Research on Institutional Change and Professional Development

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Introduction

Over the past 20 years, numerous institutions and groups have repeatedly called for changes in undergraduate STEM education in the United States in order to develop a stronger, more diverse STEM workforce, to foster a more scientifically literate society, and to improve equitable access to education for all. We now know that students frequently leave science majors because of instructional experiences and lack of advising and mentoring, rather than because they lack the ability to succeed (e.g., Griffith, 2010; Seymour & Hewitt, 1997). Pressing environmental and societal challenges require additional geoscience majors from a wider range of backgrounds, well-prepared K-12 Earth science teachers, and a scientifically-literate citizenry. To achieve these goals, geoscience education must make substantial improvements in areas as broad as instruction, mentoring and advising, and departmental climate. Our ability to change can be supported by a better understanding of how educators, departments, and institutions change and how professional development opportunities foster and support productive change.

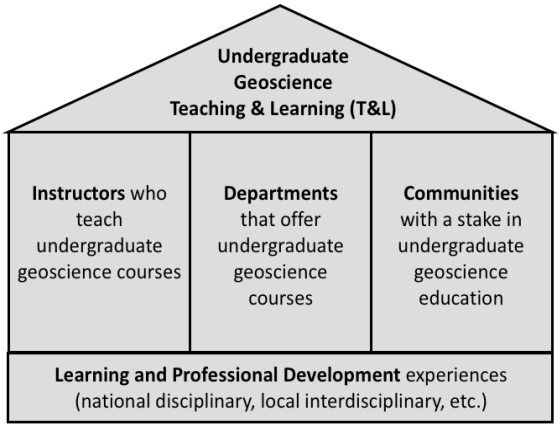

Figure 1: Instructors, departments, and communities are influenced by a variety of learning and professional development experiences, coming together to inform and enact undergraduate geoscience teaching and learning experiences.

Undergraduate geoscience education brings together students' experience in the classroom, field, and laboratory, in co-curricular activities, and in the formal and informal interactions among students, faculty, staff, and administration. Improvements in geoscience education require change in this complex system. Here we consider how future GER can address issues of change in institutions of higher education and professional development that will promote high-quality geoscience education. Specifically, we focus on three components with the potential to influence geoscience education: the individual geoscience instructor, the departments and programs in which geoscience instructors teach, and the broader communities in which these departments operate (Figure 1).

Drawing on this context and the strong research base in institutional change and education-related

professional development, we identified the three Grand Challenges (below) to guide research on institutional change and professional development in the geosciences.

Grand Challenges

Grand Challenge 1: How can we best support the continual growth of geoscience instructors' ability to teach effectively and implement research-supported teaching practices as they progress in their practice? How does the individual's cumulative experience, position type, institutional context, and the nature of the desired learning impact the type of learning opportunities that are most effective?

Instructors design and implement learning experiences, interact individually with students and manage classroom climate, and are commonly on the front lines of mentoring and advising. As we seek to broaden participation and accelerate change, further work is needed to understand how an instructor's personal history and identity interact with departmental, institutional, and disciplinary context and culture to motivate and sustain continual geoscience instructor growth and learning.

Grand Challenge 2: How can departments and programs support continuous improvement in undergraduate geoscience education?

Healthy geoscience departments and programs can be conceptualized as complex systems in which new and potentially valuable ideas about teaching and learning enter the system continuously and are discussed, experimented with, and implemented freely. Further work will need to clarify factors contributing to department or program health from both within (departmental climate) and beyond the department itself (e.g. academic advising, employers, disciplinary societies).

Grand Challenge 3: What roles do different types of professional development experiences play in promoting, facilitating, and sustaining ongoing evolution in geoscience instructors' teaching practices over time?

Geoscience educators have a rich palette of ways to learn and improve their practice, including on-campus interdisciplinary professional development, geoscience-specific opportunities offered by professional societies, in-department trainings, and national community of transformation meetings, as well as formal and informal exchanges.with peers. Changes in practice over time that may follow these learning experiences are often non-linear and multi-directional, and must be further explored.

Grand Challenge 1:

How can we best support the continual growth of geoscience instructors' ability to teach effectively and implement research-supported teaching practices as they progress in their practice? How does the individual's cumulative experience, position type, institutional context, and the nature of the desired learning impact the type of learning opportunities that are most effective?

Rationale

Instructors play a central role in the students' geoscience education. Instructors design and implement learning experiences, interact individually with students and manage classroom climate, and are commonly on the front lines of mentoring and advising. Thus, professional development supporting their growth is a first-order strategy for improving geoscience education. Prior work has demonstrated that identity, motivation, context, the design of professional development, and participation in a supportive community all impact an instructor's learning and willingness to make changes in their practice (Andrews & Lemons, 2015, Condon et al., 2016; Chapman & McConnell, 2017; Gehrke & Kezar, 2016; Henderson, Beach, & Finkelstein, 2011; Kastens & Manduca, 2017; Kastens & Manduca, 2018; Pelch & McConnell, 2016, Yerrick, Parke, & Nugent, 1997). In the past 15 years, many faculty have participated in both institutional and disciplinary professional development opportunities, but others have not; practices have changed, but practices across the community have not been transformed (Manduca et al., 2017).

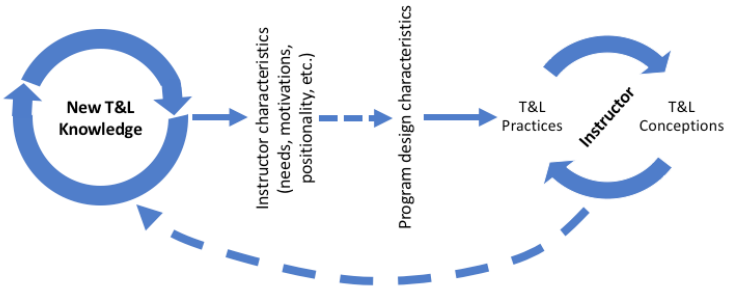

Figure 2: New knowledge about teaching and learning (T&L) generated by GER and other learning science fields is continuously generated. Uptake of that knowledge is filtered by an instructor's needs, motivations, and positionality, and is influenced by characteristics of the professional development program(s) in which the instructor learns about that new knowledge. The instructor may also produce and disseminates new knowledge.

As we seek to broaden participation and accelerate change, further work is needed to understand how an instructor's personal history and identity interact with departmental, institutional, and disciplinary context and culture to first motivate learning and then support change (Figure 2). While prior research has largely focused on single professional development programs, further work is needed to understand how an individual's learning and change are supported by multiple experiences. Preliminary evidence also suggests that different types of learning may require different types of engagement: for example, beliefs about teaching may be relatively difficult to change (Yerrick, Parke, & Nugent, 1997) but can be effectively targeted through collaborative and authentic long-term engagement (Pelch & McConnell, 2016), while changes in practice that are consistent with the beliefs already held by a participant might be easier to achieve (e.g., Glackin, 2016). Further work is also needed to investigate the most effective strategies to motivate and sustain continual geoscience instructor growth and learning of various types.

Recommended Research Strategies

1. Conduct longitudinal studies of individual geoscience instructors representing a variety of identity characteristics and institutions, with special attention to how they make decisions about potential instructional learning and change over time, and what motivational factors are at play.

2. Conduct interviews with geoscience professional development leaders and review existing literature to identify common learning objectives for geoscience instructors. Convene a small working group to sort those objectives according to the cognitive processes, level of challenge, and type of change required to provide a typology of learning objectives.

3. Based on the typology of learning objectives, identify or design assessment measures for each category. Recommend the use of those assessment instruments across future professional development programs to allow consistent comparisons and future meta-analyses.

4. Construct and widely-administer a survey designed to develop a broader picture of the teaching-related needs among a diverse geoscience instructor population (e.g., gender, race, ethnicity, socio-economic status, type of employment/position, career stage, etc.).

5. Conduct longitudinal studies of individual geoscience instructors representing a variety of identity characteristics and institutions, with special attention to how they make decisions about potential instructional learning and change over time, and what motivational factors are at play.

6. Evaluate the impact that existing types of professional development programs have on supporting diverse geoscience instructors in changing their choice and implementation of instructional strategies using longitudinal multi-case studies on programs' impact on instruction.

Grand Challenge 2:

How can departments and programs support continuous improvement in undergraduate geoscience education?

Rationale

Undergraduate geoscience content is taught in a wide variety of departments and programs beyond only traditional geoscience or geology departments, including physical science departments at community colleges, departments focused on ocean, atmospheric science, and environmental science, and even embedded within courses taught by departments such as sociology and engineering. All of these departments and programs can be conceptualized as complex systems comprised of instructors, students, staff, and administrators, as well as curricula, courses, and assessment mechanisms, as well as physical structures such as classrooms and labs (Condon et al., 2016; Manduca, 2017). These systems support students' geoscience education, the professional environment of the instructor, and the long-term character and evolution of the degree program (Tobias, 1992; NASEM, 2016). Geoscience education research can assist departments, institutions, and professional development programs in understanding how these systems function to support students and instructors in learning.

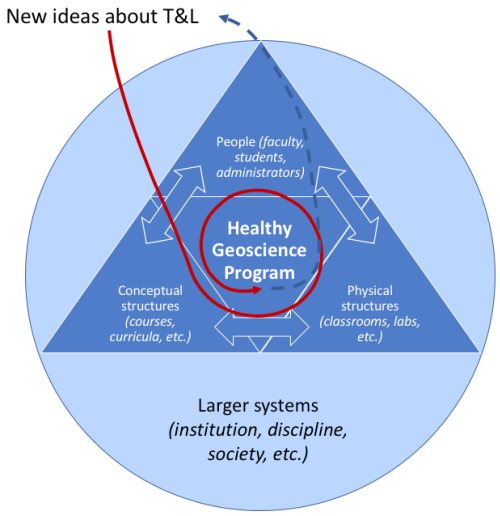

Figure 3: Geoscience programs are complex systems made up of humans, physical structures (e.g. classrooms/labs), and conceptual structures (e.g., courses, curricula). In programs with healthy teaching cultures, new ideas about T&L continuously enter the system with minimal impediment; new ideas about T&L also flow outward and back into the community. Teaching cultures are developed and maintained within the program, but are also influenced by various larger complex systems (institutions, disciplines) within which they are embedded.

Viewed from this systems perspective, in "healthy" departments and programs, new and potentially valuable ideas about teaching and learning enter the system continuously and are discussed, experimented with, and implemented freely (Manduca, 2017). A healthy department or program can respond and adapt quickly to new challenges and opportunities, drawing on this capacity for learning. Considerations affecting the health of the program include teaching-related rewards structures; resources and opportunities for professional development; collegiality among faculty, students, and staff; leadership; and other factors (Andrews et al., 2016; Walter et al., 2014).

While each geoscience department or program is a system unto itself, it is embedded within larger systems such as the college, institution, discipline and its component professional organizations, and local, national, and global societies, all of which exert various types of influences on the health of a department or program. Furthermore, individuals from a department or program may participate in communities of transformation that transcend individual disciplines (Gehrke & Kezar, 2016), and these ties may also contribute to systems health within a department or program. Thus, further work will need to clarify factors contributing to department or program health from both within (departmental climate) and beyond the department itself (e.g. academic advising,

employers, disciplinary societies). An understanding of the departmental system and its response to both internal and external influences is foundational to sustaining the highest-quality geoscience education. This Grand Challenge is summarized in Figure 3.

Recommended Research Strategies

1. Collaborate with and draw upon the work of organizational psychologists who study workplace climate to conduct mixed-methods case studies describing the health of a variety of geoscience programs, including measures of departmental climate (e.g., Walter et al., 2014) and interviews with students, alumni, faculty (full- and part-time), staff, and administrators that seek to determine their perceptions of internal and external influences on teaching and learning information flow and changes in practice.

2. Based on those case studies, formulate hypotheses about internal and external variables that appear to have the greatest impact on department or program health, and design quantitative survey instruments to test those hypotheses across a representative subsection of geoscience departments and programs in the U.S.

3. Investigate how departments and programs that support high-quality undergraduate geoscience teaching evolved to that state. Longitudinal multi-case studies of departments and program from the range of institutional types would aid in addressing this strategy.

4. Identify what chairs/heads of a diverse range of departments and programs need to foster a teaching culture that supports high-quality undergraduate geoscience education and the extent to which they think those needs are being met. A critical incident analysis of the chairs/heads experiences would assist the pursuit of this strategy.

5. Conduct social network analyses at a variety of scales within the geoscience education community, including departments and disciplinary societies, to identify the characteristics of change agents to understand of how those change agents support program health.

Grand Challenge 3:

What roles do different types of professional development experiences play in promoting, facilitating, and sustaining ongoing evolution in geoscience instructors' teaching practices over time?

Rationale

Geoscience educators have a rich palette of ways to learn and improve their practice. On-campus centers for teaching and learning typically involve participants from many disciplines, and typically focus on general teaching knowledge (Pallas, Neumann, & Campbell, 2017) and other issues that cross disciplines. Geoscience-specific learning opportunities, including those offered by NAGT, GSA, AGU, and NSF-funded programs (e.g., Manduca et al., 2017), typically focus on challenges and opportunities specific to the geosciences, including pedagogical content knowledge such as common misconceptions, pathways students follow in becoming geoscientists, and approaches to guiding geoscience learning (Pallas et al., 2017). In-department graduate teaching assistant training (Bitting, Teasdale, & Ryker, 2017), on-campus STEM centers (NSEC, 2017), and communities of transformation such as SENCER and PKAL (Gherke & Kezar, 2016) include a variety of hybrid models. Collaborative activities (e.g., co-teaching) and informal learning from peers interact with formal professional development (Condon et al., 2016). Over the arc of a career, instructors are likely to participate in multiple types of professional development and gain different benefits from each. Investigation into this mosaic of impacts will clarify the differential roles of each as well as the interaction effects that promote continual learning and growth underpinning improved practice (Figure 4).

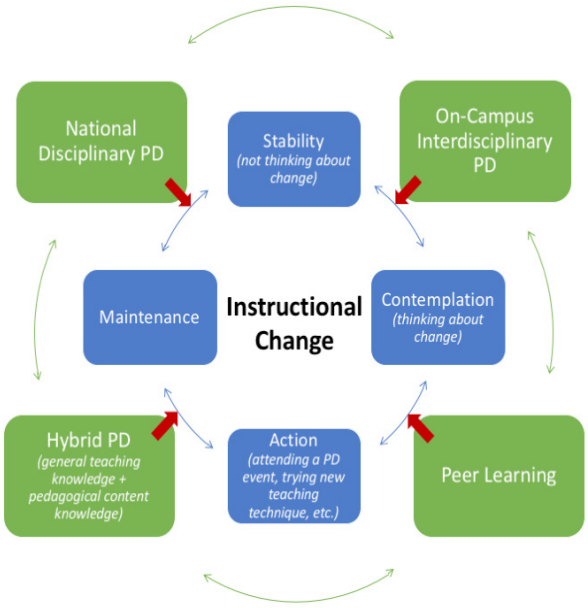

Figure 4: During one's career, learning about teaching & learning may take place via many types of experiences, including on-campus interdisciplinary professional development (PD) programs, national disciplinary programs, hybrid disciplinary-and-general teaching and learning programs, and peer interactions. These and other factors may influence instructor conceptions and practices in non-linear and complex ways, resulting in non-linear and complex changes.

Pathways through the change process (much like the rock cycle) can be non-linear and multi-directional (DiClemente & Velasquez, 2002). One instructor may participate in many different professional development experiences before deciding to experiment with a new practice, while another may incorporate small incremental changes based on each professional development experience as their thinking about teaching evolves, and another may transform their practice substantially after only one professional development experience. Future work must explore how teaching knowledge and practices change over time in non-linear ways (Manduca, 2017).

Recommended Research Strategies

1. In collaboration with and drawing upon existing work of educational psychologists, especially those who study K-12 teacher beliefs, conduct a longitudinal study following early-career geoscience instructors (graduate teaching assistants and early-postgraduates) for 10+ years to explore participants' growth and evolution in both teaching conceptions and practices, how they make decisions to pursue learning opportunities, and why they consider, adopt, and abandon or sustain changes in their practice. This strategy may be pursued in conjunction with longitudinal studies proposed under Grand Challenge 1, but those addressing Grand Challenge 1 would need to go beyond early-career instructors to capture the full range of identity and career characteristics that may be relevant.

2. Collaborate across institutions and disciplinary societies to develop and deploy common end-of-program instruments to identify different learning outcomes for instructors participating in professional development. Iteratively redesign these instruments at three- to five-year intervals, as hypotheses about relationships are formulated and reformulated with progressive analyses of the combined datasets. Using this dataset, analyze the pathways that instructors follow through multiple experiences, and the range and variety of characteristics of changes they choose to make as a result.

3. Design protocols for follow-up interviews and classroom observations with program attendees for use before and three, six, or 12 months after participation. Seek to determine how participants connect what they learned during the professional development program to their prior thinking and practice, whether they have implemented changes, and what elements of the program most strongly influenced their motivation, learning, and decision-making regarding the implementation of new practices.

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Figures

Figure 1.
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Figure 2.
Provenance: Kelsey Bitting, Northeastern University

Figure 3.
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Figure 4.
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