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An Investigation of the Products and Impact of Graduate Student SoTL Programs: Observations and Recommendations from a Single Institution

Nancy L. Chick
Vanderbilt University, nancy.chick@vanderbilt.edu

Cynthia Brame
Vanderbilt University, cynthia.brame@vanderbilt.edu

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Abstract

This study offers an investigation of three graduate-level SoTL programs offered since 2007 at a mid-size, highly selective, private, research-intensive university in the southeastern United States. We identify patterns in these early experiences with the scholarship of teaching and learning, specifically the choices made while carrying out their first SoTL projects and their perceptions of the impact of the program. We analyzed 72 project posters and 39 impact survey responses. Drawn from the rich particularities of a single institution, this study offers insight into novice SoTL work and recommendations for developing introductory SoTL programs on other campuses.

Keywords

graduate students, graduate education, SoTL programs, impact

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"Many new faculty members do not feel ready to carry out the range of roles asked of them, particularly those related to teaching."—Chris M. Golde

It's not new to lament the lack of pedagogical preparation in most graduate school programs (Bass 1999; Appleby 2006; Bass 2006; Breslow 2006; Bender 2006; Chan 2006; Cronon 2006; Golde 2006, p. 5 [above]; Graff 2006; Kwiram 2006; Lunsford 2006; Stacey 2006). This gap creates first junior faculty who struggle as teachers while also navigating the publication and other demands of being pre-tenured, and later senior faculty who don't sufficiently value effective teaching and student learning. It also underprepares contingent or adjunct faculty for their primary role of teaching, even though they often carry the heaviest teaching loads.

An effort to fill this gap has come in graduate school professional development programs focused on teaching. The Pew Foundation's Preparing Future Faculty initiative was in part a response to this dearth of essential preparation, which failed to "equip the students leaving our [graduate] programs with more than disciplinary expertise and a general sense of the mission" and contributed to "high levels of work stress early in the career" (Olsen & Crawford, 1998, p. 51-52). Skelton's (2013) in-depth interviews with 10 participants in a graduate-level teaching course at a research-intensive institution revealed students' claims that the pedagogy course had a "profound impact on participants, involving both personal and professional change" (p. 5). Robinson and colleagues (2013) describe many benefits of graduate level pedagogy programs that aid in the "successful transition to faculty life" (p. 188). For instance, participants gain "a language about teaching and tools for talking with faculty in other disciplines," and more broadly they begin to understand and construct their "professional identities...and attitudes toward ongoing professional development." Nyquist and Wulff's (1996) and Nyquist and Sprague's (1998) classic discussions of graduate teaching assistants identifies three phases of development, all of which can be supported through these pedagogical programs. First are Senior Learners who need guidance and nurturing, then Colleagues-in-Training who take on

greater responsibilities and learn pedagogical skills, and finally Junior Colleagues with even greater responsibility and a habit of reflection, particularly for “curricular and pedagogical development and potential approaches to students” with a particular emphasis on “Are students getting it?” Most programs for graduate students offer the encouraging and safe environment, the curriculum of teaching skills, and the mentoring relationships they need as they prepare and then take on greater teaching responsibilities.

Graduate programs that focus on the scholarship of teaching and learning (SoTL) represent a specific and more advanced subset that may best support the later phases of graduate student identity development, particularly through systematic approaches to and reflections on whether students are “getting it.” In their research on faculty members, Gibbs and Coffey (2004) and Postareff, Lindblom-Ylänne, and Nevgi (2007) have noted that pedagogical professional development tends to lead to stronger, student-centered approaches to teaching and learning, and that their student evaluations are higher than those without this training. Further, as Trigwell has demonstrated, those who apply specifically a SoTL lens to their pedagogical development and their students’ learning are the most likely to adopt approaches evidenced to foster deep learning, thereby making these practitioners more likely to foster deep learning (Trigwell, Prosser & Waterhouse, 1999; Trigwell 2013, p. 99-100). We therefore argue that graduate students who participate in well-mentored SoTL training will “hit the ground running” as junior faculty members, incorporating approaches that thoughtfully promote deep student learning from the beginning of their faculty career.

To explore the effects of SoTL-specific training for graduate students, we looked to finishers of the programs at our university, a mid-size, highly selective, private, research-intensive university in the southeastern United States. Because graduate students are so new to teaching, we were curious about their choices in investigating student learning, so we started by analyzing the posters they presented as the culmination of each program. We also conducted an impact survey to learn the finishers’ perceptions of all three programs.

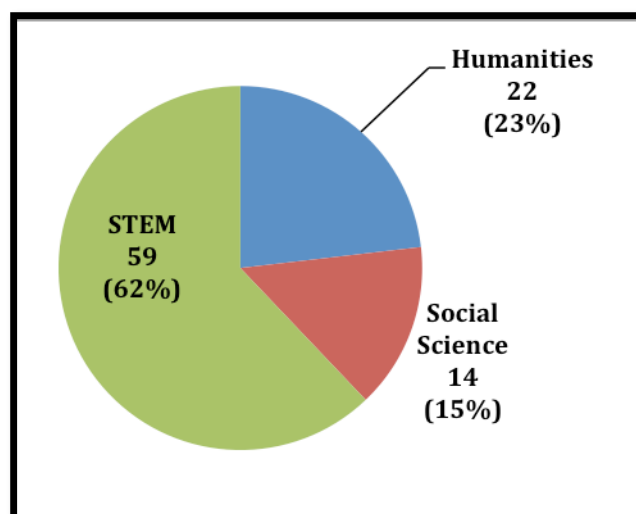
Participant Analysis

Our Center for Teaching has offered three separate SoTL programs: the third semester of a Teaching Certificate Program that had 67 finishers in its run from 2007 to 2012, the year-long Teaching-as-Research Fellowship aimed at the STEM fields with 23 finishers from 2008 to 2012, and the new year-long SoTL Scholars Program that graduated five in its first year (2012). Among these 95 graduate students, 62% were from the STEM fields, 23% from the humanities, and 15% social sciences (Figure 1, below).

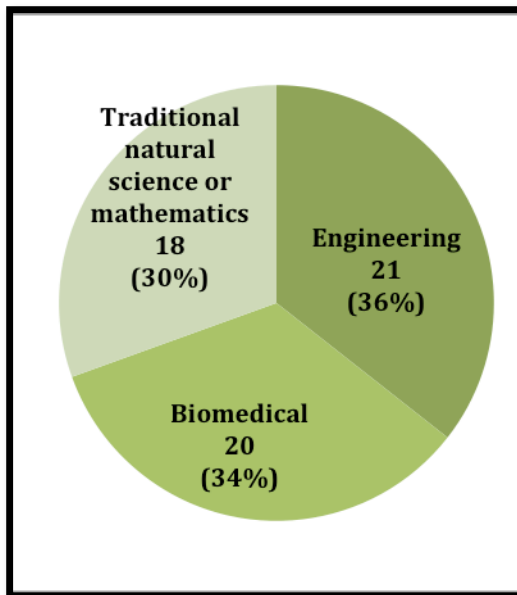
When we considered the participants' disciplines at a more granular level (Figure 1b and c, below), we noted clusters of SoTL program participants. For example, the School of Engineering produced 36% of our STEM participants, although the School of Engineering represents a much smaller fraction of STEM graduate students at the institution as a whole. Within the Humanities, the relatively small Graduate Department of Religion produced 45% of our participants. These trends suggest the importance of building a culture of SoTL training within a department, allowing the accompanying informal, word-of-mouth interactions and local presentations to help introduce new graduate students to the practice of SoTL.

Figure 1. Disciplinary distribution of program participants. A. Program participants' distribution within broad disciplinary categories of science, technology, engineering, and mathematics (STEM), the humanities, and the social sciences. B. STEM participants' distribution within engineering, mathematics or traditional natural science disciplines, or biomedical disciplines, such as molecular physiology, cancer biology, or developmental biology. C. Humanist participants' distribution among the three disciplinary areas represented within this group.

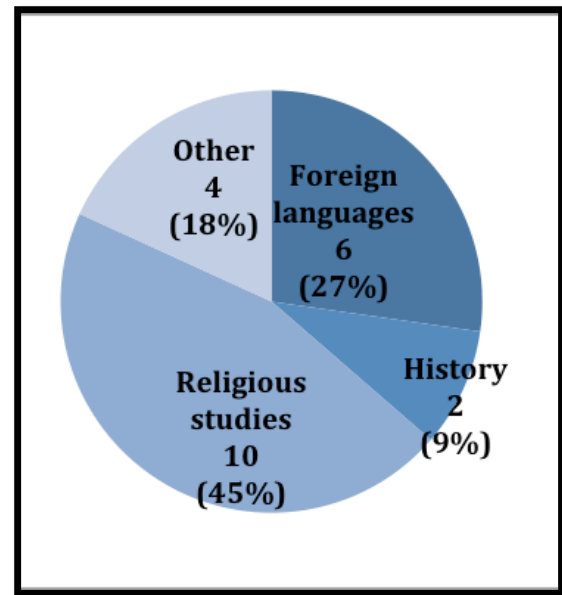
A.



B.



C.



Poster Analysis

At the end of each of the programs we examined, participants were required to present at a campus event a poster describing their SoTL project. To explore the choices made by these novice teachers and SoTL practitioners, as well as to help us understand areas of strength and areas of potential growth in our SoTL programs, we analyzed the characteristics of 72 participants' projects by examining the 65 available posters. Specifically, we asked four questions about each project:

1. *What's the problem?* Drawing on Bass's (1998) foundational text on embracing teaching and learning "problems" as opportunities for growth, we examined the problem identified in each project, a common starting point for SoTL inquiries.
2. *What type of project is it?* We used Hutchings's (2000) now-classic SoTL taxonomy to categorize the projects, identifying each as "What is?" or "What works?"—the most common types among early practitioners, in our experience—or other.
3. *What type of data did they gather, and how did they analyze it?*

4. *What aspect of student learning did they study?*

To address each of these questions, we used a modified grounded theory approach (Strauss & Corbin 1990). Each author independently reviewed the posters for answers to each of the questions above, categorized the responses, and then examined the categories to identify themes and patterns within the data. We then compared our analyses, in most cases reconciling discrepancies to arrive at a single interpretation.

What's the problem?

We found that the projects responded to problems that sorted into six categories, summarized in Table 1 below. The projects thus investigated a range of teaching problems—content understanding, generic teaching and learning strategies, student motivation and engagement, skills deficits, and persistence—that correspond to the larger landscape of SoTL, as well as investigators' particular interests and teaching contexts as novice teachers immersed within their disciplines as PhD candidates. In many cases, however, that context was incompletely conveyed in the posters, as they were generally developed for an intra-institutional audience and so rarely gave full descriptions of the details important for a complete understanding of the project (see Recommendations).

Table 1. Teaching and learning problems identified as focus of SoTL projects. The categories are listed from most to least common.

| Category | Example |
|--|--|
| Content understanding (e.g., threshold concepts, common student misconceptions, transfer) | Radioactive decay Heat transfer Fluid momentum Stereotypes relevant to community health |
| Generic teaching/learning strategy | Lecture Implicit and explicit grammar instruction Homework format Testing format |
| Motivation and engagement | Instructor/student rapport "Cookbook" labs |

| | |
|----------------------------|--|
| Content coverage | Focus on memorization Content loss via active learning |
| Skills deficit | Critical reading Spatial reasoning Time management |
| Persistence/failure | Attrition in intro course Persistence between two courses |

What aspect of student learning did it investigate?

When analyzing the aspects of student learning that participants explored, we discovered that a majority (75%) of the projects examined outcomes that mapped well within Bloom’s cognitive domain (Figure 2, below). The largest number asked questions about student comprehension (~28%) and application (25%), while relatively few asked about analysis (~17%) and even fewer synthesis (~8%) and evaluation (~8%). A few projects explored affective issues related to preference, motivation, and confidence—most directly resulting from surveys.¹

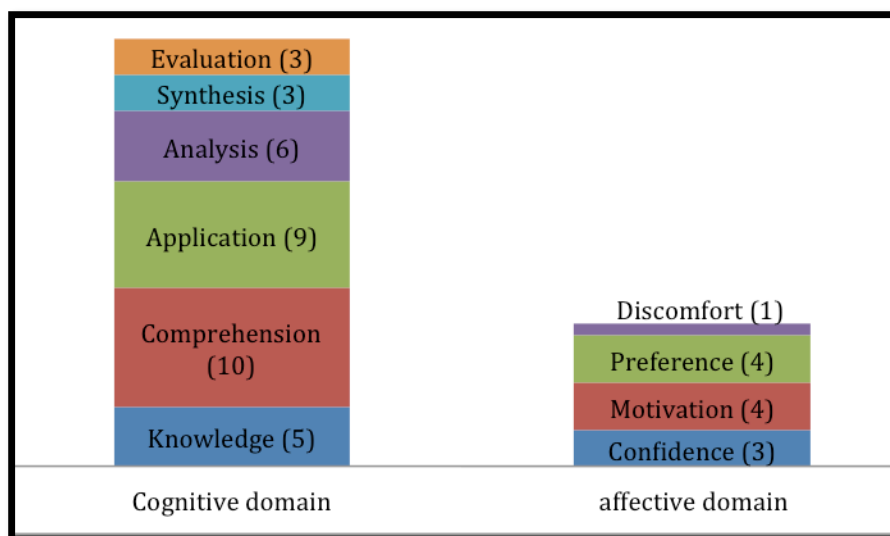
These results suggest that while novice SoTL scholars may choose projects that allow them to consider a wide range of learning questions, they may exhibit a tendency to focus on cognitive functions at the lower levels of Bloom’s taxonomy. This pattern may make sense if the projects are focusing on first-year students, but our SoTL program participants studied courses of all levels. To help novice SoTL practitioners consider the range of student learning as appropriate for their context, we recommend SoTL programs directly foster consideration of levels and domains of learning (see Recommendations below).²

¹ These affective dimensions didn’t map into Krathwohl’s 1964 addition of the affective domain to Bloom’s earlier work on the cognitive, nor did they follow any larger patterns other than being devoted to affective elements of learning.

² A useful tool for assessing the classroom application of Bloom’s taxonomy is in Crowe, Dirks, and Wenderoth (2008), and Newton and Martin (2013) offer an effective illustration of using the tool.

Figure 2.

Facet of student learning studied in SoTL projects. Projects were characterized as investigating student learning elements in the cognitive



domain (left) or affective domain (right). Projects that investigated facets of student learning that mapped within the cognitive domain were coded according to Bloom's taxonomy.

What type of project is it?

A majority of the SoTL projects we examined were "What works?" projects that sought evidence about the relative effectiveness of a particular teaching approach, with 38 of 65 projects falling into this category. Eighteen of the projects began with the question "What is?" while eight integrated both "what is?" and "what works" components. No projects fell into the other categories described by Hutchings ("visions of the possible," "theoretical frameworks").

We observed an interesting disciplinary distribution of the project types (Figure 3, below). 64% of the humanists' projects had a "what is?" component, a type with lower representation in the work by other disciplinary groups: 41% for natural scientists and mathematicians, 27% for engineers, and 22% for social scientists. We speculate that this difference arises primarily from methodologies commonly applied within the investigators' fields. For example, humanist approaches to scholarship often involve close readings that ask what a text reveals rather than whether it supports a particular hypothesis, predisposing humanist SoTL scholars to such a descriptive approach, rather than a comparison or intervention. Within the other disciplinary groups,

the explanation is not as clear. We speculate that the relative popularity of “what is” questions among natural scientists arises in part from the fact that many of these specific scholars were in biomedical disciplines, which frequently survey large data sets (e.g., genomics databases) as a prerequisite to framing a hypothesis-driven question. Thus, the natural scientists represented in our data set would be relatively comfortable with asking “what is,” perhaps in addition to or in preparation for asking “what works.” At the other end of the spectrum we observed are the social scientists. To explain the low number of “what is” projects within this group, we again invoke our local context: specifically, most of the social scientists represented within our data set are students at the School of Education, which focuses heavily on applied research and investigating the effectiveness of interventions. We therefore speculate that these students’ disciplinary training would predispose them to ask “what works” questions.

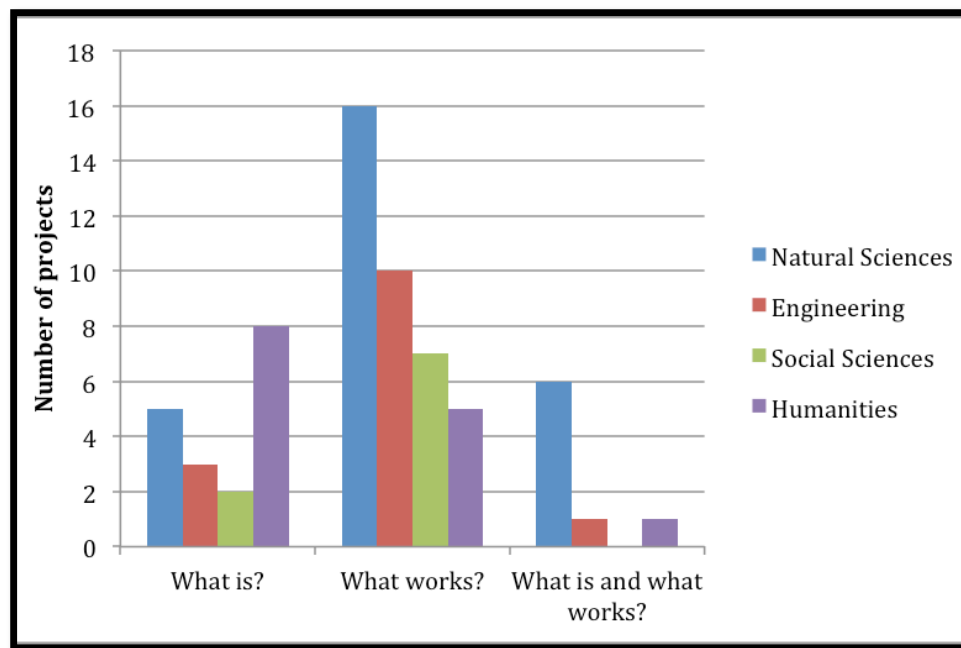


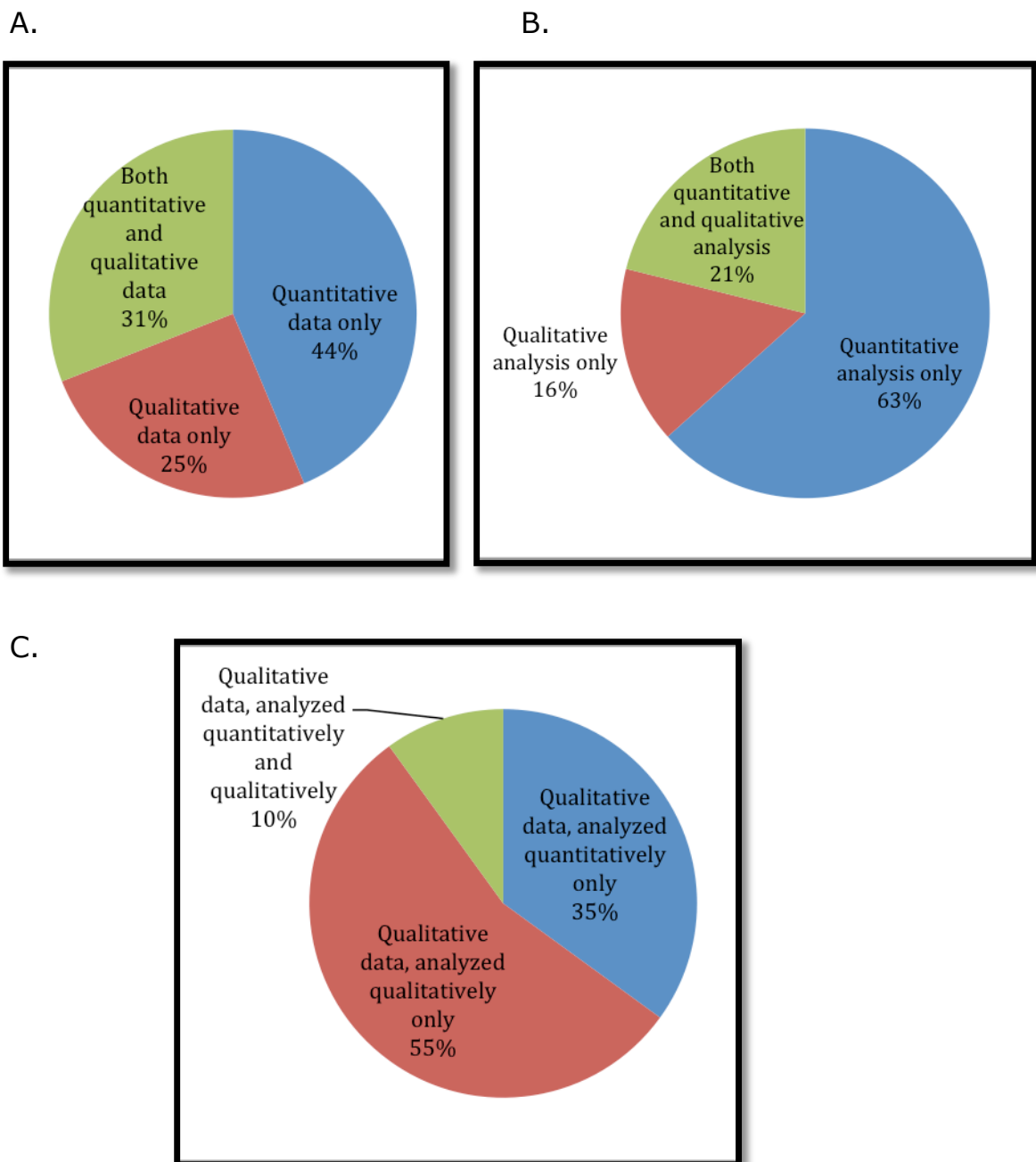
Figure 3. Characterization of SoTL project types according to Hutchings’ taxonomy and disciplinary group. The natural sciences group includes mathematics.

We also noted patterns within each project type. For instance, a preponderance of the “what is” projects sought to reveal students’ attitudes and preferences, and the vast majority of the “what works” projects measured changes in students’ perceptions of their learning. We speculate that these patterns of drawing largely on self-reports may have been due to the relative ease of gathering such data through surveys as well as to investigators’ relative lack of knowledge about more direct measures of student learning. Many of the SoTL participants had limited access to students and little control over the course within which their investigation occurred. As novice SoTL scholars, they also had limited familiarity with the range of methods common to SoTL projects and the strengths and limitations of each. SoTL programs should directly address these possibilities among their participants (see Recommendations).

What type of data was gathered, and how was it analyzed?

Initially, we considered whether the projects we examined relied on quantitative data, qualitative data, or both. As we reviewed the posters, however, we realized that identifying the participants’ methodologies was also relevant: that is, whether they chose a qualitative or quantitative analysis to make sense of their data. As shown in Figure 4 (below), the participants displayed a tendency to favor quantitative data (used by 75% of the projects) as well as quantitative analysis (applied in 84% of the projects, regardless of data type). Perhaps most notably, a majority of the projects (63%) relied solely on quantitative analysis (Figure 4B, below). To be clear, even when participants gathered qualitative data, a substantial fraction (35%) analyzed that data only through a quantitative lens (Figure 4C, below). In some cases, the participants chose a quantitative approach even when it was not best suited to their question (e.g., identifying patterns in students’ organizational structures) or to the population with which they were working (e.g., too small for meaningful quantitative analysis). Unsurprisingly, participants tended to apply approaches most similar to those in their home disciplines, reflecting a pattern in the larger landscape of SoTL.

Figure 4. Characterization of SoTL projects according to type of data collected and analysis used. A. Distribution according to type of data gathered. B. Distribution according to type of analysis performed. C. Distribution according to type of analysis performed specifically on qualitative data.



Patterns and Recommendations

The 65 posters we examined revealed a variety of SoTL projects that appropriately reflected investigators' interests and their relative teaching experiences and contexts. They investigated a spectrum of problems and facets of student learning that reflect common questions about teaching and learning in higher education, particularly those asked by early teachers. We did note, however, that the posters rarely articulated their contexts, presumably because they were shared primarily with local audiences. The projects also tended to focus on "what works" questions and favor quantitative methods over qualitative methods, quasi-experimental designs that reflect the disciplinary comfort zones of many of the participants. Within these methods, there was a heavy reliance on students' self-reports, perhaps because of the constraints on the graduate students' access to students and more direct evidence of learning. Based on these observations, we make the following recommendations for SoTL programs developed for graduate students.

- **RECOMMENDATION 1: Emphasize the importance of contextualizing SoTL work.** Because the local context is essential for understanding outcomes in investigations of teaching and learning (Shulman, 2013) and has been identified as the second "Principle of Good Practice in SoTL" (Felten, 2013), it is important for SoTL programs to emphasize clear description of and analysis of these particularities, as a fundamental move of SoTL. Further, we think that assuming an audience beyond the local context can help novice SoTL scholars understand the importance of this element and may also help them to situate SoTL work as part of their larger body of scholarly work.
- **RECOMMENDATION 2: Encourage questions across the span of the cognitive and affective domains.** We recommend that SoTL programs encourage participants to consider learning questions across the range of cognitive and affective domains

as appropriate to the context of the class, the institution, and the discipline. By supporting participants' exploration of a variety of possible questions as well as appropriate methodologies for answering those questions, SoTL programs better prepare their participants for robust investigations of teaching and learning.

- **RECOMMENDATION 3: Explicitly support both “what is?” and “what works?” questions.**
One of the key lessons we derived from our analysis is the importance of providing models of and support for both (or more) types of questions, allowing investigators to more effectively leave their disciplinary comfort zones when the problem they are addressing is best studied with a less familiar type of question. Additionally, without a thorough literature review, it can be premature to ask “what works?” questions until one knows “what is.”
- **RECOMMENDATION 4: Emphasize the importance of aligning research questions, student population, and research methods, providing models and support for a range of approaches.** To help strengthen the quality of novice SoTL scholars' work, we recommend that SoTL programs explicitly teach and support methods of qualitative data collection and analysis, in addition to quantitative methods, and address when each is most appropriate. Notably, biologist and founding president of the International Society for the Scholarship of Teaching and Learning (ISSOTL) Craig Nelson has encouraged the use of qualitative instruments and analyses “to counter the tendency in some circles to attempt to apply to SoTL the models of research that recognize only quantitative studies” (2003, p. 90), a tendency that has still persisted beyond SoTL's early stages. Collaborations across disciplinary groups will make easier this kind

of variety—a practice common among experienced SoTL practitioners. By explicitly encouraging familiarity with both and appreciation of their complementarity, programs will advance the “methodological pluralism” that Huber and Morreale identify as a critical quality in exploring teaching and learning (2002). Such support will also help graduate students develop an understanding of “epistemological diversity” that Gardner and Mendoza identify as an important goal of graduate student education and socialization (2010, 257-61). This work should complement discussions of direct and indirect measures of student learning, and the contributions that each can make to addressing the research question. SoTL programs’ explicit support of the variety of approaches that can contribute to effective investigations has potential short- and long-term benefits, from increasing the quality and richness of the projects to strengthening participants’ development as scholars and future faculty members.

- **RECOMMENDATION 5: Encourage SoTL participants to share their work with the broader SOTL community.** Although we note the benefit of local presentations in promoting a culture of SoTL within departments or schools (see Figure 1), we strongly recommend that SoTL programs encourage students to share the results of their work beyond their local setting to introduce participants to a larger community of SoTL scholars and to help situate this work in their broader academic lives. Because conference presentations and publications are academic currency, this broader sharing provides a means to integrate SoTL work into a multi-faceted professional identity, ensuring that SoTL scholars’ investigations of teaching and learning provide the credit necessary for academic recognition.

Survey

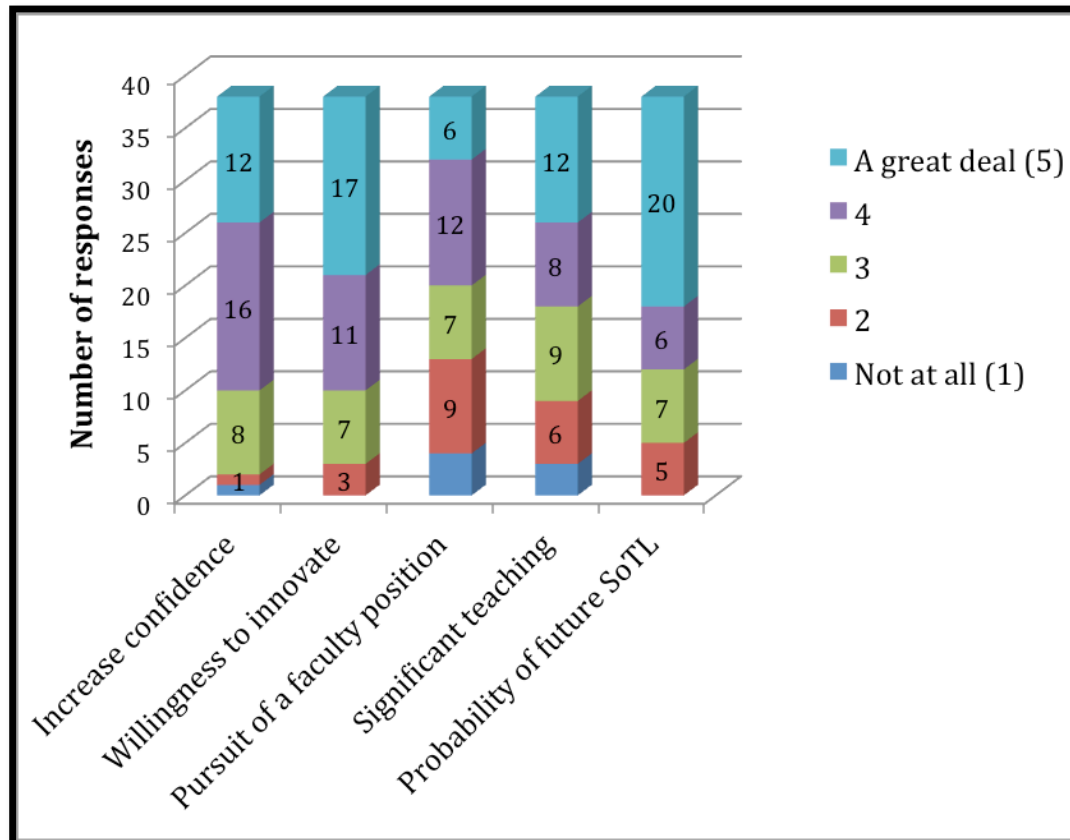
In addition to our direct analysis of the project posters, we were interested in their perceptions of the impact of the program, so we surveyed the 73 program participants for whom we still had contact information. 39 completed the anonymous online survey, giving us a 53% response rate. The survey questions were the following:

1. *Please write one paragraph describing your professional or work life and its trajectory since participating in one of the CFT's SoTL Programs. Has it been satisfactory, fulfilling, what you hoped for—or not? Explain.*
2. *How much did your participation in this program affect your confidence as a teacher?*
3. *How much did your participation in this program affect your willingness to adopt unfamiliar pedagogies or create innovative teaching approaches?*
4. *How much did your participation in this program influence the likelihood that you'll pursue a faculty position?*
5. *How much did your participation in this program influence the likelihood that you'll pursue a faculty position with a significant teaching component?*
6. *How much did your participation in this program increase the probability of pursuing subsequent SoTL projects?*

Question 1 was accompanied by a large box for respondents to write or paste longer text, while questions 2 through 6 were measured on a 5-point Likert scale (from “Not at all” to “A great deal”). Each of these numerical questions was followed by a follow-up prompt (“Please explain or give an example illustrating your answer to question above”) with a mid-size box for writing or pasting text.

Nearly $\frac{3}{4}$ of respondents reported increased confidence and an openness to innovative pedagogies as a result of the program. Over half claimed they intend to seek a faculty position with a teaching emphasis, and almost $\frac{2}{3}$ indicated an interest in doing more SoTL work. (The precise numerical results are available in Figure 5, below.) These results reflect similar findings in other, albeit more general studies on programs or courses supporting the development of graduate student teaching (Skelton, 2013).

Figure 5. Survey results characterizing the program’s impact. Participants used a Likert scale to characterize their SoTL program’s impact on current and future professional questions. There were 38 respondents for each question; the number of respondents for categories 2 through 5 are shown for each question on the graph. Survey questions are summarized in x-axis categories; the full questions are available in the text.



For question 1 (“Please write one paragraph describing your professional or work life and its trajectory since participating in one of the CFT’s SoTL Programs. Has it been satisfactory, fulfilling, what you hoped for—or not? Explain.”), we had planned on analyzing the responses through the work of O’Meara, Terosky, and Neumann (2008) on how faculty describe their careers and work lives. After interviewing hundreds of faculty from a range of institution types and analyzing 15 to 20 years of extensive literature by and about faculty, they identified two narrative patterns. First is one of constraint, in which faculty

primarily see “barriers” and “overloaded plates” that lead to a professional life of “treading water,” especially when it comes to teaching (p. 16). The second pattern is a “narrative of growth” in which faculty see themselves as “carving out strategies to make meaningful contributions” by “putting students first” and “taking teaching seriously,” among other ways of “composing new professional roles and work lives where they can find meaning, continue to learn, and make commitments to rigorous and meaningful research, teaching, and engagement” (p. 21). O’Meara and colleagues point out that constraint is the dominant narrative, and they challenge faculty and faculty developers to develop more narratives of growth.

Although their study included faculty across the career spectrum, and ours was limited to recently hired faculty, post-docs, and graduate students nearing completion, we find O’Meara and colleagues’ analysis useful because it frames academics’ perceptions of professional life, integrating our questions about expectations, satisfaction, and fulfillment. It organizes these perceptions into a more comprehensive explanation—a narrative, a “commonly told story” (p. 16)—of how they experience their lives in the profession. Finally, in addition to the effect on specific and quantified characteristics like confidence, openness to innovation, job preferences, and potential to do more SoTL work, we were curious about how our SoTL program graduates viewed the subsequent quality and depth of their work lives and their situations within (or, in a few cases, outside of) the larger context of academia. What we found using the lens of O’Meara and colleagues’ narratives, however, proved interesting and useful for internal assessment, but less meaningful in a larger analysis: 38 of the responses were clearly growth narratives, and only one was of constraint. Consequently, we did a closer analysis of these narratives.

A careful, iterative look at these written responses resulted in four subcategories of growth narratives. The first and most frequent type is a narrative of gratitude: just over half (20) enthusiastically looked upward and forward, noted accomplishments, and attributed at least some to their participation in the SoTL program, which they described using language like “lay the path for,” “opened so many doors in my

professional life,” “gave me access to,” and “will prepare me now for whatever comes next.” We also categorized the nature of this gratitude. Many described discovering a “passion for teaching” and thus gaining clarity about what kind of position to pursue in their job searches. Next, responses noted the usefulness of the credentials associated with completing the SoTL program, which they claimed not only strengthened their CVs but also prepared them for job interviews in terms of both confidence and content. Third, descriptions in this largest pattern of gratitude cited specific experiences, skills, or accomplishments they directly attributed to the program: teaching classes, advising other faculty, gaining communication and leadership skills, and developing a course, presenting at a conference, or publishing a paper. Finally, some of these narratives expressed gratitude that the SoTL program “filled in a gap” in their graduate education.

Fewer were narratives of accomplishment (9) that read more like prose versions of CVs, focusing factually on recent or past successes without explicitly attributing them to their work in the SoTL program (e.g., “I now have a position at the University of [institution redacted] as a [discipline redacted] department faculty member who teaches and does research”; “I am currently an Associate Professor of [discipline redacted] at a small liberal arts institution. I began this position shortly after completing cycle 3 of the teaching certificate program. During the academic year, I teach 4-5 courses, direct independent study projects, and serve on college and university committees. In the summer, I mentor 2-3 research students actively participation in research in my small laboratory”).

The remaining 10 growth narratives were evenly split between *in medias res* narratives and narratives of ambivalence. *In medias res* narratives focus in the still-in-process nature of program graduates’ entry into a career. The jury is still out about their future and the impact of the SoTL program (e.g., “Since completing Cycle 3, I have been writing my dissertation, working on articles, and coordinating a project [description redacted]. It has been satisfactory so far. I go on the job market this Fall”; “I recently applied for a part-time position at this same institution in their Department of [discipline redacted], but they have not begun the interview process for that position yet. I actually plan

on quitting my full time post-doc position soon (due to the birth of a child) and hope to teach part time at a small liberal arts college in [city redacted] in the future.”) This perspective is understandable for those just barely out of the SoTL program, so we were surprised more didn’t reflect this sense of uncertainty. Finally, narratives of ambivalence cite both successes and failures since the SoTL program, the “ups and downs” (as one described the experience) of their career trajectories so far. (e.g., “My work life has generally been split between my thesis research and teaching upper level [discipline redacted]. For the most part, it has been a good experience, though I have certainly spent a lot of time feeling inadequate as an academic”).

Summary and implications

We find that SoTL programs for graduate students provide significant value to participants, helping them to craft identities as confident, innovative teachers focused on whether their students are actually learning. To ensure that these programs have the greatest impact on participants, both helping them to situate their SoTL work in their larger professional identity and helping them to effectively answer questions about teaching and learning, we recommend that SoTL programs consider the recommendations noted above. In so doing, they can forestall several common patterns we observed, such as

- A tendency for participants’ projects to focus on the lower levels of cognitive function, such as content understanding, as well as generic teaching and learning strategies. These tendencies make sense, as the participants in our programs were PhD candidates’ immersed in their fields with a preference for focusing on content understanding. In addition, the participants were novice teachers, helping to explain their focus on generic teaching and learning strategies.
- A preponderance of “what works” projects that compared approaches or examined the effects of interventions.

- An overreliance on quantitative data and methods of analysis, even when these approaches were not best suited to the research question or study population.

While our analyses of their projects make sense within the program participants' experiences and contexts, we encourage those who support SoTL work to be aware of these particularities and the larger goals of SoTL and graduate education. By considering the relationship between these contexts and goals and addressing common problems, graduate student developers focused on SoTL programs can maximize the value of the programs to their participants, both in the short run and as part of a longer career trajectory.

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