in which it was learned.
Learning theories related to Indigenous Education

4) Influence of culture, place, and language (e.g. Bang, Cajete)
   • Importance of Native Knowledge
   • Knowledge rooted in places
   • Community is foundational

“The study of biological cognition has been driven by Western conceptions of the natural world as opposed to characterizing the conceptual and epistemic ecologies of individuals and communities on their own terms. I suggest that a shift away from intended or unintended privileging of Western perspectives and framings opens up opportunities for significant advances...by expanding our understanding of the possible range of human knowledge organization and reasoning patterns” (Bang, 2015)
Validation methods

Sociocultural theories

Identify important geoscience topics

Identify roles of place and culture in geoscience
Design methods

Theories related to conceptual understanding
Focus on local content and language
Methods drawn from assessment design (Libarkin & Anderson; Haladyna and Rodriguez; Solano-Flores and Nelson-Barber)

Faculty writing workshop
Generate place-based items (open-ended)

Pilot items

Faculty writing workshop
Generate place-based items (selected response)

Pilot items
Example place-based concept question

How did the mountains form here? CHOOSE ALL THAT APPLY

• Collision of tectonic plates
• Collision forms rock layers
• Rock layers pushed up
• Rock layers shifted over

Authors: Melissa Weatherwax, Mike LaFromboise, Theodora Weatherwax
New place-based questions

• Pre and post testing of students
  • Pre-test: Identify conceptual knowledge of students
  • Post-test: Changes to conceptual knowledge

• The difference: Conceptual questions have *multiple* correct answers
Next Steps

Reliability of place-based assessments
  • Use new place-based questions with larger number of students
  • Place-based interventions occur in both formal and informal contexts

Holistic assessment of place-based education
  • Cognitive, Behavioral and Affective variables
  • Is place-based teaching and learning more effective?
Conclusions

• Project drew upon constructivist learning theories in the design of place-based assessment items
• Theories frame the way conceptual understanding and learning is researched
• Mixed methods used to identify important cultural knowledge and physical places used in teaching geoscience
• Information used to design valid place-based test questions for specific geographic regions
Questions?

Check out the upcoming Geoscience Alliance Conference
January 2019 – Tempe, AZ

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• Acknowledgements: Thank you to the participants from Diné College, Blackfeet Community College, and Arizona State University; and members of the Blackfeet and Navajo communities. This project is supported by the National Science Foundation (NSF GEO-1034909 and GEO-1034926). Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the National Science Foundation.