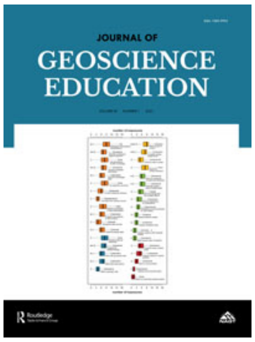

Journal of Geoscience Education

ISSN: (Print) (Online) Journal homepage: https://www.tandfonline.com/loi/ujge20

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To cite this article: Shandy Hauk , Kristen St John & Megan Jones (2021): Profiles of readiness: Using a blended framework to explore what it takes for faculty to be ready to change instructional practice, Journal of Geoscience Education, DOI: 10.1080/10899995.2021.1878573

To link to this article: https://doi.org/10.1080/10899995.2021.1878573

Published online: 19 Feb 2021.

JOURNAL OF GEOSCIENCE EDUCATION
https://doi.org/10.1080/10899995.2021.1878573

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Profiles of readiness: Using a blended framework to explore what it takes for faculty to be ready to change instructional practice

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ABSTRACT

In answer to calls for research about professional change, this study addressed the question: What is involved in college science faculty readiness for change in instructional practice? The setting was a professional development experience in oceanography/marine science and paleoclimatology among 32 faculty from 2- and 4-year colleges. Ten of the 32 participated in interviews, and all provided survey responses and documents used in the study. Cycles of inductive analysis generated three example case stories to illustrate a new model for exploring faculty readiness for change in teaching. The model blends results from the health sciences on readiness for behavioral change with research on the personal, external, professional, and consequence domains of a professional change environment. The blended model attends to how an instructor draws on the domains to (a) see an instructional challenge as requiring intentional action to be resolved; (b) notice new significance (for the instructor) in some aspect of instructional practice; (c) feel able to manage instructional stressors/challenges; (d) have commitment to initiate/sustain change; and (e) perceive adequate support in undertaking change. Profiles of instructional readiness for change are represented by composite cases named Lee, Pat, and Chris. In the case of Lee, factor (c) drove change efforts; for Pat, factors (a) and (b) were in the forefront; and for Chris it was factors (d) and (e). The three cases are valuable both as sketches of the blended model in use and as touchstones for future research and development related to postsecondary faculty professional learning.

ARTICLE HISTORY
Received 19 October 2018
Revised 5 January 2021
Accepted 16 January 2021

KEYWORDS
Faculty professional development; readiness; commitment; support

Introduction

Readiness for change is a concept that informs the examination of learning in many disciplines, from health and behavioral sciences (e.g., Holt et al., 2007; Weiner et al., 2008) to organizational management (e.g., Clegg & Walsh, 2004; Naquin & Holton, 2003; Zayim & Kondakci, 2015). The assumption is that before people can successfully alter behavior, they need to be ready to change behavior (Andrews et al., 2016; Schultz, 2014).

Useful tools for noticing, talking about, and understanding "readiness to change instructional practice" are valuable both for people who are providers of professional learning programs and for participants in those programs. If providers know how instructional change is shaped by individual readiness, they can more effectively differentiate instruction in the design and delivery of professional development. For example, goals for a professional learning experience might be the same for all participants, but opportunities, activities, and particular expectations for instructional change could be designed to be responsive to instructor readiness. For instructors, understanding their own readiness to change as a multifaceted developmental process can support more effective and satisfying self-directed learning and participation in larger, organizational change (e.g., learning to learn from their own change efforts; see Ermeling & Graff-Ermeling, 2014; Pellegrino & Hilton, 2012).

Being ready to change is both a state of mind and a process, involving willingness and intent to act. Holt and colleagues, for example, characterized readiness for change as:

> a comprehensive attitude that is influenced simultaneously by the content (i.e., what is being changed), the process (i.e., how the change is being implemented), the context (i.e., circumstances under which the change is occurring), and the individuals (i.e., characteristics of those being asked to change) involved and collectively reflects the extent to which an individual or a collection of individuals is cognitively and emotionally inclined to accept, embrace, and adopt a particular plan to purposefully alter the status quo. (Holt et al., 2007, p. 236)

In health, behavioral, and social research to date, most attention has been paid to the *degree* of readiness to change (Glanz et al., 2015). Those who attempt behavioral change

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with higher readiness report less frustration, less depression, and more optimism in the face of change (Dalton & Gottlieb, 2003). Degree of readiness has been a tool in monitoring the success of change efforts in health and behavioral sciences, such as interventions for those with a chronic condition or among those aiming to adopt healthier life habits (e.g., to lose weight or to stop smoking; see Glanz et al., 2015).

What makes one ready to change? It takes more than evidence that the change is worthwhile. For example, despite thorough verification of the efficacy of exercise and clean air in improving health, many persist in sedentary living and tobacco smoking. Or consider the geosciences, in which there is evidence of the positive impact of professional development on instructional practice. A multi-institutional study of 236 geoscience instructors indicated that faculty who engaged in at least 24 hours of professional development activities were significantly more likely to teach with effective student-centered practices than those who participated for less time (Viskupic et al., 2019). Also, research has demonstrated that faculty who participated in *On the Cutting Edge* programs and regularly used resources from the *Cutting Edge* website were statistically more likely to use active learning strategies (Manduca et al., 2017). Nevertheless, despite the demonstrated positive effects of active, student-centered college instruction, most faculty continue to rely on teacher-centered lectures (Freeman et al., 2014; Kobler, 2015; Kuh, 2008; Laursen et al., 2019). Before instructors can *create* change they need to be *ready* to change.

Research question and context

The work reported here is rooted in a design and implementation project: Create and deliver a professional development program for geoscience faculty who teach at minority-serving institutions. Initially, associated research was to evaluate the professional learning experiences of participants in the program and give feedback to providers for improving the program. Iterations of data gathering, analysis, and communication among providers and evaluators motivated a research extension that emerged toward the end of the project. The extension addressed practical concerns among providers about motivating participants to change instruction.

The exploration reported here was the result of that end-of-project research extension. It is from the vantage point of a particular kind of professional development, one offered to a group and targeting individual instructor change. That is, the research context was one of many possible formats of learning about teaching (other formats include programs for instructors working in teams, one-on-one coaching, and individual self-development). The research question was this: What does it take for faculty to be ready to change their instructional practice?

Addressing the question involved cycles of data analysis and theory building. The goal was to capture and communicate aspects of instructional readiness for change in ways useful for providers of and participants in professional development in college teaching. Research design started with a focus on readiness to change and iterations of data analysis led to descriptions and visual representations of readiness within a larger model of the professional change environment. The analysis was *post hoc*: The designers of the professional development program had based it on their knowledge and experience, not on an explicit model of professional readiness. The blended model offered here emerged from the end-of-program research effort.

Theoretical perspectives on instructional change

The content, process, and context aspects of becoming ready to change outlined by Holt et al. (2007) involve multiple environmental and social factors. Also noted by Holt and colleagues are the importance of personal factors like motivation, self-regulation, and self-efficacy, which contribute to (or hinder) readiness to change behavior (Bandura, 1997; Glanz et al., 2015). When people experience a high degree of readiness, they are more than motivated, they are both willing and prepared to implement something that departs from their *status quo* (Weiner et al., 2008).

The model developed for and applied in the work reported here blends two existing models of human experience: a model for the professional change environment from education research and a model for readiness to change from health science behavioral research. After describing each separately, the descriptive value of merging of the two into an *instructional readiness for change model* is explained and illustrated.

Model for the professional change environment

Clarke and Hollingsworth (2002) argued that pathways to faculty change and long-term professional growth are idiosyncratic and individual in nature. Thus, they claimed, when examining the impact of experiences intended to change faculty practices from some "State A" to another set of practices, "State B," one must consider the whole change environment in which professional learning occurs. The complexity of the journey from A to B is shaped by many factors. Within the change environment, Clarke and Hollingsworth categorized four domains of knowledge and activity. Three of the domains are aspects of an instructor's everyday world: professional experimentation as realized in teaching practice (domain of practice); individual knowledge and affect, including beliefs and attitudes, that prompt and respond to such experimentation (personal domain); and salient outcomes such as change in classroom environment or in student behavior, knowledge, or skills (domain of consequence). The fourth domain in the change environment captures perturbing factors from outside of self and classroom (external domain). Each domain includes short time scale aspects, like a workshop, as well as medium- and long-term effects that might arise from changes in department, staffing, or institutional policy. The change environment model is represented in Figure 1.

Implicit in the model, and represented to some extent by the enactment and reflection arrows in Figure 1, are various

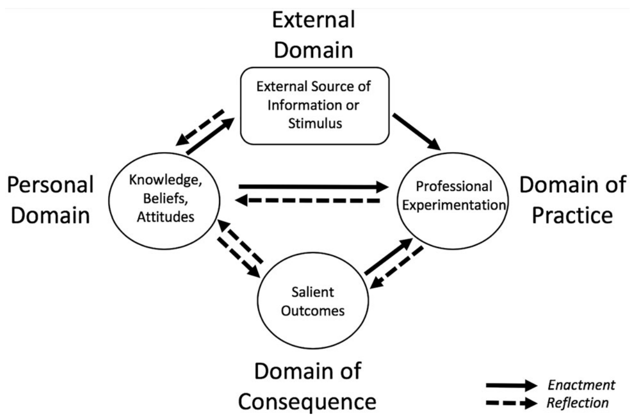


Figure 1. Model of the Change Environment (Clarke & Hollingsworth, 2002).

feedback loops. For example, in the figure, change in knowledge of what students find confusing (personal domain) may be stimulated by professional development (external domain) and also depend on short time scale feedback from a particular class meeting (domain of practice) as well as reflection about how students responded to a midterm evaluation question about what they find challenging in the class (salient outcome, domain of consequence). The model is echoed in the findings of Wilson (2013), that the kinds of implementation and experimentation that result from professional development are context-dependent.

The model in Figure 1 captures valuable detail by distinguishing among multiple aspects of professional experience (external, practical, and consequential) while still attending to the personal. These components resonate with calls in the research on organizational change, particularly recent work indicating that responses to change efforts are shaped by personal psychological resources as well as perceptions of institutional environments (Bitting et al., 2018, Challenge 2; Kirrane et al., 2017). One example of the usefulness of the model is the *InTeGrate* project (Pelch & McConnell, 2016). In addition to explicit attention to the change environment, project research and evaluation used the model to document and describe the relationship between the central activity of materials development and the faculty learning outcome of beliefs about instructional practices.

The Clarke and Hollingsworth (2002) model highlights the fact that postsecondary instruction happens in a system that includes people (e.g., instructors, students, and administrators) as well as the sometimes-implicit values built into conceptual structures (e.g., curricula, committees, and policies), physical structures (e.g., classroom, lab, library, and cultural center), and professional norms (e.g., valued forms of communication), along with relationships among all of these (Bitting et al., 2018; Reinholz & Apkarian, 2018). Certainly, all four of the domains in Figure 1 interact. Also as certain (although beyond the scope of this article) is that learning is shaped by more than what happens in the classroom (e.g., by learner experiences and interest; see Bransford et al., 2000; McNeal et al., 2018; Riggs et al., 2018; van der Hoeven Kraft et al., 2011, 2017).

Recent commentary has urged the professional development research community toward models that recognize instructors as agents of change in both their own learning and the learning done by others—including research investigating faculty experiences at multiple points along the journey in developing teaching expertise (Bitting et al., 2018; Manduca, 2017). Instructional change happens in the context of a system in which many of the components, constraints, and conditions can be understood and manipulated. A faculty professional development program is a complex system with sensitive dependence on initial conditions. The initial condition of interest here is readiness for change.

Model for readiness to change

As a research construct, readiness to change emerged in medicine and psychology from a rethinking of the stages approach. A classic example of the stages view attempts to model how people change behaviors related to smoking tobacco as a progression through somewhat arbitrarily determined stages of concern or engagement (West, 2005). Rather than describing stages—each made up of particular types of awareness, motivation, intention, and implementation—a readiness to change model considers these and other factors as nonlinearly interacting aspects in behavioral change. Dalton and Gottlieb (2003, p. 108) described five factors that signal readiness for changing health-related behavior:

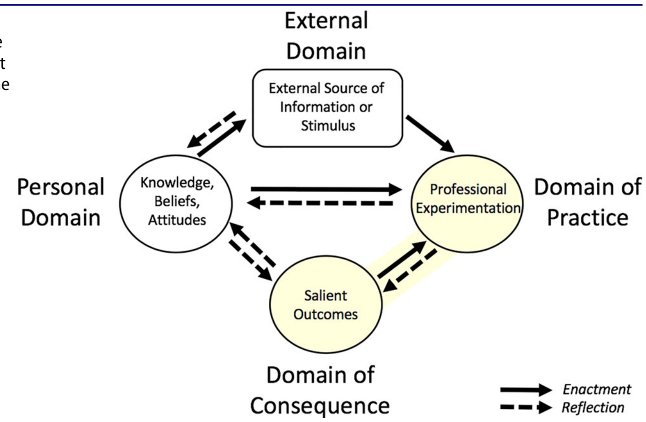
> These include when: (a) clients perceive that a health concern is not going to resolve, (b) a change in a client's physical condition takes on new significance, (c) clients feel better able to manage their stress, (d) clients have sufficient energy, (e) clients perceive that they have adequate support in undertaking change.

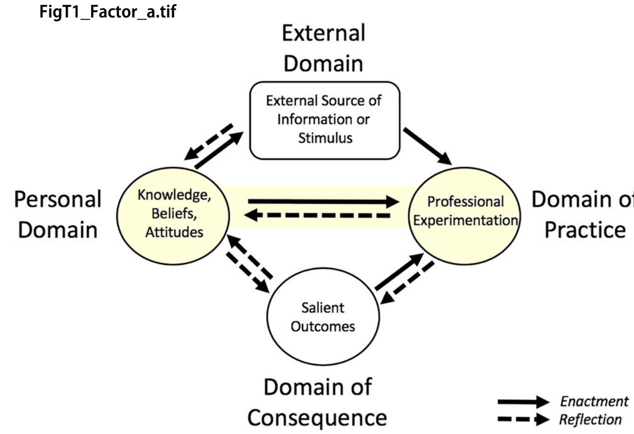
Although managing a medical condition is quite different from managing a professional challenge, the similarities are striking. In particular, both involve balancing competing demands over which personal control varies and both involve self-regulation and agency (purpose-driven action; see Bandura, 1997).

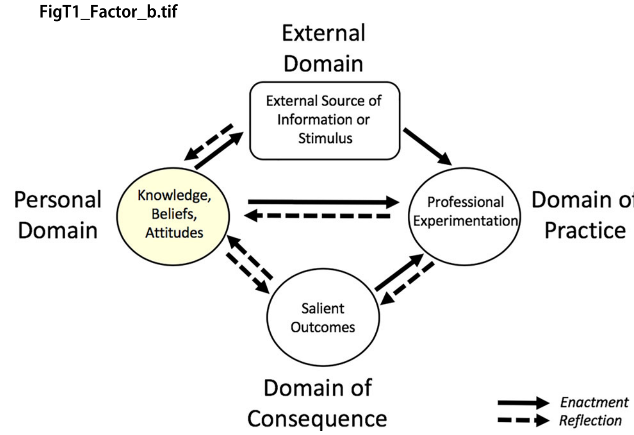
At the same time, when applying the health-related model in an educational setting, two sets of theory and research in higher education suggest a recasting of "sufficient energy" in Dalton and Gottlieb's Factor d. First, science faculty see personal considerations like time management and prioritization—aspects of commitment—as requiring energy (Sunal et al., 2001). Second, the work of Clarke and Hollingsworth (2002) noted the energy of commitment in persistence from short-term change sequences to long-term growth networks. As a result, for the purposes of the work reported here, Factor d "Clients have sufficient energy" was recast as a broader statement: "Instructor has commitment to initiate/sustain change." With this revision to Factor d, and some adjustments for context-relevant wording, Dalton and Gottlieb's factors can describe readiness to change regarding instructional behavior at the postsecondary level. These are when an instructor:

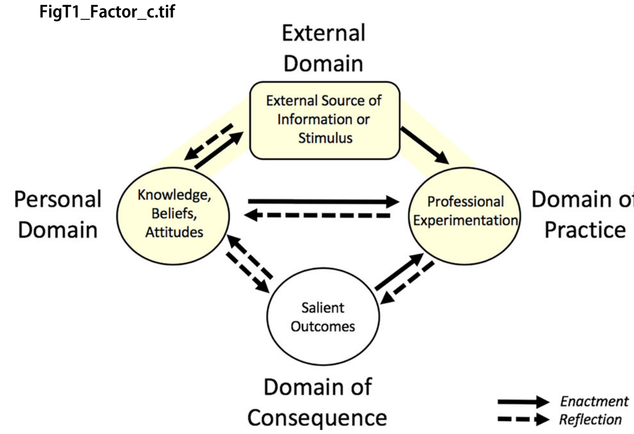
1. sees an instructional challenge as requiring **intentional action** to be resolved;
2. notices **new significance** (for the instructor) in some aspect of instructional practice;

Table 1. Merging the five readiness factors (Dalton & Gottlieb, 2003) and change environment (Clarke & Hollingsworth, 2002) into a blended instructional readiness for change model.

<table>
<tr><th>Faculty readiness for change factor</th><th>Illustration</th></tr>
<tr><td>(a) A person sees an instructional challenge is not going to resolve without intentional action.
This is represented in the diagram by the highlighting of domains of consequence and practice and their interaction because the instructional challenge is an outcome that has become salient (now matters) to the instructor and professional experimentation (intentional action) is what the instructor sees as the primary mechanism for influencing the outcome. Although a change in personal views might play a role, the perspective of the instructor is that aspects of the personal are not as important or consequential as practice for the desired outcome(s).</td><td>

FigT1_Factor_a.tif</td></tr>
<tr><td>(b) An aspect of instructional practice takes on new significance.
This is represented in the diagram by highlighting of domain of practice and personal domain interaction because what is valued by the instructor or perceptions of self as instructionally adept have shifted. Beliefs and motivations about what constitute good or effective teaching and personal investment in professional growth interact in decision making about what to do in practice.</td><td>

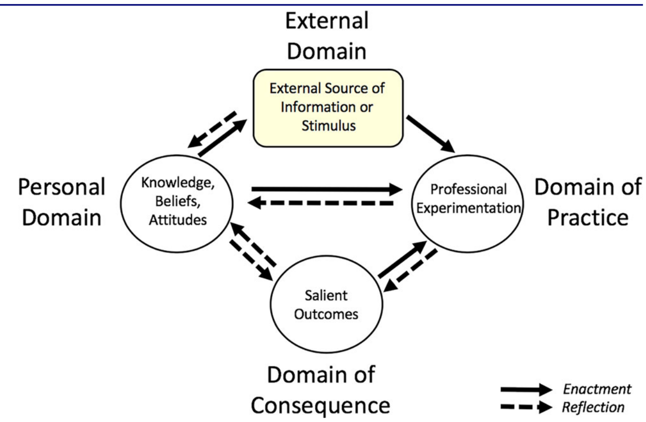
FigT1_Factor_b.tif</td></tr>
<tr><td>(c) An instructor feels able to manage instructional stressors/challenges.
This is represented in the diagram by highlighting of the personal domain because self-regulation and concept of ability are internal, personal factors. The actual management of instructional stressors/challenges would involve all aspects of the diagram, but feeling able to manage is a blend of belief, attitude, and self-knowledge.</td><td>

FigT1_Factor_c.tif</td></tr>
<tr><td>(d) An instructor has commitment to initiate/sustain change.
This is represented in the diagram by highlighting of two connected subsets: interaction between personal and external domains, and enactment from external into domain of practice because the long view required for commitment to initiate takes into account the tensions between personal and external domains whereas commitment that is sustained as professional experimentation is done in the face of /dependent on external pressures and sources.</td><td>

FigT1_Factor_d.tif</td></tr>
</table>

(*continued*)

Table 1. Continued.

Faculty readiness for change factor	Illustration
(e) An instructor perceives adequate support in undertaking change. This is represented in the diagram by highlighting of the external domain because "support" here refers to outside-the-instructor stimulus. The interaction between external and internal factors is a matter of commitment (see d, above), not of perception of support. Similarly, using or responding to the support is an aspect of commitment, not of perception.	 FigT1_Factor_e.tif

3. feels able to **manage** instructional stressors/challenges;
4. has a **commitment** to initiate/sustain change; and
5. perceives adequate **support** in undertaking change.

Blended instructional readiness for change model

The Clarke and Hollingsworth (2002) model is broad, about the entirety of professional change (not just instructional change), whereas the Dalton and Gottlieb (2003) model was designed to address the highly constrained context of establishing new habits for specified health-preserving behaviors (much narrower than the complex interactions involved in the readiness called for by an evolving set of targets for instructional behaviors). The collection of factors about readiness to change can be used to reconsider the model in Figure 1 to examine faculty experience of, and uptake from, instructional professional development. Note that this was a focused blending. The blended model is streamlined for effective design and realization of professional development programs of the type researched (i.e., of professional growth through a particular method).

The blended model is illustrated in Table 1. In each case, a readiness factor is represented in the context of the change environment. Each representation highlights relevant readiness-related components and paths in a change environment diagram. Recall that the lines and arrows in the change environment diagram (Figure 1) represent a person's action or reflection; activity in one domain can stimulate activity in another domain. In blending the models, there were distinctions to be made in order to tease apart the most important characteristics associated with each of the readiness factors: a, b, c, d, and e. Every participant in a professional development program is subject to the external domain stimulus of the program itself. Given the reality of this context, the external domain is only highlighted in a factor when something other than the professional development program is meant (e.g., see the descriptions in Table 1 for Factors d and e).

Methods

Rather than the goal of broad generalizability found in large, quantitative studies, the aim was to generate results—in the form of a carefully described blended model and case stories to illustrate it—that would be transferable to other professional learning contexts with care. The foundations of the model appear in Table 1. This section describes case story development.

Setting and participants

The study emerged from a professional development project: *MSI-REaCH: Minority-Serving Institution—Reconstructing Earth's Climate History, Program to Enhance Ocean and Climate Curricula*. The goals of the MSI-REaCH program were to prepare faculty to:

- integrate short-course paleoclimate curriculum into new or existing geoscience courses and/or begin or expand paleoceanography, paleoclimate, and/or marine science research opportunities for undergraduate students; and
- attend a follow-up meeting and, when possible, a professional meeting at which participants present their instructional, curricular, or action research outcomes.

The residential, summer, weeklong short-course was held at the International Ocean Discovery Program (IODP) Gulf Coast Repository in College Station, Texas. It was led by six program facilitators, who were also the project leaders and program designers (referred to as the providers). Project providers said that participants were, "targeted with the hopes of getting better pedagogy, better content, into the classrooms of underrepresented groups" (member of the provider team, July 2016). What providers promoted as "better pedagogy" for faculty were the best practices that had been identified at institutions where most students came from the U.S. majority "culture of power" (Delpit, 1995, p. 25). That is, providers sought to bring power-culture-proven practices to faculty in colleges where many students were not from the power culture. Purposeful recruiting of faculty was done by email and mailing of a printed brochure to eligible MSIs that offered ocean science courses or general education courses in which ocean science was a significant component.

Participants

Participants taught at two- and four-year institutions with minority enrollment of at least 25%. Thirty-two faculty from 31 institutions attended the two offerings of the short-course (two faculty from the same institution participated, but in different cohort years). The first cohort of 16 participants started in June 2015 and continued to work with project mentors through 2017. The second cohort of 16 began in June 2016 and worked with mentors through 2017. Each cohort attended a summer institute and engaged in individual and group follow-up activities. Among the participants there was some diversity of race and ethnicity as well as first language and professional role (e.g., participating faculty included full- and part-time/contingent instructors). To protect the anonymity of participants, no individual information is included.

MSI REaCH program

The short-course was designed to offer hands-on activities to hone knowledge of content and skills about ocean core sampling and analyses, examination of data about climate change, and how to infuse these into undergraduate experiences at home institutions (see Appendix A). Follow-up mentoring by providers was based on individual participants' action plans. Follow-up ranged from two hours to more than 10 hours per participant. Participants also completed semiannual surveys about their professional experiences and contexts, and attended video conference discussions; more than half submitted draft abstracts to a project-related Geological Society of America (GSA) conference session; about one-third presented their work at the GSA meeting.

Participants drafted action plans during the summer short-course (see Appendix B). Among other things, the template for the plan asked for instructor goals (primary focus of the plan) and statements of student learning objectives. However, the template did not include a place to describe the nature of the change faculty expected to see in themselves or ways of evidencing progress toward a successful shift in practice.

Ten faculty, five from each cohort, did presentations at GSA. These 10 also participated in individual and small-group interviews for the end-of-program research reported here.

Data analyses

The 10 interviews formed the foundation for analysis. Additional data came from several sources. Applications to the program gave details of experience (e.g., years of teaching, types of positions held). Program evaluation surveys and documentation of program activities provided details about experiences during and after the program (e.g., action plans, field-notes from online sessions, and GSA presentations). Case outlines emerged from analytic inductive analysis of the responses of the 10 participant interviewees.

Analytic induction is a qualitative research method for identifying necessary criteria for a phenomenon. The induction process starts with a hypothesis about a phenomenon based on existing theory and research. Analysis then examines a small number of instantiations of the phenomenon to challenge the hypothesis. If an instantiation does not fit the hypothesis, then the hypothesis is changed *or* the hypothesized definition of the phenomenon itself is refined. Further instances are studied until no changes in hypothesized explanation or primary definition are needed. The phenomenon for the work reported here was "readiness for behavioral change related to teaching." The hypothesized explanation was that *Factors a, b, c, d, and e—situated in the change environment model (i.e., the blended model, Table 1)*—could usefully characterize faculty experiences and orientations to their own instructional change.

To ensure rigorous research methodology while using analytic induction, attention was paid to credibility, transferability, authenticity, dependability, and confirmability, (Creswell & Creswell, 2017; Feig & Stokes, 2011; Lincoln & Guba, 1985; Mertens, 2005; Patton, 2015). Credibility—the trustworthiness of researcher portrayal of participant intentions, perception, and actions—was addressed as the researchers relied on checking in with others in several ways. First and foremost, there were member checks with the 10 participant interviewees, who gave feedback on case development and on drafts of this report. The authors' colleagues gave feedback on interim reports, and expert peer reviews of the manuscript shaped reporting. Member checks occurred at three points: at the end of each interview, at the end of coding, and when an early draft of this report was shared with the 10 interviewed faculty. Each interviewee was asked to review the manuscript and say which case resonated most with his or her own experience. Responses confirmed researcher selections. Other participant feedback was incorporated into this report, particularly in embellishing the case descriptions.

Also essential in support of credibility is falsification. Of the 10 interviews, seven were coded and used to establish and refine the blended model. Three were held in reserve. These three were later used for falsification as potential negative cases (i.e., to test the stability of the blended model by determining whether or not changes in the hypothesized model were needed in order to completely characterize the reserved interviews). No new adjustments were required when these three interviews were coded. As researchers progressed through writing, reviewing, sharing, and revising, the findings were shaped by researcher memos about the research process (kept as notes within the coding spreadsheets). These notes were discussed at each data coding and case development calibration conversation.

Transferability enables a reader to make connections to broader issues as well as interpret the research in other contexts. This was addressed by including rich descriptions of

Table 2. Interview prompts.

1. Tell a little story about your LEARNING experience in the program. Potential follow-up prompts: Here's where you might say a bit about some aspect of your experience with mentoring in the MSI-REaCH program. Any aspect you choose is fine. What happened? With whom? Where? When? How? Learning is a change in knowledge, what changed?
2. Tell a little story about your TEACHING experience in the program. Potential follow-up prompts: Here's where you say a bit about some aspect of your experience with using ideas from the MSI-REaCH program in your teaching. Any aspect you choose is fine. What happened that was new or different? With whom? Where? When? How? How did you know it was different? What changed?
3. Please describe at least one way that MSI-REaCH mentoring could better meet your needs or expectations. Potential follow-up prompts: What advice do you have for MSI-REaCH mentors or other faculty participants on the best ways to support you in keeping in touch with them? Are there other things about which you want mentoring, things we have not mentioned?
4. What was in MSI-REaCH that was explicit/implicit for you about being at a minority-serving institution?
5. Other thoughts or comments you'd like to share?

study context and details about the professional development experience (e.g., in this section and in the Appendix).

To ensure authenticity, researchers relied on established models and tested the blending of those models while attending to participant voices. This occurred through developing the cases, sharing the cases with participating faculty, and getting feedback from them that confirmed the cases authentically represented their perspectives.

Dependability and credibility were addressed in the description of data collection that clearly stated the conditions (warts and all): details of the professional development context, what participants generated, and the *post hoc* nature of the study. Some of this information is under "setting and participants" and some in appendices about the professional development program. A final aspect of credibility was researchers writing out, reflecting on, and including in this report a statement of researcher perspective (Appendix C).

Coding of interviews

The first author conducted all interviews, typing verbatim what each person said as he or she said it, verifying and clarifying statements in the moment if any confusion arose (yes, she types very fast). These transcripts were separated into topic utterances. If the speaker changed topics, the subsequent statement was considered a new utterance. In this way the 10 interviews became a collection of 150 utterances. Separately, the authors reviewed 20 utterances to code them, identifying which (if any) of the five readiness areas—Factors a through e—the speaker seemed to be addressing. In each case, a researcher memo that included justification for choice of code(s) was recorded by the coder. The authors met and calibrated their use of the codes, particularly making distinctions between Codes a and c: Recognition that an interviewee's intentional action is required for Code a, whereas interviewees' perception of being equipped to manage an instructional stressor/challenge was required for Code c. After calibration, researchers coded 20 more utterances separately and recalibrated, then coded the remaining utterances and reconciled any differences in coding, coming to consensus on all final codes for each of the utterances. For each interview, all utterances were coded as at least one of Factors a through e, and for each utterance a foregrounded primary factor was identified.

The interview prompts (see Table 2) were intentionally broad. This allowed individual differences of experience with external, personal, practical, and consequential domains to be expressed. Probing questions sought detail about the particulars of experience and of local relationships with institution, department, policy, colleagues, and students. The interview touched on three categories of professional development: learning, teaching, and mentoring. The fourth interview prompt opened the door to feedback about the relevance of the short-course, given the external factors of a particular MSI workplace.

Developing the cases

The process of moving from lists of coded statements to identifying clusters of commonalities was the final phase of analysis. This phase ended when the new model could be used to characterize faculty experiences and orientations to their own instructional change, for all 10 interviews. In the first step of this phase, the qualitative data were distilled into proportions of utterances by category. Development of the cases involved two more steps. After the relative proportion of Codes a through e was tabulated and visualized using radial diagrams (more on this below), three clusters of participants with similarity in coding became apparent, each a potential case. Researchers grouped the other data for each potential case (e.g., survey responses, application documents, and action plans). Then, making note of similarities and differences within the clustered data and across those clustered collections of data, the stories of "Lee" and "Pat" and "Chris" were drafted. After initial feedback from an expert peer and member checks with participating faculty, these descriptions were extended to provide details that humanized each case character (e.g., age, more details about professional preparation, and details about how the character perceived past experiences). Final revisions to the three cases responded to the final member check, to clarify that no case character was in any way "better" than another, each was at a different point in the journey to being satisfied that his or her teaching practices were headed toward a desired destination.

Results

The primary result has two parts: the blended model for examining faculty readiness to change instruction (Table 1) and three short narratives illustrating its use. The model in Table 1 is a result because it stood up to the rigors of falsification: The iterative analytic induction validation process led

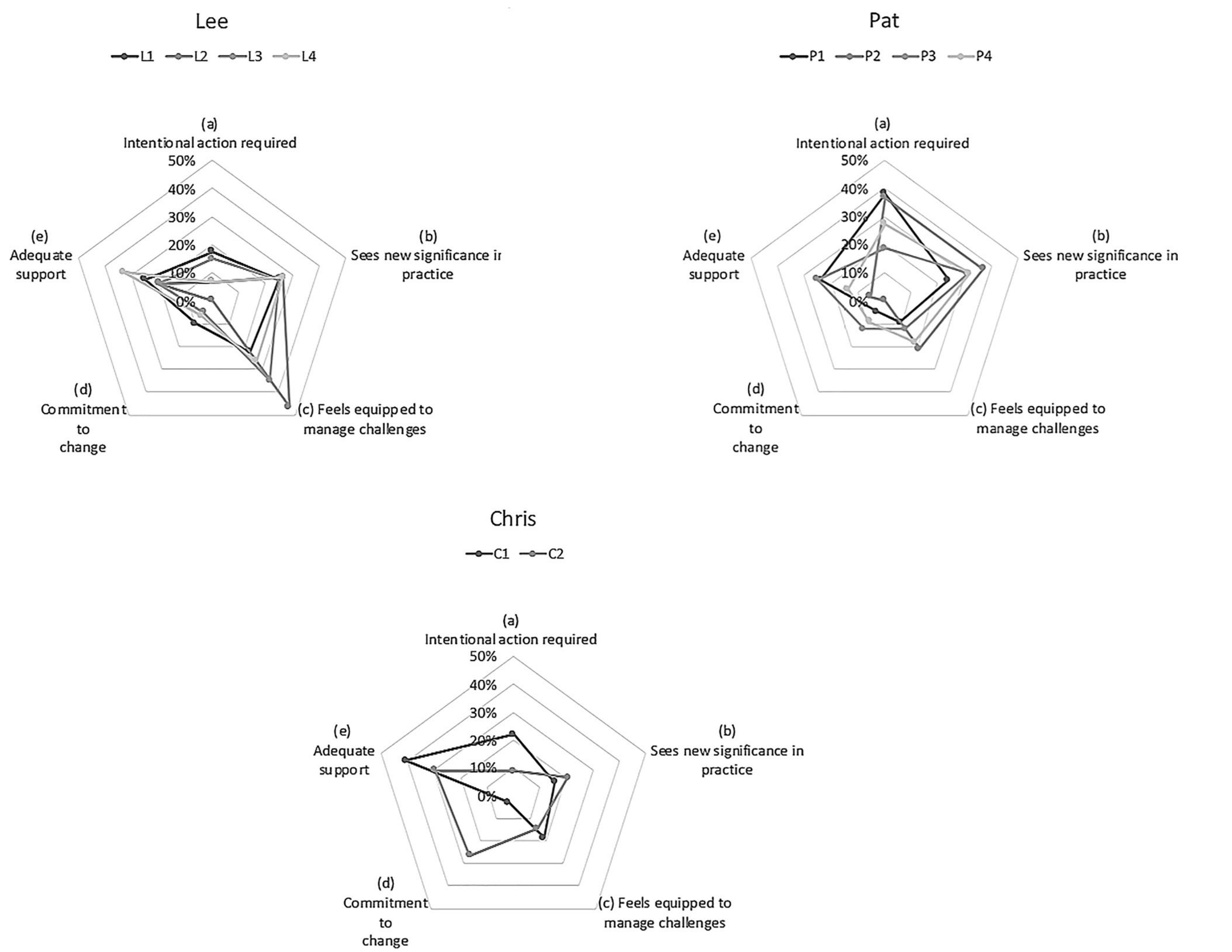


Figure 2. Radial displays of the data from interviews, grouped by clusters of response. Each closed path [polygon] represents one interviewee. The three clusters represent composite cases given the names Lee, Pat, and Chris.

to a stable model, and no adjustments were required when the last three interviews were analyzed.

The cases were developed in service of the goal of illustrating use of the blended model and are distinguished by the case names Lee, Pat, and Chris. The radial diagrams in Figure 2 collect the results of qualitative coding of interviews as visual displays. Each diagram gives the proportion of each of the five category codes for interviews, grouped by similarity of proportional pattern. Also known as radar graphs, each closed polygon represents the relative frequency of the five codes for one interviewee (Atchison & Libarkin, 2016).

Table 3 is a numerical summary of the clusters in Figure 2, giving the proportion of each code—a through e—for each case. Apparent in these data (Figure 2 and Table 3) is that, in every case, more than one factor was in play. At the same time, also visible are the high proportion of Code c for the cluster that is named Lee as well as the relative significance of Codes a and b for Pat and of Codes d and e for Chris. Tabulated data in the diagrams shown in Figure 2, for each instructor, are available in Appendix D.

The characterization of Lee emerged from similarity in the pattern of coding among four of the 10 interviewed faculty members. Pat's profile emerged from a different pattern of similarity in coding for four other faculty members. Finally, a distinctly different profile was apparent for Chris, arising from collectively considering the statements of two faculty members.

As indicated in the final column of Table 3, about one-third of all interview utterances were accounted for by each profile (slightly more for Lee, at 37% of all interview statements, and slightly less for Chris, at 30% of all interview statements). It is worth noting that if everyone had said about the same amount, each of the interviewees would represent 10% of the statements; so, the two faculty members whose experiences are represented in Chris were a bit more talkative than the four represented by Lee and the four represented by Pat. Also, in Table 3 the percentages in Lee's row indicate that the statements grouped as Lee represented the majority of the statements coded as c (54%), and a large proportion of b (39%) and e (38%). Thus, the profile for Lee foregrounded readiness for change Code c most, along with b and e. The same process meant the profile for Pat foregrounded Codes a and b, whereas Chris's profile foregrounded Codes d and e. Each case description was developed as a fictionalized amalgam of several faculty members, rooted in the interview coding.

Table 3. Summary of proportion of each coded factor across the three cases.

	% **Code (a)** - **Intentional action** required	% **Code (b)** - Sees **new significance** in practice	% **Code (c)** - Feels equipped to **manage** challenges	% **Code (d)** - **Commitment** to change	% **Code (e)** - Adequate **support**	% of all utterances
Lee (c, b, e)	26%	**39%**	**54%**	29%	**38%**	37%
Pat (a, b)	**52%**	**41%**	24%	24%	22%	33%
Chris (d, e)	22%	20%	22%	**48%**	**40%**	30%
Total	100%	100%	100%	100%	100%	100%

Note: Shading indicates dominant characteristics: light gray greater than 33% and dark gray greater than 40% of codes in a category (column). Due to rounding, columns may not sum to exactly 100%.

Before presenting the three case descriptions, some notes on their content and representativeness are in order. In the development of each case, average values have been used (e.g., the four faculty from which Lee is generated ranged in age from their early 30s to mid-50s, and Lee's age is given at the mean of 42). Each case profile offers details for the differences and the similarities across the case groups. For example, in the Chris case group, everyone was in a second or third career (this was not the true in the other two groups). The type of variation within a commonality in a case is represented in parenthetical descriptions (e.g., description of degree areas). Within each case group there were faculty from each cohort, from both two- and four-year institutions, people who identified as male and female, people who identified as majority U.S. culture and not, and people for whom English was and was not a first language. So, the group of 10 interviewees was representative of the entire population of 32 faculty participants in many ways. However, the 10 interviewees were not representative in a few ways (some we know about and some we probably do not). In particular, highly varied professional experiences and having at least 15 years teaching experience may be overrepresented by the cases of Pat and Chris; such backgrounds were present for about 30% of participants (not two-thirds). In this sense, Lee may be more closely representative of the professional experiences and time in the academy of the majority of the faculty involved in the program.

Lee: Can manage instructional stressors/new challenges with external support (c, b + e)

Lee was trained traditionally as a science researcher who would also teach. Lee's advanced degree is in a marine science or paleogeography field (e.g., marine biology, oceanography, paleoecology, environmental science, geology). Now about 42 years old, Lee has taught undergraduate science for more than 10 years (ever since leaving graduate school), and values vicarious learning, both as a method of teaching and a method of learning. For Lee, witnessing someone else enact a model of new teaching practice is an essential piece of support, required before Lee is ready to consider trying the new practice in class. Lee has students do experiments and take exams, but student perceptions of these are not salient to Lee; of greater importance when considering changes in practice are Lee's personal intentions and access to resources for realizing those intentions in the classroom (see Figure 3).

In interview comments, Lee reported relying on intended goals, "I went back several times, to the action plan over time. I had short-, medium-, and long-term goals that were important," and frustration about "students who don't learn how I expect, how I learned."

Lee identified changes for practice, created and carried out an action plan, and reported on orchestration of classroom lectures and activities. Lee's focus was on what students would do (as opposed to what they would learn): "[Another department] was getting all new microscopes, so I saw about getting some of their old ones. They are new for us! Microscopy was an old love of mine. I had the sediments from the MSI REaCH workshop and knew what I could have students do."

Missing from Lee's reporting was attention to reflecting on student outcomes and how that might interact with or play a role in instructional change efforts. That is, understanding the nature of student thinking or student learning were not salient for Lee as a part of instructional change.

Lee found it challenging to consider a future norm of instructional practice, a goal State B, that was much different from Lee's current State A. In survey items that asked, "How much alignment do you see between [a given student-centered practice] and what is valued by your department?" Lee's average response was "a lot" (5, on a scale from "1 = none" to "6 = a great deal"). Lee saw the focal practices in the program as consonant with local department values. However, Lee reported that these focal practices would require changes in Lee's own uses of curriculum, course design, and/or teaching habits. From interview comments as well, it was clear that although student-centered practices would bring Lee into greater alignment with department expectations, the members of the department generally did not talk about their teaching (although they did talk about their students). Lee noted the "exception" of a small subgroup in the department paying attention to teaching, but Lee did not want to be a member of that group. At the same time, Lee was not sure how to manage instructional change and asserted a need for support within the department (from someone(s) other than the existing group; hence, the absence of yellow highlight from external domain to domain of practice in Lee's profile diagram; see Figure 3).

Lee reported being willing to change if change meant low-risk adaptation and "fitting in of some of the new stuff into what was already happening." For Lee, there did not yet seem to be an instructional challenge that demanded resolution through instructional action (Code a); nor did Lee have a commitment to an identified change (Code c). Moreover, while noting a need for support (Code e), the support desired was assistance in identifying aspects of instructional practice that would have (new) significance to Lee (Code b). Essentially, for Lee the prevalence of Code c—

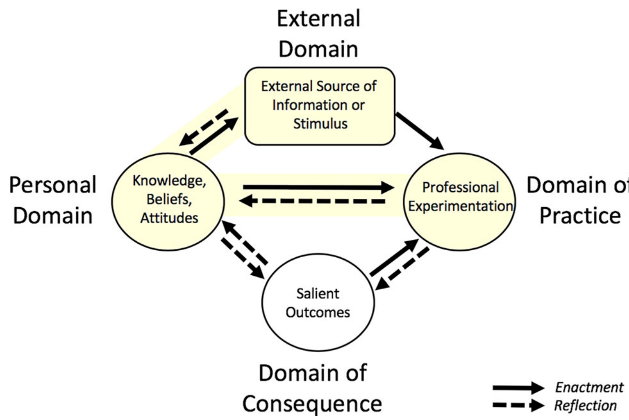


Figure 3. New model illustration for Lee's readiness.

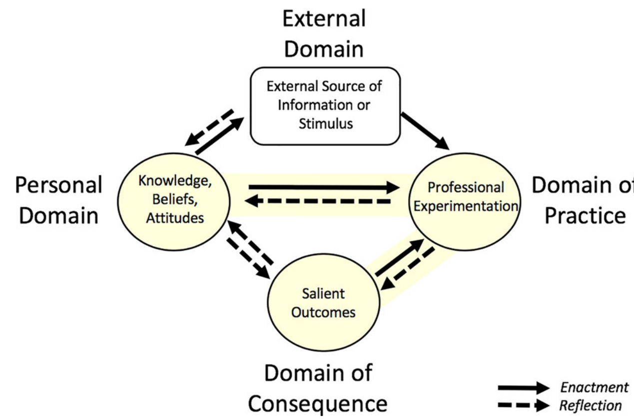


Figure 4. New model illustration for Pat's readiness.

a feeling of efficacy for managing change—was not sufficient for readiness to change. In fact, Lee tried several things (e.g., adapting activities and using them, partial course redesign) to move from Lee's current State A. But after a year, Lee still was still unsure what personal and professional successes had occurred and unsure how long it would take to identify a State B toward which the work was aimed. Ironically, Lee had done all the "to do" items of the professional development (completing an action plan, attempting new instructional or curricular things, and participating in dissemination) but did not have a connected understanding of what the providers intended Lee to learn from doing those things.

Pat: Intentional action to address new significance (a + b)

Pat is an adventurer, a polyglot in the multiple languages of science. A 49-year-old career shifter within the academy, in 18 years of teaching Pat has taught many different courses across the typical disciplinary boundaries (e.g., chemistry, physical science, mathematics, earth science, life science). New teaching assignments gave paleoceanography and paleoclimatology new significance. As with Pat's previous professional expansions, getting ready to teach the new topic was an instructional challenge that required purposeful experimentation. In most cases in the past, Pat's teaching had explored nonlecture methods. Pat often felt isolated as a teacher, without external or networked support for a teaching style that seeks to be engaging to students. Pat noted, "relevance is hard. The bridge the PD gave me was access to ODP data—with samples near our state; it gave me opportunity to make the activities more relevant, real, to the students."

Pat's own experiences as a learner have been multidisciplinary. Pat's undergraduate and advanced degrees are in different areas of allied fields (e.g., physics, science education, earth science, chemistry). Pat did not have extensive formal training in a geoscience- or paleogeography-related field and joined the MSI-REaCH program to expand personal domain content knowledge as well as knowledge about teaching to support professional experimentation (see Figure 4).

When drafting the action plan, Pat highlighted a "sense of discovery and significance of the science" that students would experience (rather than the detailed lists of what lessons would cover and checklists of what students would do provided by Lee). Like Lee, Pat reported on orchestration of classroom activities but not on how gathering and reflecting on student outcomes might interact with Pat's knowledge or attitudes about students. Unlike Lee, Pat did address what outcomes (for students and for Pat) were salient in terms of future practice and instructional change efforts.

Pat's action plan details for goal State B were more about the processes of student engagement than the content of student learning. Pat reported achieving the goal of students having a sense of discovery, but also reported concern that it came at the cost of mastery of science fact and skill, which Pat described as professionally "disappointing." Unlike Lee, Pat's average response on items that asked, "How much alignment do you see between [a given student-centered practice] and what is valued by your department?" was low (3.8, between "little" and "some"). So, any goal State B using program ideas would put Pat further out of alignment with local department values.

Like Lee, Pat reported that an absence of support in the department was a familiar barrier. For Pat, the goal B and journey from A to B would have to navigate these roadblocks. In fact, Pat had stopped looking within the department/university for any community or support regarding instructional change. Pat's plans focused on what Pat would do to create discovery experiences. In reporting on the results of the action plan, Pat included metrics for salient (to Pat) outcomes such as growing enrollments and popularity of the courses in which MSI-REaCH ideas had been used, use of program ideas with additional populations (e.g., in professional development for K–12 teachers), and more interest in undergraduate research opportunities among science majors who had come through courses in which program ideas had been implemented by Pat. Pat made more regular use of MSI-REaCH mentors than either Lee or Chris.

Chris: Committed to change and marshaling support (d + e)

Chris is an experienced team leader and user of applied science. Now in a second (or third) career, Chris also knows what it takes to start something new. Chris's science training is in geology or geography, and previous careers have tended

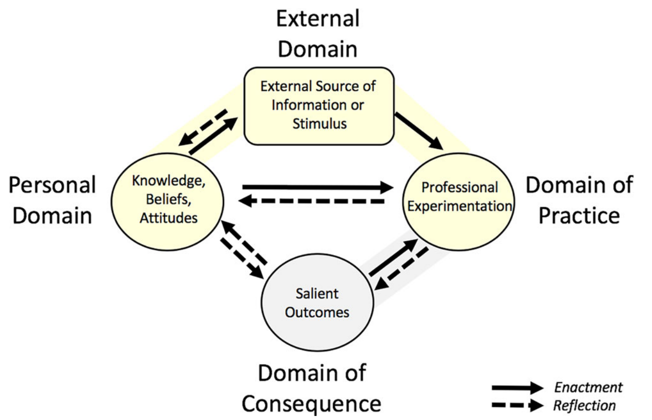


Figure 5. New model illustration for Chris' readiness (grey represents established habit).

to be in the field, using science to do a job with a team of peers rather than teaching science to students. In fact, although nearly a decade older, at age 58, Chris has about the same amount of classroom teaching experience as Pat.

Laser-focused on what the goal outcomes are for a class, for Chris effective instruction is *driven* by consequence. Chris regularly checks in with students through informal and midterm surveys to confirm the evidence from project, lab, and exams that students are aware of and see ownership in their own learning. Hence, reflection and enactment related to the domain of consequence is an established habit (i.e., no change to a new state regarding consideration of salient outcomes is needed, represented by gray in Figure 5).

For Chris, the most important aspect of preparing for, experimenting with, and sustaining change are "strong relationships with others who have power and influence" to support the change: "My department chair got on board and my dean because I was enthusiastic. Had to start buying my own [materials], so had to make a good case to administrators." Chris had an agenda coming into the summer institute and was quick to make connections between what was learned in the summer and how to find resources/support to make action plan progress. Chris' plan was specific in terms of outcome goals, support structures for meeting those goals, and structures for monitoring and managing the projects that the team (the class) was attempting to complete.

Chris' goal (State B) was engaging and learning with and from students. Chris reported achieving that goal to at least some degree that was professionally satisfying. Similar to Pat's, Chris's average response on items that asked, "How much alignment do you see between [a given student-centered practice] and what is valued by your department?" was not high (4, "some"). The chosen route from A to B for Chris was the action plan. Chris felt like State B had been achieved and a new State C that involved change would iterate on what had been learned in implementing ideas from the professional development program.

Limitations of the study

Although transferability rather than generalizability was the goal, several aspects of this small study warrant caution in transferability to other contexts. Case study participants were all MSI faculty and were a subset of about one-third of those who participated in the MSI-REaCH program. The 10 interviewees demonstrated some level of success as perceived by the providers because these participants submitted abstracts and designed and delivered oral or poster presentations about their project-related activities at a national conference (GSA). Because all were from MSIs, the results may be of limited use to faculty at non-MSI campuses. It was a qualitative study relying on interviews as the primary data source and documents (e.g., action plans, applications) as secondary data. A repetition of the study could be augmented by adapting one of the many surveys listed in the review by Holt et al. (2007).

Discussion and implications

The three composite cases emerged as a means to distinguish among instructor experience in ways that could be useful to others in thinking about how to promote instructional change. The results can inform the design and development of faculty learning experiences. Moreover, research can build on the results to generate ideas and tools, from examining the dynamics of readiness to change among groups or departments to theorizing additional details about the blended instructional readiness for change model.

Implications for providers

Design and delivery of faculty professional development

Pat's case suggests that the program focus on student-centered practices was reassuring, and Pat took it up enthusiastically. Actually, Pat may have been ready for more nuanced student-centered professional learning (e.g., about how to use formative assessment and tools for gathering and responding to student feedback, something the program did not address). The question arises: Pat was ready, but *for what*? That is, just as differentiated instruction is valuable in teaching science, it is needed when teaching faculty about teaching science. Whereas Pat might have been ready to gather and respond to feedback from students, Lee might not have had the same readiness to change (in part, because Lee saw each classroom of students, more often than not, as one conglomerate learner, "the class" rather than individual humans with whom individual relationships were needed). Additionally, from Chris's case, readiness to change Factors d and e (commitment to initiate/sustain change and perceived support), in combination with an established habit of reflecting on and acting on salient outcomes to inform practice, might indicate someone ready for fairly independent cycles of instructional change.

Recall the providers' intention was to share power-culture-proven best practices in the MSI-REaCH program. Essentially, providers were in the position described by Henderson et al. (2011) of unawareness of assumptions. There was a tacit agreement among the providers that little explicit attention to the variety in life-worlds of MSI college students was needed. This assumption on the part of the providers left it up to faculty participants to define for themselves how the program (an external domain component) might connect with the identification of salient outcomes for working at an MSI. In the model, the connections from this external domain to the domain of consequences pass through both personal beliefs and professional experimentation. With Lee (see Figure 3), readiness was coded as occurring mostly in the upper portion of the model, not connected to the domain of consequence. On the other hand, with Pat (see Figure 4), readiness was coded as mostly in the lower portion of the model, isolated from external stimuli (other than individual learning by Pat) in the external domain. That is, the visualization for the blended model reveals two distinct opportunities to support faculty: one that would scaffold Lee in risk taking connected to the salient outcomes, and another that would scaffold Pat in further external domain risk taking (beyond the MSI-REaCH program).

The action plan was a mechanism for providers and participants to communicate about experimentation. There was no similarly structured mechanism for communicating about the personal domain or about its connections to experimentation (although these connections were informally touched on during some mentoring interactions).

As noted, professional development design and delivery might offer differentiated instruction. One start would be to prepare strands of activities appropriate to the readiness in the three profiles. Also, it might be useful to create questionnaires to be completed as part of an application that might give providers a better sense of the profiles of faculty who are coming into a program. This could allow providers to better match activities to faculty needs and readiness. Similarly, such information could shape design of mentoring.

The importance of success (and defining it)

For the providers of the MSI-REaCH program, success was defined in several ways, some individual and some shared by most or all of the six providers. In fact, the goals of the project shifted during the planning year and were reprioritized and revised again in the first year of implementation in response to several stimuli, including regular summaries of feedback gathered from participants by an independent evaluator.

Every morning during the weeklong summer workshop, providers gathered to discuss and reflect on their experiences in facilitating activities the previous day, examine results from an evaluation summary of a survey of participants from the previous evening, and consider how these would inform plans for that day and the rest of the program. Often implicit in these leadership meetings was what the salient outcomes for the program were. Like Lee, when providers met the focus was on adjustments in what participants would *do* in the workshop. And similar to Pat, all providers sought to have participants experience a feeling of discovery.

Recall that Chris's was the only case in which the action plan write-up included learning goals as well as related, measurable objectives for keeping track of student success. Like the plans created by Lee and Pat, the plans designed by the program providers did not state detailed learning objectives or how participant progress toward meeting those objectives would be monitored. Instead, providers created an agenda for the workshop with guiding questions for each day that embodied instructional goals. For example, implicit in the Day 1 question, "What types of material make up seafloor sediments?" was an expectation by providers that participants would take up the offers to discover answers. It may be important that provider design teams include people like Chris, whose type of learner-centered habits include the disposition and skill to articulate success in terms of what the learner knows and can do (in addition to what the instruction offers).

Implications for research

In an extensive review of publications about strategies for professional change, Henderson and colleagues (2011) asserted that attempting to develop and have faculty use best practice curricular materials and "top-down'" policy making had little influence on instructional practices. According to their meta-analysis of 191 articles, efforts were effective when they aligned with or sought to change the beliefs of participants and included sustained support in promoting "high-impact practices" (Kuh, 2008). That is, effective professional development was aimed at the personal domain along with change in practice (Code d) and adequate support (Code e). The meta-analysis also concluded that "change strategies that span multiple categories appear to be fruitful and change agents would be wise to learn about strategies outside of their typical practice" (Henderson et al., 2011, p. 979).

In other words, the Henderson et al. study said that evidence from existing research suggests a faculty member has to become a Chris (or at least to pass through a Chris-like phase of professional readiness). Additional investigation is needed that leverages the existing work on goal-oriented professional development while also attending to how people make professional decisions (Schoenfeld, 2010; Shulman, 2002). In terms of the blended model presented here, this would include research examining the enactment and reflection arrows inherited from the environment model of Clarke and Hollingsworth (2002).

The six providers who designed and delivered the MSI-REaCH program were themselves science faculty. The group may have included several Lees and one or two Pat- or Chris-like people in terms of their readiness for change *as instructors of professional development*. This leads to a potential area of future research on readiness for change among people who design and provide faculty professional development and, further out, how designer readiness may interact with participant readiness.

Some work on this, focused on research-based instructional practices, has already begun among science faculty whose scholarly work includes both educational research and faculty development (Bush et al., 2019). In fact, the important "levers for change" contributing to an instructor's change environment also play a role in a *provider's* professional environment. These include external domain aspects for providers such as (a) addressing diversity and inclusion of students, (b) orchestrating communities of faculty learners, and (c) reaching out to college instructors earlier, as in the preparation of graduate students for college teaching (Laursen et al., 2019). Action that aims to change provider skills in STEM fields exists (e.g., *On the Cutting Edge*, https://nagt.org/nagt/profdev/oce.html; PULSE, https://pulse-community.org; the Academy of Inquiry Based Learning, http://www.inquirybasedlearning.org, and CoMInDS, http://cominds.maa.org). However, much research is still needed to understand what contributes to the differential impact of those actions from the perspective of providers.

Also, future research can explore if and how the case profiles may themselves, as a collection, represent aspects of a developmental continuum for professional learning. In particular, if additional research verifies that Lee's profile is most common, researchers might review existing reports of successful professional development programs and identify how the program was aimed at Lee's profile (or not) and examine the nature of the goal State(s) B promoted and achieved by faculty (e.g., use the lens to examine work like that reported by Andrews et al., 2016 or Brey et al., 2015). In fact, when Pelch and McConnell (2016) applied the Clarke and Hollingsworth (2002) model to explore how *InTeGrate* professional development challenged instructors to change, they concluded that collaboration among geoscience professionals was one of the drivers for change. Their "collaboration" was very similar to Code e, about adequate support and a sense of belonging. Code e was a central component in the profile of Chris and an aspect of note for Lee. Related research could explore the above in reports on postsecondary as well as K–12 teacher development to test the boundaries of the usefulness of the profiles in different professional cultures.

Finally, in the world of college faculty development, professional learning communities have emerged as powerful but underresearched supports in change efforts (Kastens & Manduca, 2017). Further research can explore the dynamics of *group* readiness.

Conclusion

College faculty, whether full- or part-time, have multiple professional responsibilities. For many, instruction is the largest part of both professional work and evaluation. Certainly, for the faculty who participated in the MSI-REaCH program this was true. Those who went to the trouble of applying to the short-course demonstrated in their application letters a willingness to depart from their current State A and an interest in learning about options on offer from MSI-REaCH for a new State B. But what was the nature of their readiness to craft their own State B? To plan and take the journey to get from A to B? To be both adventurous and thoughtful about monitoring progress along the way? To reflect on these efforts as the goal B might, itself, change?

Chris, Pat, and Lee were ready to change instruction, but the factors contributing to decisions about the new form of instruction (i.e., goal State B) were different for each character:

- Chris was ready for student-centered, student-responsive change.
- Pat was ready for student-centered change but unsure how to make it also be responsive to student learning needs.
- Lee was ready to change instructional behavior, but the envisioned change was teacher-centered and the role of the student was not yet in the foreground of that change.

Instructors can be called on to expand their knowledge base and learn new skills through professional growth opportunities that are informal (e.g., reading, talking with peers) or formal (e.g., workshops, short-courses). Which kinds of interactions are most useful depends on the person. This examination of readiness to change gave some insight, in the context of formal professional development, into the personal, external, experimental, and consequential domains and interactions that are at work for faculty seeking to alter their instructional practices. The blended model and the illustrative cases also offer professional development providers a structure for considering aspects of design, recruitment, and evaluation of the success of their efforts.

Acknowledgments

Our profound thanks to the faculty who contributed their time and energy to the interviews and reviews of drafts of this report and to the patient and immensely helpful reviewers of the manuscript as it was prepared for publication.

Funding

This material is based on work supported by the National Science Foundation (USA) under Grant Nos. ICER-1443178, DUE-1432381, and DUE-1625215.

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References

Andrews, T. C., Conaway, E. P., Zhao, J., & Dolan, E. L. (2016). Colleagues as change agents: How department networks and opinion leaders influence teaching at a single research university. *CBE-Life Sciences Education*, *15*(2), 1–17.

Atchison, C. L., & Libarkin, J. C. (2016). Professional held perceptions about the accessibility of the geosciences. *Geosphere*, *12*(4), 1154–1165. https://doi.org/10.1130/GES01264.1

Bandura, A. (1997). *Self-efficacy: The exercise of control*. W.H. Freeman.

Bitting, K., Arthurs, L., Chapman, L., Macdonald, H., & Manduca, C. (2018). Research on institutional change and professional development. In K. St. John (Ed.), *Community Framework for Geoscience Education Research*. National Association of Geoscience Teachers. https://nagt.org/nagt/geoedresearch/GER_framework/theme10/index.html

Bransford, J. D., Brown, A. L., & Cocking, R. R. (Eds.). (2000). *How people learn: Brain, mind, experience, and school*. National Academy Press. https://www.nap.edu/read/9853/chapter/1

Brey, J. A., Mills, E. W., Day-Miller, E. A., Geer, I. W., Weinbeck, R. S., Blair, B. A., Hopkins, E. J., O'Neill, K. L., Nugnes, K. A., & Asokan, A. (2015). The AMS DataStreme Earth's Climate System teacher professional development course: Results from a three year study. *Journal of Geoscience Education*, *63*(1), 47–56. https://doi.org/10.5408/13-038.1

Bush, S. D., Stevens, M. T., Tanner, K. D., & Williams, K. S. (2019). Evolving roles of scientists as change agents in science education over a decade: SFES roles beyond discipline-based education research. *Science Advances*, *5*(6), eaav6403. https://advances.sciencemag.org/content/advances/5/6/eaav6403.full.pdf https://doi.org/10.1126/sciadv.aav6403

Clarke, D., & Hollingsworth, H. (2002). Elaborating a model of teacher professional growth. *Teaching and Teacher Education*, *18*(8), 947–967. https://doi.org/10.1016/S0742-051X(02)00053-7

Clegg, C., & Walsh, S. (2004). Change management: Time for a change! *European Journal of Work and Organizational Psychology*, *13*(2), 217–239. https://doi.org/10.1080/13594320444000074

Creswell, J. W., & Creswell, J. D. (2017). *Research design: Qualitative, quantitative, and mixed methods approaches* (5th ed.). Sage.

Dalton, C. C., & Gottlieb, L. N. (2003). The concept of readiness to change. *Journal of Advanced Nursing*, *42*(2), 108–117. https://doi.org/10.1046/j.1365-2648.2003.02593.x

Delpit, L. (1995). *Other people's children: Cultural conflict in the classroom*. The New Press.

Ermeling, B. A., & Graff-Ermeling, G. (2014). Learning to learn from teaching. *International Journal for Lesson and Learning Studies*, *3*(2), 170–191.

Feig, A. D., & Stokes, A. (Eds.). (2011). *Qualitative inquiry in geoscience education research*. Special Paper 474. Geological Society of America.

Freeman, S., Eddy, S. L., McDonough, M., Smith, M. K., Okoroafor, N., Jordt, H., & Wenderoth, M. P. (2014). Active learning increases student performance in science, engineering, and mathematics. *Proceedings of the National Academy of Sciences*, *111*(23), 8410–8415. https://doi.org/10.1073/pnas.1319030111

Freire, P. (1970). *Pedagogy of the oppressed*. (M. Bergman Ramon, Trans.) Continuum.

Glanz, K., Rimer, B. K., & Viswanath, K. (2015). *Health behavior: Theory, research, and practice*. John Wiley & Sons.

Henderson, C., Beach, A., & Finkelstein, N. (2011). Facilitating change in undergraduate STEM instructional practices: An analytic review of the literature. *Journal of Research in Science Teaching*, *48*(8), 952–984. [Database] https://doi.org/10.1002/tea.20439

Holt, D. T., Armenakis, A. A., Feild, H. S., & Harris, S. G. (2007). Readiness for organizational change: The systematic development of a scale. *The Journal of Applied Behavioral Science*, *43*(2), 232–255. https://doi.org/10.1177/0021886306295295

Kastens, K. A., & Manduca, C. A. (2017). Leveraging the power of community of practice to improve teaching and learning about the Earth. *Change: The Magazine of Higher Learning*, *49*(6), 14–22. https://doi.org/10.1080/00091383.2017.1398997

Kirrane, M., Lennon, M., O'Connor, C., & Fu, N. (2017). Linking perceived management support with employees' readiness for change: The mediating role of psychological capital. *Journal of Change Management*, *17*(1), 47–66. https://doi.org/10.1080/14697017.2016.1214615

Kobler, N. (Ed.). (2015). *Reaching students: What research says about effective instruction in undergraduate science and engineering*. National Research Council.

Kuh, G. D. (2008). *High-impact educational practices: What they are, who has access to them, and why they matter*. Association of American Colleges and Universities.

Laursen, S. w., Andrews, T., Stains, M., Finelli, C. J., Borrego, M., & McConnell, D. (2019). *Levers for change: An assessment of progress on changing STEM instruction*. American Association for the Advancement of Science.

Lincoln, Y. S., & Guba, E. G. (1985). *Naturalistic inquiry*. Sage.

Manduca, C. A. (2017). Surveying the landscape of professional development research: Suggestions for new perspectives in design and research. *Journal of Geoscience Education*, *65*(4), 416–422. https://doi.org/10.5408/17-281.1

Manduca, C. A., Iverson, E. R., Luxenberg, M., Macdonald, R. H., McConnell, D. A., Mogk, D. W., & Tewksbury, B. J. (2017). Improving undergraduate STEM education: The efficacy of discipline-based professional development. *Science Advances*, *3*(2), e1600193. https://doi.org/10.1126/sciadv.1600193

McNeal, K. S., Van der, H., Kraft, K., Nagy-Shadman, E., Beck, M., & Jones, J. (2018). Research on geoscience students' self-regulated learning, metacognition, and affect. In K. St. John (Ed.), *Community framework for geoscience education research*. National Association of Geoscience Teachers. https://nagt.org/nagt/geoedresearch/GER_framework/theme9/index.html

Mertens, D. M. (2005). *Research and evaluation in education and psychology: Integrating diversity with quantitative, qualitative, and mixed methods*. Sage.

Naquin, S., & Holton, E. (2003). Motivation to improve work through learning in human resource development. *Human Resource Development International*, *6*(3), 355–370. https://doi.org/10.1080/13678860210154431

Patton, M. Q. (2015). *Qualitative research & evaluation methods: Integrating theory and practice* (4th ed.). Sage.

Pelch, M. A., & McConnell, D. A. (2016). Challenging instructors to change: A mixed methods investigation on the effects of material development on the pedagogical beliefs of geoscience instructors. *International Journal of STEM Education*, *3*(1), 5. https://doi.org/10.1186/s40594-016-0039-y

Pellegrino, J. W., & Hilton, M. L. (Eds.). (2012). *Education for life and work*. Report of the Committee on Defining Deeper Learning and 21st Century Skills, National Research Council of the National Academies. National Academies Press.

Reinholz, D. L., & Apkarian, N. (2018). Four frames for systemic change in STEM departments. *International Journal of STEM Education*, *5*(1), 3. https://doi.org/10.1186/s40594-018-0103-x

Riggs, E. M., Callahan, C., & Brey, J. (2018). Research on access and success of under-represented groups in the geosciences. In K. St. John (Ed.), *Community Framework for Geoscience Education Research*. National Association of Geoscience Teachers. https://nagt.org/nagt/geoedresearch/GER_framework/theme5/index.html

Schoenfeld, A. H. (2010). *How we think: A theory of goal-oriented decision making and its educational applications*. Routledge.

Schultz, C. (2014). Learning is change: Creating an environment for sustainable organizational change in continuing and higher education. *Canadian Journal of University Continuing Education*, *40*(1), 1–26. https://doi.org/10.21225/D5602Q

Shulman, L. S. (2002). Making differences: A table of learning. *Change: The Magazine of Higher Learning*, *34*(6), 36–44. https://doi.org/10.1080/00091380209605567

Sunal, D. W., Hodges, J., Sunal, C. S., Whitaker, K. W., Freeman, L. M., Edwards, L., Johnston, R. A., & Odell, M. (2001). Teaching science in higher education: Faculty professional development and barriers to change. *School Science and Mathematics*, *101*(5), 246–257. https://doi.org/10.1111/j.1949-8594.2001.tb18027.x

van der Hoeven Kraft, K. J. (2017). Developing student interest: An overview of the research and implications for geoscience education research and teaching practice. *Journal of Geoscience Education*, *65*(4), 594–603. https://doi.org/10.5408/16-215.1

van der Hoeven Kraft, K. J., Srogi, L., Husman, J., Semken, S., & Fuhrman, M. (2011). Engaging students to learn through the affective domain: A new framework for teaching in the geosciences. *Journal of Geoscience Education*, *59*(2), 71–84. https://doi.org/10.5408/1.3543934a

Viskupic, K., Ryker, K., Teasdale, R., Manduca, C., Iverson, E., Farthing, D., Bruckner, M. Z., & McFadden, R. (2019). Classroom observations indicate the positive impacts of discipline-based professional development. *Journal for STEM Education Research*, *2*(2), 201–228. https://doi.org/10.1007/s41979-019-00015-w

Weiner, B. J., Amick, H., & Lee, D. S. Y. (2008). Conceptualization and measurement of organizational readiness for change: A review of the literature in health services research and other fields. *Medical Care Research and Review*, *65*(4), 379–436. https://doi.org/10.1177/1077558708317802

West, R. (2005). Time for a change: Putting the transtheoretical (stages of change) model to rest. *Addiction (Abingdon, England)*, *100*(8), 1036–1039. https://doi.org/10.1111/j.1360-0443.2005.01139.x

Wilson, S. (2013). Professional development for science teachers. *Science (New York, NY)*, *340*(6130), 310–313. https://doi.org/10.1126/science.1230725

Zayim, M., & Kondakci, Y. (2015). An exploration of the relationship between readiness for change and organizational trust in Turkish public schools. *Educational Management Administration & Leadership*, *43*(4), 610–625. https://doi.org/10.1177/1741143214523009

Appendix A

MSI-reach short-course agenda and program timeline

Day 1 Participants arrive to hotel (before 5 pm)

5:00 pmIntroductions and logistics (meet in hotel's conference room)

- How will the week progress?
- How can we facilitate implementation of what you learn this week?
- Discuss actions Plans and mentoring rubric.

6:00 pmGroup dinner

Day 2 Breakfast at hotel

7:30 am Shuttle to IODP Gulf Coast Repository

8:00 am **Introductory activity**: *What do you observe?*

- Gain a snapshot of the content themes of the week.
- Experience a short do-talk-do pedagogical approach.
- Icebreaker for small group work.

8:45 am Connect participants' computers to the internet

9:00 am **Welcome and IODP overview**: *How and why do we sample the subseafloor via coring?*

- Gain context for why and how cores are obtained.
- Learn about the teamwork involved and analyses made on the cores at sea.

9:45 am Tour of IODP Gulf Coast Repository: *What happens when cores arrive at the repository?*

- See how cores are curated.
- Learn how sample requests are made for research (or education) purposes.

10:35 am Break

10:40 am **Marine sediments**

What types of material make-up seafloor sediments?

- Describe the physical characteristics of sediment cores.

12:30 am Lunch at IODP Gulf Coast Repository

1:15 pm *What are the main marine sediment types (lithologies) of the global ocean?*

- Identify major sediment components and their origin.
- Use composition and texture data from smear slide samples to determine the lithologic names of the marine sediments.
- Gain experience making smear slides and using a binocular microscope.
- Gain experience finding IODP scientific data online.

3:30 pm *Is there any pattern to the geographic distribution of marine sediment types in the global ocean today?*

- Apply what you learned and practice determining lithologies.
- Make a map showing the distribution of the primary modern sediment lithologies of the Pacific and North Atlantic Oceans.
- Practice map interpretation skills and explain the distribution of modern marine sediments on their map.
- Gain experience making hypotheses.
- Accurately predict what the modern sediment lithologies are at other locations on the seafloor (e.g., in the Indian Ocean).

4:45 pm *How can I use what I learned in my teaching and/or student research?*

- Participant reflection and discussion and action plan development. Ask questions of potential mentors.

5:15 pm Start of week road check: Online survey

5:30 pm Shuttle to dinner and group dinner

Day 3 Breakfast at hotel

7:30 am Shuttle to IODP Gulf Coast Repository

8:00 am Announcements

8:10 am *What other resources are there to teach about marine sediments in my classroom and lab?*

- Explore the IODP Borehole Map access in Google Earth and show that cores photos can be printed.
- Explore the NSF-funded GEODE Marine Sediment Map and Exercises in Google Earth.
- Explore the NSF-funded GEODE Physical and Virtual Core Kit.

9:10 am **Microfossils and biostratigraphy**

A. *How are microfossils used to infer past climate or ocean conditions?*
B. Gain experience identifying important microfossil groups.
C. Gain experience inferring climate and ocean conditions from proxy data.
D. *What evidence is there that life changes through time (i.e., that evolution and environmental change occurs)? How is it used to determine ages and sedimentation rates?*
E. Make observations about microfossil abundance data and make hypotheses to explain their observations.
F. Apply a biostratigraphic zonation to microfossil abundance data and use it to interpret relative ages.
G. Use microfossil data to calculate rates of sediment accumulation.
H. Gain experience interpreting data tables.
I. Gain experience making graphs.

12:20 pm *How can I use what I learned in my teaching and/or student research?*

- Participant reflection and discussion and action plan development. Ask questions of potential mentors.

12:30 pm Lunch at IODP Gulf Coast Repository

2:00 pm **CO_2 as a climate driver in the Phanerozoic and today**:

A. *How and why has CO_2 changed in the recent past?*
B. *What evidence is there that CO_2 is a climate driver in the Phanerozoic?*
C. *If CO_2 and global temperatures were higher in the geologic past, why is global warming a concern today?*

- Describe how and why CO_2 has changed at multiple scales of observation: seasonal, decadal, over thousands of years, and over hundreds of millions of years.
- Identify times of greenhouse and icehouse worlds during the Phanerozoic and use this knowledge to put modern and predicted future climate conditions into a geologic context.
- Gain skills in graph interpretation.
- Integrate new knowledge with prior knowledge on carbon cycle.
- Recognize and address misconceptions.
- Put modern change in a paleoclimate context.

4:00 pm *How can I use what I learned in my teaching and/or student research?*

- Participant reflection and discussion and action plan development. Ask questions of potential mentors.
- Catch-up on any lab work (e.g., making smear slides, washing samples for microfossils, looking at samples under microscopes).

6:00pm Shuttle to dinner and group dinner
Day 4 Breakfast at hotel
7:30 am Shuttle to Lake Somerville
8:30 am **Field trip at Lake Somerville Spillway**:
What would a greenhouse world look like?

- Gain experience thinking like a student in the field.
- Gain experience making observations and interpretations about past environments at the outcrop scale.

11:00 am Shuttle to hotel
12:00 pm Box lunch at hotel
1:30 pm Shuttle to IODP Gulf Coast Repository
2:00 pm **Stable oxygen isotopes**:
How do little fossils in the ocean tell us big things about past climate?

- Work though logic scenarios on how oxygen isotopes in water molecules are fractionated as the water travels through the hydrologic cycle.
- Explain how foraminifera (and other carbonate-shelled marine organisms) record the isotopic composition and the temperature of seawater in which they live and are, therefore, a biogeochemical proxy of climate change.
- Explain how $^{18}O/^{16}O$ ratios in samples are measured and calculate $\delta^{18}O$ given measured and standard values.
- Make observations and paleoclimate (ice volume and temperature) interpretations of marine $\delta^{18}O$ data for the Cenozoic. Distinguish between slow, gradual change and abrupt and rapid change.

4:30 pm *How can I use what I learned in my teaching and/or student research?*

- Participant reflection and discussion and action plan development. Ask questions of potential mentors.

5:25 pm Mid-week road check: Online survey
5:30 pm Shuttle to hotel and group dinner
Day 5 Breakfast at hotel
7:30 am Shuttle to IODP Gulf Coast Repository
8:00 am Announcements
8:10 am **Climate cycles Shatsky Rise case study**:
What evidence is there for climate cyclicity?

- Make evidence-based hypotheses on the nature of Pleistocene climate variability in the northwest Pacific region.
- Practice describing core.
- Practice making smear slide analysis.
- Practice making hypotheses.
- Gain experience making and interpreting graphs using Excel.

10:10 am **Climate cycles**:
How is periodicity determined?

- What are the common periodicities in paleoclimate records, and why do these occur?
- Gain experience with quantitative reasoning (calculating periodicity).
- Practice interpreting scientific diagrams.
- Describe the variety of ways that climate cycles are recorded in sedimentary records.
- Calculate the periodicities of climate proxy records.
- Differentiate among eccentricity, precession, and obliquity and how they cause climate cycles.

11:15 am *How does modern global warming relate to these cycles?*

- Put modern change in a paleoclimate context.
- Practice graph interpretation skills.

11:45 am How can I use what I learned in my teaching and/or student research?

- Participant reflection and discussion and action plan development. Ask questions of potential mentors.

12:00 pm Lunch at IODP Gulf Coast Repository
12:45 pm **Abrupt climate events**:
What can paleoclimate records tell us about the PETM?

- Explain how carbon isotopes are used to infer past changes to the global carbon cycle, and apply their understanding of $\delta^{13}C$ proxy data to characterize these changes.
- Synthesize observational data to construct a sequence of events during the PETM.
- Consider hypotheses for the potential cause of the PETM.
- Apply lessons learned about the causes, consequences, and rate of the PETM to a discussion of modern global warming.

4:30 pm *How can I use what I learned in my teaching and/or student research?*

- Participant reflection and discussion and action plan development. Ask questions of potential mentors.

5:00 pm Group dinner with activity

- Identify priorities in individual action plans and take steps toward those goals.
- Individual action plans: Post two priorities for course curriculum or for student projects.
- Whole group discussion: Talk through potential plans and ideas.
- Small group or individual meetings with potential mentors.
- Catch-up on any lab work (e.g., making smear slides, washing sample for microfossils, putting in any sample requests to support action plans).

8:00 pm Shuttle to hotel
Day 6 Breakfast at hotel
7:30 am Shuttle to IODP Gulf Coast Repository
8:00 am **Climate and human civilization**:
What evidence is there that climate change impacts human civilization?

- Investigate high-resolution marine sediment record(s) that spans the Pleistocene and Holocene.

- Investigate how climate change can impact civilizations.

11:45 am Online evaluation survey on content and skills of course
12:00 pm Meet with mentors

- Participant action plan work.

12:30 pm Lunch at IODP Gulf Coast Repository
1:15 pm Meet with mentors; Action plan work continues.
3:15 pm Report out to whole group on action plan progress

- Participants' formal presentation: 1–2 slides each that include learning objectives, tasks, and timelines of important steps.

4:55 pm Action plan and mentoring road check: Online survey
5:00 pm Shuttle to dinner and group dinner
7:30 pm Shuttle to hotel
Day 7 Breakfast at hotel

- Participant departures to airport

MSI-REaCH: After the short-course follow-up: Meetings and deliverables

Fall 2017 semester: Stay in communication with their mentor(s) via email or phone calls as they have questions, ideas, need materials, or need clarity on what/how they plan to implement their action plans.

January 2017: Video/teleconference follow-up meeting

Participants present two slides: (a) what worked well for them as they used the curricula in fall semester/how they modified curricula for their student population, and (b) what they needed/wanted some help with and/or what did not work with their students.

Spring 2017 semester: Continued communication with their mentor(s) via email or phone calls as they have questions, ideas, need materials, or need clarity on what/how they plan to implement their action plans.

March 2017: Submit draft abstract emailed to mentor

Purposes: (a) Writing about their classroom experience gives participants a chance to really think about how their action plan worked for them by putting their experience into words. (b) Several participants wanted to go to an annual geologic meeting and present what they did (our professional development course had funding to defray some of the participants' expenses). So those had plenty of time to refine their abstract for submission to a meeting (GSA abstract submission is during the summer).

All participants wrote a 250-word draft abstract summarizing what curricula, or parts of it, they implemented; how they changed it for their students (if they did); where there were kinks, if there were any; student successes, or what did not work the way you thought it would; and what would you change for next time?

Mentors reviewed abstracts, making comments, asking questions by either phone calls or email, and sent them back for a rewrite. This occurred over a period of weeks to months.

April through September 2017: Participants, in conjunction with their mentors, worked to create their presentation (poster or slides) for the meeting.

October 2017 at the GSA annual meetings

Participants met with course facilitators and other participants for support if needed for those whose presentation was their first and for social time.

Most participants who attended a meeting met with the professional development course evaluator for interviews about their entire experience from course to the meeting.

Appendix B

Action plan template

MSI-REaCH: Minority-serving institution—Reconstructing Earth's climate history

Participant action plan template

Program participant objectives:

- integrate workshop paleoclimate curriculum into new or existing geoscience courses, and/or
- begin or expand paleoceanographic, paleoclimatic, and/or marine science research opportunities for undergraduate students, and
- present curriculum or research outcomes at a follow-up professional meeting (e.g., GSA, AGU, AMS).

Recommendations: Use either this document or your yellow notebook to develop your action plan. Complete each section as thoroughly as possible. Be specific about your idea; how it relates to what you already do with students; how it relates to content, skills, and materials from the workshop; student learning goal outcomes; resources needed; time needed; and support needed from program mentors.

You will share this action plan with your mentors. You can use this template for a single goal or multiple goals that you have for curriculum and/or research. Copy the whole template or expand the boxes to make it most useful to you.

Select the primary focus of your action plan:

_____Integrate workshop paleoclimate curriculum into a new or existing geoscience course that you teach.

_____Begin or expand paleoceanographic, paleoclimatic and/or marine science research opportunities for your undergraduate students,

____Both.

_____Other (describe).

Target audience

Student learning objectives

What content do you want students to learn and why? What skills do you want students to learn and why?

Action summary

Write a short description of what you want to do to meet your student learning objective(s).

Action details

What do you need to do? Make a detailed list.

Building from the workshop

What content, skills, and/or resources from the MSI-REaCH workshop will you be drawing on?

Help from mentors

What questions do you have for your mentors? How can they best help you achieve your objective?

Resources

What resources do you have? What do you need to obtain?

Time

When do you want to implement your plan? Work backward to determine benchmark deadlines.

Sharing with others

What aspect of your plan do you want to present at a professional meeting? What are some other ways you plan to share your experience with other professionals?

Appendix C

Researcher perspectives

Part of qualitative research credibility is explicit reporting of researcher position and characteristics. A brief background for each researcher is offered to allow the reader a glimpse of the orientations and experiences of the authors. These are often tacit in research and might be a source of bias. For example, two authors acknowledge the affinity they feel with traditional science values, and one has no affinity with those values.

Shandy Hauk is from an upbringing in the United States steeped in sociocultural and ethnic diversity. She completed a bachelor's degree in the arts and became a certificated secondary school teacher of English and mathematics. After a few years, she left K–12 teaching, completed a Ph.D. in mathematics and a postdoctoral fellowship in mathematics and science education, and became a university faculty member in mathematics. Over the last 20 years, she has advised students completing research doctorates in undergraduate mathematics education, science education, mathematics, and sciences. A recipient of departmental and institutional teaching awards, Hauk's perspective on college instruction is responsive: Good instruction models ways to engage with disciplinary content that are culturally aware as well as socially and ethically informed. Teaching is the act of supporting students as fellow humans in critique, conversation, planning, and implementation of ideas. Hauk's view is associated with the theory of critical pedagogy (Freire, 1970).

Kristen St. John was raised in a rural majority culture community in the United States. A high value on education was instilled at a young age by parents who were first-generation college graduates. After completing a doctorate in geology with emphasis on marine sedimentology and paleoclimatology, St. John went on to her first tenure-track position at a small state university. There she discovered the hard way how important a supportive department culture is to career growth (i.e., how a dysfunctional department negatively affects faculty). She relocated to a vibrant and supportive geology program at a peer institution. St. John's perspective on college instruction is intentional and reflective. Instructional decisions have purpose, are informed by past experiences (her own and others'). She is the recipient of awards on teaching, mentoring, and other career accomplishments. Over the last 20 years, her involvement in research and scholarship on instruction in undergraduate geoscience education has primarily focused on curricular design and faculty professional development.

Megan Jones grew up as the oldest of four children in a middle-class, majority culture household in a predominantly white community in the United States. She was a first-generation college student. She completed three degrees: a B.S. in geological oceanography, and a master of arts and Ph.D. in geology. After completing the doctorate, she began teaching in a community college system. That work included teaching at a nearby women's prison. Teaching in these settings introduced her to student lives and student preparations very different from her own. Jones uses an active and inquiry-based approach for engaging students as scientists, so they learn not only what scientists know but how they know it (process of science). Her philosophy about teaching and learning is that they are collaborative and reflective processes for both students and instructors. In 2019, Jones was named her state's outstanding community college science educator of the year.

Appendix D

Supporting data

Table D. Data coding proportion for each interview and overall.

	(a) Intentional action required	(b) Sees new significance in practice	(c) Feels equipped to manage challenges	(d) Commitment to change	(e) Adequate support
L1	18%	25%	23%	10%	25%
L2	7%	27%	47%	0%	20%
L3	15%	25%	35%	5%	20%
L4	7%	27%	27%	7%	33%
P1	38%	24%	10%	5%	24%
P2	37%	37%	21%	0%	5%
P3	19%	31%	13%	13%	25%
P4	27%	32%	18%	9%	14%
C1	22%	16%	19%	3%	41%
C2	9%	21%	15%	26%	29%
Average*	20%	25%	21%	9%	25%

*Proportion of utterances across the 150 utterances, total, in the 10 interviews.