Connecting Teaching Beliefs and Practices in Post-Secondary Geoscience Classrooms

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Why study teaching practices and beliefs in concert?

- Reformed, active-learning techniques are well connected to student learning in science education research\(^1-^3\).

- However, reformed teaching practices are not consistently translated to the classroom\(^4\).

- Adoption of reformed, inquiry-based materials is done at the discretion of college geoscience instructors, and is often controlled by teaching beliefs\(^5-^7\).

- Teaching beliefs have been identified as one of the driving forces behind instructors’ pedagogical decisions\(^8-^{11}\).

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\(^{1-3}\) Blanchard et al., 2010; Knight and Wood, 2005; Prince, 2004; \(^{4}\) Ebert-May et al., 2011; \(^{5-7}\) Blecher, 2010; Joseph 2010; Wigfield and Eccles, 2000; \(^{8-11}\) Olafson and Schraw, 2006; Vartuli and Children, 2005; Kagan, 1992; Pajares, 1992
What we say is not always what we do

Beliefs: Theories of action

Practices: Theories in use

- Prior Experience
- Knowledge

- Skills
- Time
What we say is not always what we do

“Interested candidates should submit a CV, a statement of teaching philosophy, and a research statement.”

“I teach the Thursday after GSA.”
Beliefs: telling half the story

• Linked to the use of inquiry, national reforms, and constructivist practice in the classroom\(^1-^4\)

• Professional development experiences that support meaningful change take into account and address teachers’ beliefs\(^5\)

• Many studies make claim about teaching practice based on what teachers say about their beliefs\(^6\)

• What is the relationship between teachers’ beliefs (espoused theories of action) and teachers’ practices (theories in use)\(^6\)?
Characteristics of beliefs

- General or group consensus regarding the validity and appropriateness of a belief
- Internal consistency within a belief system

Model from Rokeach, 1968; Borg, 2001
What is meant by ‘teaching beliefs’?

• Information a teacher holds about a person, group of people, a behavior or an event

• Guide instructional decisions, influence classroom management, perceptions and judgments, which in turn affect behavior in the classroom and provide a lens for understanding classroom events

• Generally comprise two orientations: subject matter vs student

• Influence how we conceptualize tasks and learn from experience

1 Fishbein & Ajzen, 1975; 2-4 Jones & Carter, 2007; Pajares, 1992; Richardson, 1996; 3-5 Meirink et al, 2009; Van Driel et al., 2007; 6-10 Ashton, 1990; Ashton & Webb, 1986; Brookhart & Freeman, 1992; Buchmann, 1984; Clark, 1988; 11 Nespor, 1987
Instruments to measure beliefs

- Most often assessed as *espoused beliefs* through semi-structured interviews\(^1\)\(^-\)\(^2\) and surveys questionnaires\(^3\)

<table>
<thead>
<tr>
<th>Instrument</th>
<th>Grade level</th>
<th>Outcome(s)</th>
<th>Guiding principles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Views on the Nature of Science (B) survey and interview (VNOSS)(^3)</td>
<td>Post-secondary</td>
<td>Factors affective preservice teacher conceptions of NOS on classroom instruction</td>
<td>Abd-El-Khalick and Lederman’s Nature of Science</td>
</tr>
<tr>
<td>Level of Understanding (LoU) interview(^4)</td>
<td>K-16</td>
<td>Extent of mastery of an innovation, such as reformed teaching</td>
<td>Innovation adoption</td>
</tr>
<tr>
<td>Pedagogical Discontentment Survey (PDS)(^5)</td>
<td>K-12</td>
<td>Science teachers’ ‘affective states’ as they enter PD activities</td>
<td>Models of conceptual change</td>
</tr>
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</table>

\(^1\)Chen, 2008; Gess-Newsome et al, 2003; \(^3\) de Vries et al 2013; \(^3\) Abd-El-Khalick, Bell and Lederman, 1998; \(^4\) Hall and Hord, 1987; \(^5\) Southerland et al, 2006
**Instruments to measure beliefs**

- Most often assessed as *espoused beliefs* through semi-structured interviews\(^1\)-\(^2\) and surveys questionnaires\(^3\)

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<tr>
<td>Teacher Beliefs Interview (TBI)(^3)</td>
<td>Secondary</td>
<td>Science teachers’ beliefs</td>
<td>Epistemological understanding of beliefs</td>
</tr>
<tr>
<td>Science Teaching Efficacy Beliefs Instrument (STEBI)(^4)</td>
<td>Pre-service elementary</td>
<td>Preservice teachers’ science teaching efficacy beliefs</td>
<td>Bandura’s social learning theory</td>
</tr>
<tr>
<td>Beliefs about Reformed Science Teaching and Learning (BARSTL)(^5)</td>
<td>Elementary</td>
<td>Alignment of teaching beliefs and practices with the reform movement in science education</td>
<td>Von Glasersfeld’s Constructivism</td>
</tr>
</tbody>
</table>

\(^1\)-\(^2\)Chen, 2008; Gess-Newsome et al, 2003; \(^3\)de Vries et al 2013; \(^4\)Luft and Roehrig, 2007 \(^5\)Enoch and Riggs, 1990; \(^6\)Sampson and Benton 2006
What is known at the post-secondary level?

• Few studies have examined teacher and collective efficacy of college-level instructors\(^1\)

• Most work done with Graduate Teaching Assistants\(^2-3\)

• Relationship between teacher efficacy and motivation to improve teaching\(^4\)

• Efficacy in university faculty varies by gender\(^5-7\); professional rank\(^8\); and age, experience, and gender make-up of academic departments\(^6\).

• University teacher efficacy is more dependent on individual than collective traits (compared to K-12 teachers)\(^9\)

\(^1\)Fives and Looney, 2009; \(^2\)Heppner, 1992; \(^3\)Preito & Meyers, 1999; \(^4\)Young & Kline, 1996; \(^5\)Brennan, Robison, & Shaughnessy, 1996; \(^6\) Landino & Owen, 1988; \(^7\)Schoen & Winocur, 1988; \(^8\)Schoen & Winocur, 1988; \(^9\)Loup et al., 1997
Questions asked with the STEBI

1. How does pre-service elementary teachers’ science teaching efficacy change over a semester and why?

2. What do students perceive has changed about their efficacy, and to what do they attribute those changes?

1 Luft and Roehrig, 2007; 2 Enoch and Riggs, 1990
Measuring Self-Efficacy

STEBI: Science Teaching Efficacy Belief Instrument

Two subscales
- Outcome expectancy: student learning can be influenced by effective teaching
- Personal science teaching efficacy: confidence in their own ability to teach

<table>
<thead>
<tr>
<th>Item</th>
<th>Statement</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>When a student does better than usual in science, it is often because the teacher exerted a little extra effort.</td>
<td>SA A UN D SD</td>
</tr>
<tr>
<td>2.</td>
<td>I will continually find better ways to teach science.</td>
<td>SA A UN D SD</td>
</tr>
<tr>
<td>3.</td>
<td>Even if I try very hard, I will not teach science as well as I might other subjects.</td>
<td>SA A UN D SD</td>
</tr>
<tr>
<td>4.</td>
<td>When the science grades of students improve, it is often due to their teacher having found a more effective teaching approach.</td>
<td>SA A UN D SD</td>
</tr>
<tr>
<td>5.</td>
<td>I know the steps necessary to teach science concepts effectively.</td>
<td>SA A UN D SD</td>
</tr>
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1Riggs and Enochs, 1990
Quantitative STEBI survey results

- No significant differences in STEBI subscales, gains, or overall score based on area of study.
- Science and math teachers outperformed two of their counterparts on lecture exams ($p < 0.005; g = 0.66$), but not on labs or overall course grade ($p > 0.05$)

Average Exam Grade (Out of 100)

- Intent/Undecided ($n = 26$)
- Special Education ($n = 32$)
- Science and Math ($n = 41$)
- Social Science (LA, Theater, Language, History) ($n = 19$)
- Early Childhood Education ($n = 24$)
Quantitative STEBI survey results

- No significant differences in STEBI or learning (lab scores, exam average, course grade) based on EMU GPA or credit hours taken.

- Males had significantly higher gains than females on the Outcome subscale, leading to overall higher scores ($p < 0.05; g = 1.07$).

- No significant difference between males and females on labs, exams, or overall course performance ($p > 0.05$).
Survey

Pick five statements that you feel have changed the most for you over the semester and write 2-3 sentences describing how and why they’ve changed.

Note: There are no wrong answers here, so long as they honestly reflect your beliefs!

<table>
<thead>
<tr>
<th>Statement number (1-25)</th>
<th>How do you think your beliefs about this statement have changed over this semester and why? What caused them to change?</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>I feel that I have the concepts of science down. I know that I will be effective at teaching science even tho it doesn’t appear that way in looking at my grade.</td>
</tr>
<tr>
<td>Item 2</td>
<td>I will continually find better ways to teach science. (Personal)</td>
</tr>
<tr>
<td>&quot;I think originally when I read this question, I thought it was my obligation as a teacher to put that I agree, but after this semester I am excited to find better ways to teach science. I know many more resources than I did and I want to use them to help me find the best teaching method for my students.&quot;</td>
<td></td>
</tr>
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</table>
Four principal sources of efficacy expectation

- **Enactive Information**
  - “I got an A on my test.”

- **Vicarious Information**
  - “I saw a fellow classmate succeed.”

- **Persuasory Information**
  - “Dr. Ryker told me I could succeed.”

- **Emotive Information**
  - “I was anxious before the test, but exhilarated afterward.”

SE model: Bandura, 1977
Thematic content analysis

759 individual responses
Each response read 3+ times
110 initial codes developed from student responses, e.g.
  ◦ I have a deeper understanding of the content I will teach
  ◦ Seeing an enthusiastic/excited teacher
  ◦ Talking to Dr. Ryker one-on-one
  ◦ Science has always been hard for me
Sorted into one of four themes
Iterative coding process reduced number to 32 codes
Intra-rater reliability\(^1\): \(K = 0.94\)

<table>
<thead>
<tr>
<th>Theme</th>
<th>Count (n)</th>
</tr>
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<tr>
<td>Performance</td>
<td>74</td>
</tr>
<tr>
<td>Vicarious</td>
<td>19</td>
</tr>
<tr>
<td>Verbal (Social)</td>
<td>2</td>
</tr>
<tr>
<td>Physiological (Emotional)</td>
<td>15</td>
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</table>

\(^1\) Cicchetti and Sparrow, 1990
Performance accomplishments are the most important factor students attribute changes in their SE (outcome AND personal) to (73.5%, 76.6%)

- “My success in our class activities and discussion groups showed me that I understand the content. When I did well on exams, I felt like I could have a greater impact on student success.”
- “Getting my classmates engaged with my lesson plan on weather showed me I could be effective. [My instructor] gave me a lot of constructive feedback beforehand that helped me get an A. I feel confident that I can teach that unit now.”

Performance accomplishments: 73.5% outcome, 76.6% personal
Vicarious experiences: 11.1% outcome, 0% personal
Verbal persuasion: 1.1% outcome, 0% personal
Physiological feedback: 4.9% outcome, 12.3% personal

Outcome
Personal
Questions asked with the TBI

1. Do Graduate Teaching Assistants (GTAs) change their teaching beliefs over time as a result of teaching inquiry-based labs?

2. What is the relationship between teaching practices and beliefs for geoscience instructors?

1 Luft and Roehrig, 2007; 2 Enoch and Riggs, 1990
How do you describe your role as a geology teacher?

How do your students learn science best?

How do you maximize student learning in your classroom?

How do you know when learning is occurring in your classroom?

How do you decide when to move on to a new topic in your class?

How do you know when your students understand?

In the school setting, how do you decide what to teach and what not to teach?

Total score is referred to as the TIBI score.

Luft & Roehrig, 2007
Teaching Beliefs of GTAs over time

*“Guide on the side”*

More Reformed Teaching Beliefs

Non Inquiry-lab GTAs vs Inquiry-lab GTAs

Hannah (Experienced)

Madison (New)

Olivia (Experienced)

Benjamin (New)

“Sage on the stage”

Pre-Fall | Post-Fall | Post-Spring

- Hannah (Experienced)
- Madison (New)
- Olivia (Experienced)
- Benjamin (New)
Relationship between teaching practices and beliefs for geoscience instructors

More Reformed Teaching Practices

More Reformed Teaching Beliefs

"Sage on the stage"

"Guide on the side"

\[ R^2 = 0.6082 \]

One-tailed p value: <0.005
Considerations for studying the connection between beliefs and practices

- Make theoretical framework explicit
- Use instruments that align with theoretical framework
- Clarify ‘espoused theories’ from ‘theories in practice’
- Have participants explain why there is (or isn’t) a relationship between their beliefs and practices
- Replication or longitudinal studies important to see how beliefs change over time

**Questions? Want to get involved?**
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