Feeding Two Birds with One Scone? The Relationship between Teaching and Research for Graduate Students across the Disciplines

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We surveyed over 300 graduate students at a Southeastern research university to increase our understanding of their perceptions of (a) the connection between teaching and research, (b) the means by which integration occurs, and (c) the extent to which teaching and research contribute to a shared skill set that is of value in both contexts. We also examined differences across disciplines in the perception of this teaching-research nexus. Overall, findings indicate that graduate students perceive important relationships between teaching and research, and they point toward opportunities for administrators to promote teaching and research integration.

Introduction

Faculty at research universities often define their professional role by the two core faculty activities of teaching and research (Colbeck, 2002). However, some scholars (e.g., Barnett, 1992; Feldman, 1987) have proposed that these two activities have inherently divergent purposes and that success in these distinct domains requires different skill sets and personal attributes. Correlational studies examining the relationship between faculty publication rates and teaching quality, assessed generally through course evaluations, have been consistent with this view (Feldman, 1987; Hattie & Marsh, 1996; Marsh & Hattie, 2002). These findings, however, conflict with the stance that teaching and research are complementary and support one another, a view espoused by many faculty and their respective universities (e.g., Colbeck, 1998; Neumann, 1992; Schapper & Mayson, 2010). To increase our understanding of the relationship between teaching and research and importantly, to illuminate this relationship as perceived by the next generation of university faculty, the current study investigated graduate students' views of this relationship across a variety of disciplines.

Literature Review

Two primary roles of research universities are to facilitate student learning through teaching and to contribute to existing knowledge through research. Although the definitions of teaching and research are complex, nuanced and discipline-specific (Brew, 1999), teaching generally reflects the transmission of knowledge or facilitation of knowledge construction (Barr & Tagg, 1995). Academics have become interested in the value of this dual purpose of the research university, searching for commonalities and highlighting differences that exist between teaching and research. As Neumann (1994) noted, the question of whether teaching and research have a mutually beneficial or antagonistic relationship is at "the heart of academic work" (p. 323).

Generally, research is understood to be theoretical or empirical investigations into the *content* of the faculty member's discipline. However, research is the pursuit of an answer to a question (Neumann, 1992), and the research question can also concern the best ways to *teach* in one's specific discipline. This is known as the "Scholarship of Teaching and Learning" (SoTL), and often involves conducting research on the impact of one's pedagogy on student learning outcomes (Boyer, 1990). Given the importance of both content- and pedagogy-focused research, the current work examines the nexus between teaching and both of these types of research.

Quantitative Studies Examining the Teaching-Research Relationship

Early studies investigating the relationship between teaching and research primarily used correlational methods (e.g., Aleamoni & Yimer, 1973; Harry & Goldman, 1972; Hoyt & Sprangler, 1976). These studies typically measured research productivity by the number of funded grants, publications and citations. Teaching productivity was assessed through student evaluations, peer evaluations and self-evaluations of teaching quality. These studies served as the building block for Feldman's (1987) and Hattie and Marsh's (1996) meta-analyses of the teaching-research relationship. Both of these meta-analyses found insubstantial relationships between teaching and research; Feldman's meta-analysis yielded a correlation of .12, and in spite of this small effect size, it was

nonetheless twice as large as that found by Hattie and Marsh. Hattie and Marsh (1996) offered several explanations for why there may be no relationship—or even an inverse relationship—between teaching and research. These included that (a) teaching and research are inherently different activities: research is knowledge discovery, and teaching is knowledge transmission, (b) investment of time, energy and commitment to one of these areas (e.g., teaching) detracts from resources committed to the other area (e.g., research), (c) teaching and research require differing personality types, i.e, the researcher requires independence and the teacher requires interaction, and (d) the university system provides distinct rewards for teaching and research, with research being rewarded through direct salary increases and teaching being rewarded through university recognition and awards.

Qualitative Studies Examining the Teaching-Research Relationship

In addition to correlational studies, researchers have also employed qualitative methods to categorize perceptions of the teaching-research relationship. Grant and Wakelin (2009) indicate that this work explores the "actual interactions, connectivity and networks" between teaching and research and thus should be a primary focus of investigation (p. 141). Neumann's (1992) framework for describing the nature of the relationship between teaching and research is one of those most widely cited. To develop this framework, Neumann interviewed higher education administrators and then categorized their responses according to four distinct views that they espoused regarding the nature of the teaching-research relationship. The first category, a *tangible connection*, reflects the view that research contributes to teaching by providing a venue for dissemination of knowledge gained through one's research. The second category, an *intangible connection*, reflects the perspective that doing research enables teachers to foster among their students positive attitudes and critical approaches toward knowledge construction. The third category, a *global connection,* captures the idea that teaching and research are perceived to be related at the departmental level – for example, when ongoing departmental research influences course curricula. The fourth category is *opportunity for teacher-student interaction*, which captures the idea that student awareness of faculty members' research helps students get to know professors on a more personal level and helps builds teacher-student rapport.

Roughly a decade later, Robertson and Bond (2001) conducted a similar study, but directly queried faculty members instead of administrators. Like Neumann (1992), the framework they derived captured perceptions of tangible and intangible teaching-research connections. However, Robertson and Bond also identified categories reflecting two extremes: the perception that there is *not* a relationship between teaching and research and the view that research and teaching are inseparable and interdependent.

Although researchers (e.g., Neumann, 1992; Robertson & Bond, 2001) have begun to explicate the various connections between teaching and research, more work in this area is needed. Neumann (1992) and Robertson and Bond (2001) offer seminal findings about the distinct potential relationships between teaching and learning, but as Griffiths (2004) writes, extant research does "little to reveal the different types of mechanisms through which teaching might draw on staff research, and (reciprocally) research might benefit from teaching" (p. 721). Existing frameworks acknowledge that research can impact teaching and that this relationship may be bi-directional. However, these frameworks have not dedicated substantial attention to capturing how teaching impacts research, a gap in the literature that other researchers have previously noted (Brew & Boud; 1995; Grant & Wakelin, 2009; Hattie & Marsh; 1996). We thus sought to increase our understanding of the connections between teaching and research, including to identify if and how graduate students, who represent future academics, believe teaching impacts research.

One way to explore the relationship between teaching and research is to examine how they contribute to abilities (e.g., knowledge, skills) that may mutually benefit both teaching effectiveness and research productivity. Examining these abilities may highlight connections between teaching and research that are mediated by these abilities and that which would not otherwise be considered in understanding the connection between teaching and research.

Early studies began heading in this direction when they explored how general intelligence impacted both teaching and research performance, but as Feldman (1987) noted, "a measure of more specific ability pertinent to research performance *and* to instructional effectiveness may be needed" (p. 257; italics in original). Several researchers have proposed connections between teaching and research abilities. For example, Hattie and Marsh (1996) indicate that knowledge, critical thinking and organization influence both teaching and research. However, these proposed, ability-mediated relationships have not been systematically investigated. To illuminate this unexplored area of research, the current study examined the ways in which graduate students perceive teaching and research impact academic skills, including those

that promote both teaching effectiveness and research productivity.

Disciplinary Differences

Previous studies suggest that differing departmental, university and disciplinary norms influence the complex teaching-research relationship (Brew, 1999; Colbeck, 1998; Feldman, 1987; Griffiths, 2004; Healey, 2005). Although there are numerous important distinctions between disciplines, these researchers agree that a discipline's degree of paradigm consensus— defined as "the theories, methodologies, techniques, and problems addressed within a discipline" (Colbeck, 1998, p. 651) - is strongly related to perceptions about teaching-research integration. Paradigm consensus is typically stronger in the "hard" disciplines (e.g., sciences) where there is more agreement around "curriculum content, research collaboration, competition for recognition and funding, clearly defined intellectual boundaries, and gatekeeping of those boundaries by a powerful elite" (Colbeck, 1998, p. 651). Perhaps unsurprisingly, then, there is less flexibility in expectations for faculty in the hard disciplines, where Colbeck (1998) found that faculty have fewer opportunities to integrate teaching and research than faculty in "soft" disciplines (e.g., humanities, social sciences, languages).

Although this work, and that of Colbeck (1998), Griffiths (2004) and Healey (2005), contribute to our understanding of disciplinary differences, there has been little empirical work on how perceptions about the teaching-research relationship differ across academic disciplines from the graduate student perspective. How early in the professorial preparation process do disciplines begin to exert their influence on teaching-research perceptions? Will disciplinary differences (albeit roughly categorized into "hard" and "soft" disciplines) emerge before students become faculty, and perhaps even before some have experience in teaching or research? Another key purpose of the current study, then, is to address this gap in the literature.

Research on Graduate Students' Views

Although administrators' and faculty members' perception of the teaching-research relationship have been explored, investigations into students' perceptions of the teaching-research relationship have been sparse. Most research on students' views of the teaching-research relationship has targeted undergraduates (e.g., Jenkins, Blackmon, Lindsay, & Paton-Saltzberg, 1998; Neumann, 1994; Zamorski, 2002). This lack of attention to graduate students' view is critical for several reasons. First, there have been many discussions about the length of time to degree completion for

doctoral students (e.g., Golde, 2000; Carnegie Initiative on the Doctorate, 2001). If graduate students were provided with information about, or even better, trained on how to integrate their teaching and research, graduate programs could become both more effective and more efficient: graduate students ideally would learn to use their research to inform their teaching and to use their teaching to grow their research. Essentially, they could learn to "kill two birds with one stone," or even better, "feed two birds with one scone." Second, studying graduate students' perceptions can inform our understanding of academia broadly and how faculty develop specifically. As Shulman (2005) cites Erik Erikson:

> If you wish to understand a culture, study its nurseries. There is a similar principle for the understanding of professions: if you wish to understand why professions develop as they do, study *their* nurseries, in this case, their forms of professional preparation (p. 52).

Graduate students receive their preparation to assume professorial responsibilities – to *become* the next generation of university faculty – in graduate school. It is in graduate school that they develop the knowledge, skills and perspectives that will facilitate the integration of their teaching and research activities (Austin, Connolly, & Colbeck, 2008; Golde & Dore, 2001; Henkel, 2000). Given that graduate students *are* the next generation of university faculty, knowledge of their views on the teaching-research relationship is of utmost importance, both for understanding their current perspectives and for informing any programs designed to foster a more connected and mutually beneficial relationship between research and teaching.

To date, only a handful of studies have been conducted on graduate students' perceptions of the teaching-research relationship. Deem and Lucas (2006) and Robertson and Blackler (2006) explored how graduate students experience research. Deem and Lucas studied Education master's degree students' views of (a) what research is (they did not discuss the role of theory in doing research and they reported learning to do research more through a transmission teaching model), (b) the skills needed by researchers (primarily reading and critical thinking), and (c) how research methods should be taught (recommendations involved more student practice). Robertson and Blacker (2006) examined the views of 10 graduate students in physics, geography, and English. Consistent with faculty-based research, they noted important disciplinary distinctions, finding that students in disciplines with high paradigm consensus (e.g., hard disciplines) reported that faculty research informed the content they learned through coursework, whereas in the soft disciplines, students

were more likely to develop knowledge through conducting research themselves. These studies may provide some useful insights, but one major shortcoming has been their scant sample sizes: Deem and Lucas' (2006) work reflected the voices of only 19 master's degree students, and Robertson and Blacker (2006) involved only one master's degree student, and nine Ph.D. students, with 24 undergraduate degree students also included in the sample.

In addition to small sample sizes limiting generalizability, Deem and Lucas, as well as Robertson and Blacker, focused on one direction of the teaching-research relationship: how teaching impacted students' views about research. Neumann (1994), on the other hand, targeted perceptions about the teaching-research relationship by investigating whether graduate students perceived a teaching-research relationship as a result of their experiences as students. His study showed that graduate students perceived several connections between teaching and research and that four factors mediated their view: student ability and motivation (where more able and motivated students are more likely to perceive a connection), discipline (students were more likely to perceive that research impacts teaching in biology than in physical science and mathematics), course type (where a connection is more commonly perceived in elective courses), and their connection with the instructor (where stronger relationships are related to stronger perceived connections between teaching and research). However, small sample size again undermines the generalizability of Neumann's work: it reflected the voices of a mere five Ph.D. students.

Consequently, several gaps exist in the literature on graduate students' views of the teaching-research relationship. First, what little is known about graduate students' perceptions of the teaching-research relationship is based on limited student samples and limited sampling of disciplines. Second, only Neumann's (1994) study focused on bi-directionality in the teaching-research relationship, and he only explored this issue by asking graduate students to consider their experiences as students; he did not investigate how graduate students' own teaching and research experiences were interconnected. The current study thus will also address these gaps in the literature.

Study Purpose

The current study sought to increase our scope and depth of understanding of the teaching-research link among graduate students, to identify the nature of this relationship, and to explore cross-disciplinary differences in graduate students' perceptions of the teaching-research relationship.

The research questions that guided this study include:

1. Do graduate students report a relationship between teaching and research? If so, what is the nature of that relationship? If not, why not?
2. Do graduate students' perceptions of a teaching-research relationship vary as a function of teaching and research experience?
3. Do perceptions of this relationship differ across disciplines? If so, how?
4. What perceptions do graduate students hold about how teaching and research facilitate the attainment of academic skills?

Method

This study was part of a larger project examining the impact of science, technology, engineering and mathematics (STEM) graduate students' teaching experiences on the development of their research skills (Feldon et al., 2011). As a separate part of this project, STEM graduate students described the relationship between their teaching and research activities. These responses formed the bases for the development of the survey used in the current study, described below. A survey-based approach was employed to for three purposes: (a) to reach a larger sample, (b) to access a broader disciplinary range, and (c) to enable direct comparison of participant responses across subgroups (e.g., graduate students who have no teaching experience vs. those that do).

Participants and Survey Administration

Graduate students from a large, research university with very high research activity (Carnegie Classification RU/VH, formerly known as "R1") voluntarily participated in this study. Participants were recruited during their attendance at a university-required workshop for new graduate student assistants, including both teaching assistants and research assistants. Workshop topics included those common to graduate assistant teaching preparation, such as assigning and assessing student work. Relationships between teaching and research were not addressed. Of the approximately 600 students who attended the workshop, 308 (51.3%) completed the study survey. To protect participant anonymity and to increase their likelihood of responding candidly, students were instructed not to provide their names on the survey.

Of the 308 participants, 290 provided information about their degree programs. A little more than half (168, 58%) pursued a doctorate. Of these doctoral students, 127 (76%) reported prior research experience and 65 (39%) reported prior teaching experience. One

hundred twenty-two (42%) pursued a master's degree; of these, 92 (75%) reported prior research experience, while only 32 (26%) reported prior teaching experience. Graduate students from the social sciences, humanities and natural sciences constituted the majority of the sample (Table 1).

Survey Development and Description

To develop the survey, we first examined the graduate student descriptions of the relationship between teaching and research activities that were collected as part of the broader NSF project. Specifically, two researchers independently examined interview transcript data to identify common themes regarding the connection between teaching and research. These themes were used to develop survey items which were reviewed by the research team at weekly meetings. We also developed demographic questions of interest, including questions regarding current degree program, level of prior teaching and research experience, and expected involvement in teaching and research in the ensuing academic year.

The first item on the survey asked respondents to indicate whether they perceived a relationship between teaching and research. A text box was provided in which participants could explain their response to this question.

The second portion of the survey contained five items assessing perceptions of how teaching and research contribute to the development of skills pertinent to these two domains of academia. Each item presented a specific skill and asked participants whether that skill could be developed through teaching, through research, through neither teaching nor research, or through both teaching and research.

The final portion of the survey assessed the nature of the teaching and research relationship using ten Likert-scale items. For example, one item from this section asked participants to rate their level of agreement with the following statement: "Doing research helps/will help me teach students about how research is conducted in my field."

Data Analysis

Chi-square tests of independence were conducted to test for discipline-based differences in graduate students' views of the teaching-research relationship. The first and third author independently coded all responses to students' descriptions of the relationship between teaching and research. Inter-rater agreement was computed to be 84.6%. Coding discrepancies were resolved through discussion, a process regarded as a good strategy for improving accuracy and reliability (Johnson, Penny, & Gordon, 2000; Johnson, Penny, Gordon, Schumate, & Fisher, 2005).

Results

In Their Own Words: The Nature of the Teaching-Research Relationship

The vast majority of graduate students (280, 91.8%) perceived a relationship between teaching and research (Table 2). However, eighteen different themes emerged from the 223 participants who described this relationship. These eighteen themes fell into four broad categories: research influences teaching, teaching influences research, there is a reciprocal relationship, and there is a disconnected or antagonistic relationship. As Table 3 shows, graduate students commonly characterized the relationship as unidirectional.

The most commonly nominated relationship among participants was that research influences teaching (37.5% of responses; 67% of participants who responded on-topic). Informing the content of teaching (14.0% of responses; 25.1% of participants) was the most commonly cited means by which research impacts teaching. Participants' elaborations specified that this was often accomplished through using useful examples from one's research during instruction or through disseminating one's current research in the classroom. For example, one graduate student shared, "Your scholarship is what you know. People generally teach what they know. Regardless of the course description, they lean towards their scholarship."

The second most frequently nominated relationship between research and teaching was that teaching influences research. One quarter of responses and 44.8% of participants who provided an on-topic response expressed this view (Table 3). One graduate student described several ways in which his/her teaching influences his/her research:

> Teaching can render insight into variables related to human nature that might be useful in studies. Apparently it can improve time management as well. Most importantly through the process of answering student questions, it can encourage you to increase your own knowledge base.

The third most commonly nominated link between research and teaching was that of a reciprocal relationship (11.8% of responses; 21.1% of participants). As one graduate student described, "Each activity informs the other – it is a reciprocal relationship. Also these are two perspectives or avenues for exploring your subject matter area." Some participants explained that the two activities share common skill sets (e.g., communication skills, organization skills, creativity, and critical thinking), or that university structure often dictates that academics do both teaching and research.

Table 1
Distribution of Participants by Discipline

Discipline	N	%
Social Sciences (e.g., psychology, anthropology)	72	23.5
Humanities (e.g., English, foreign languages)	66	21.4
Natural Sciences (e.g., biology, physics)	62	20.2
Engineering	24	7.8
Formal Sciences (e.g., math, statistics)	20	6.5
Health Sciences (e.g., physical therapy, sports management)	20	6.5
Education	12	3.9
Business	2	0.6
Journalism	1	0.3
Unknown	29	9.5
Total	308	100.0

Table 2
Distribution of Participants' Reporting a Relationship between Teaching and Research

	N	%
Yes/Perceived Relationship	280	90.9
No Relationship Perceived	25	8.1
No Response	3	1.0
Total	308	100.0

Over 8% of respondents selected that they do not perceive a relationship between teaching and research (table 2), and a small portion (4.5% or responses, 8.1% of participants; table 3) described the relationship as disconnected or antagonistic. For example, one participant indicated that teaching and research do not influence each other: "Well, I've always just thought that the two were separate. Even as I see my professors, it seems like they even view them separately. Teaching=Job, Research=Passion." A participant who held the view that the relationship between teaching and research was antagonistic explained, "Both take a separate demand on a person's time (i.e., having to choose between the two)."

The Influence of Prior Teaching and Research Experience on Perceptions of the Teaching-Research Relationship

Given that our sample included graduate students who have taught, conducted research, taught and conducted research, or neither previously taught nor conducted research, we conducted an analysis to examine whether their perceptions of a teaching-research nexus were related to their prior experiences. Table 4 shows the percentage of graduate students who reported a relationship between teaching and research as a function of their prior research experience, teaching experience, both, or neither. Chi-square analyses revealed that graduate students' perception of the teaching-research relationship was independent of their prior experience ($\chi^2[3] = 1.575$, $p = .665$) We also analyzed participants' responses to the open-ended question asking them to describe the nature of the teaching-research relationship with respect to their prior teaching and research experience. Table 5 shows that participants with prior teaching experience slightly more often reported that research influences teaching, though this difference was non-significant ($\chi^2[1] = 2.349$, $p = .083$), whereas participants with prior research experience more frequently reported that teaching influences research, although this difference was also non-significant ($\chi^2[1] = 3.130$, $p = .052$). Participants who had both teaching and research experience more often reported a reciprocal relationship between teaching and research as compared with other groups, though again this difference was not statistically significant ($\chi^2[1] = 3.137$, $p = .057$).

Perception of a Teaching-Research Relationship across Disciplines

When data were disaggregated by discipline (Table 6), discipline-specific patterns in graduate students' perceptions of the teaching-research relationship emerged. For example, participants from engineering

Table 3
The Nature of the Teaching-Research Relationship: Number and Percentage of Participants

Relationship Type	N	%
Research Influences Teaching	150	37.5
Research informs the content of teaching (e.g., share examples from your research; disseminate findings)	56	14.0
Through research, you develop increased disciplinary knowledge	53	13.3
Research influences teaching (no articulation of mechanism)	16	4.0
Research makes you more enthusiastic and committed to your discipline, which can be expressed in your teaching	8	2.0
Research informs pedagogy	6	1.5
If you have done research, then you can teach your students how to do it	4	1.0
If you have done research, then you can inspire your students to do research	6	1.5
Research provides an opportunity to work with/help your most talented students	1	0.3
Teaching Influences Research	100	25.0
Teaching inspires research (e.g., get ideas from your students about potential research topics)	31	7.8
Teaching increases disciplinary knowledge which forms the foundation of one's research	30	7.5
Teaching influences research (no articulation of mechanism)	10	2.5
Teaching improves your research skills (e.g., ability to look at a problem in new ways)	29	7.3
Reciprocal relationship between teaching and research	47	11.8
Reciprocal relationship between teaching and research (no articulation of mechanism)	31	7.8
Teaching and research share a common skill set (e.g., communication skills)	10	2.5
Teaching and research are conducted by the same people/ University structure dictates that academics do both	6	1.5
Disconnected/Antagonistic Relationship	18	4.5
The relationship depends on other factors (e.g., level of students you teach, extent to which the classes you teach are related to your research foci)	9	2.3
Teaching and research are different and can't be compared	6	1.5
Antagonistic relationship between teaching and research	3	0.8
Other	-	-
Off-topic response	30	7.5
Blank	55	13.8
Total	400	100.0

Notes. The number of responses exceeds the number of respondents because many respondents identified multiple ways in which teaching and research influence each other.

Table 4
Relationship between Prior Teaching and Research Experience and Perceptions of a Relationship between Teaching and Research

Relationship Type	Yes Perceived Relationship	No Perceived Relationship	Total
No teaching or research experience	48	4	52
Has prior teaching experience, no prior research experience	13	0	13
Has prior research experience, no prior teaching experience	138	12	150
Has both teaching and research experience	81	9	90
Total	280	25	305

Note. Three participants did not respond to the closed-ended item. These 3 respondents are not included in this analysis.

were significantly less likely to report a relationship between teaching and research than participants from other disciplines ($\chi^2[1] = 18.597$, $p < 0.001$). Respondents in the formal sciences, health sciences, and natural sciences were also significantly more likely than other groups to report no relationship between teaching and research ($\chi^2[1] = 8.859$, $p = .004$). Combined across all four "hard" disciplines (engineering, formal sciences, health sciences, and natural sciences), 103 of 124 students (83%) perceived a teaching-research relationship, while 21 of 124 (17%) did not. Conversely, *every* participant affiliated with a "soft" discipline (business, education, humanities, journalism, law, and social sciences) reported a relationship between teaching and research.

Because graduate students who were pursuing degrees in the "hard" disciplines were less likely to perceive a relationship between teaching and research, we investigated their responses to the open-ended item that asked them to describe the relationship (or lack thereof) between teaching and research. We hoped this analysis would reveal how their perceptions differed from graduate students in the "soft" disciplines. As Table 7 shows, graduate students in the "hard" disciplines were significantly less likely than graduate students in the "soft" disciplines to discuss how research influences teaching (25.2% vs. 48.4% $\chi^2[1] = 22.762$, $p < .001$). Table 7 also shows that graduate students in the "hard" disciplines were significantly more likely than graduate students in the "soft" disciplines to report an antagonistic or disjointed relationship between teaching and research (8.6% vs. 0.5%, $\chi^2[1] = 14.608$, $p < .001$). The rate of expression of the other two themes (e.g., teaching influences research, reciprocal relationship) was more similar across the two groups.

Closed-Ended Items Assessing the Relationship between Teaching and Research

Participants were asked to rate their agreement with ten Likert-scale items that assessed their views of the nature of the teaching-research relationship. Table 8 presents participants' mean ratings. The items that were most strongly endorsed were, "Doing research helps/will help me teach students about how research is conducted in my field," "Being knowledgeable about current research and research methods in my field helps/will help me to better design courses," and "I share/will share aspects of my with my students."

Development of Academic Abilities

The last section of the survey examined participants' perceptions about how teaching and research activities impact knowledge and skill development in five areas. Table 9 presents the frequency of response to these

items. The majority of participants indicated that both teaching and research could improve specified skills or increase their knowledge, with the exception of developing writing skills; fewer than half of graduate students (42.9%) indicated that writing skills are usually developed through research (but not teaching). Communication skills and disciplinary knowledge were identified by the largest number of students as being developed through both teaching and research.

Discussion

Most graduate students in this study perceived a significant, supportive relationship between teaching and research. Thus, study findings corroborate prior self-report research examining other samples' perception of the nature of the teaching-research relationship (Colbeck, 1998; Neumann, 1992; Neumann, 1994). Of note, most students perceived a significant, supportive relationship between teaching and research regardless of the extent of their prior experience with either activity. This suggests a window of mutability in perceptual development independent of previous teaching or research engagement. It also suggests that graduate students, like most faculty and the universities at which both graduate students and faculty work, have internalized the perception that teaching and research are complementary regardless of experiential evidence that supports or contradicts this viewpoint.

A deeper consideration of the nature of the teaching-research relationship revealed that many graduate students characterized the relationship as unidirectional, with research improving teaching by enabling instructors to use the content of their research to inform their teaching, such as by offering real-world examples. This type of relationship was consistent with Neumann's (1992) *tangible connection*, and Griffith's (2004) and Healey's (2005) *research-led* teaching, and it was a view that participants further endorsed via their strong agreement with the statement, "I share/will share aspects of my research with my students." This standpoint emphasized conveying a body of knowledge about research findings, as opposed to teaching students about the process of doing research.

Although respondents rarely described in their own words the importance of doing research in order to be able to teach others how it is done/how to do it, they nonetheless strongly agreed with the statement, "Doing research helps/will help me teach students about how research is conducted in my field." There are multiple possible interpretations of this ostensible contradiction. One possibility is that graduate students in this study may not have had the opportunity to teach students about how research is conducted. However, if given the opportunity to do so, they view conducting their own research as playing an important role in developing the ability to

Table 5
Reported Nature of the Teaching-Research Relationship by Prior Teaching and Research Experience

Teaching-Research Relationship Theme	Prior Teaching and Research Experience				
	No Teaching or Research Experience	Teaching Experience Only	Research Experience Only	Prior Teaching and Research Experience	Total
Research Influences Teaching	23 (37.7%)	10 (55.6%)	64 (32.8%)	53 (42.4%)	150
Teaching Influences Research	11 (18.0%)	3 (16.7%)	60 (30.8%)	26 (20.8%)	100
Reciprocal Relationship Between Teaching and Research	4 (6.6%)	2 (11.1%)	21 (10.8%)	20 (16.0%)	47
Disjointed/Antagonistic Relationship	4 (6.6%)	2 (11.1%)	7 (3.6%)	5 (4.0%)	18
Off-Topic	7 (11.5%)	1 (5.6%)	14 (7.2%)	8 (6.4%)	30
Blank	12 (19.7%)	0 (0.0%)	29 (14.9%)	13 (10.4%)	54
Total	61 (100.0%)	18 (100.0%)	195 (100.0%)	125 (100.0%)	399

Note. One person did not identify their prior teaching or research experience and thus is not included in this analysis.

teach others how to conduct research. Alternatively, graduate students in this study may not have commonly contemplated how their own experiences as a researcher could help them teach the research process, but when prompted, they recognized the importance of this experience.

Disciplinary affiliation was an influential component in graduate students' perceptions of the teaching-research relationship, consistent with the work of Colbeck (1998) and Feldman (1987), who found that faculty in the "hard" disciplines perceive more difficulty in integrating their teaching and research. In the current study, almost a third of engineering participants perceived no relationship between teaching and research. Further, approximately 10-15% of graduate students in the formal, health, and natural sciences (also known as "hard" disciplines) also reported no relationship between teaching and research. In comparison, participants from the "soft" disciplines each unanimously endorsed a relationship between teaching and research (although we note that one [of 190] reported a disjointed/antagonistic relationship when asked to describe the relationship in their own words).

Why were graduate student participants in the "hard" disciplines less likely to perceive a teaching-research relationship? Perhaps our findings are a reflection of our sample: we included many graduate students who have either never taught (74%) or never conducted research (25%). It is possible that these graduate students had not yet had the opportunity to figure out how to integrate their teaching and research. Although this is a theoretical possibility, direct examination of the relationship between these prior

academic experiences and perceptions the teaching-research relationship revealed that the views of graduate students who had these prior academic experiences did not differ from the views of those who had not.

Alternatively, the lack of connection between teaching and research in the "hard" disciplines may reflect that academics in the "hard" disciplines have less freedom to create those connections (Colbeck, 1998). For example, it could be argued that the curriculum for teaching Sociology 101 is more flexible than Physics 101, in which undergraduates will need to learn more specific content to be successful in Physics 102. This may restrict the opportunities that academics in the STEM disciplines may have to discuss their research in the undergraduate courses they teach.

Another explanation for why graduate students in the "hard" disciplines less often perceived a connection between teaching and research may be because their disciplinary environment more strongly encourages targeted and limited focus, thereby decreasing opportunities to juggle resources/responsibilities. Research conducted by Theall, Mullinix and Arreola (2010) provides support for this hypothesis. Through surveying 415 faculty and administrators, these researchers found that STEM faculty reported significantly lower skill levels in terms of ensuring efficient use of resources as compared with Social Science and Education faculty.

This study also explored graduate students' perceptions of how teaching and research facilitate attainment of academic skills. About 70% of students perceived that both teaching and research facilitates

Table 6
Number and Percentage of Participants Reporting a Relationship between Teaching and Research by Discipline

	Yes/Perceived Relationship		No Relationship Perceived	
	N	%	N	%
"Hard" Sciences				
Natural Sciences	53	85.5	9	14.5
Formal Sciences	17	85.0	3	15.0
Health Sciences	17	89.5	2	10.5
Engineering	16	69.6	7	30.4
"Soft" Sciences				
Social Sciences	72	100.0	0	0.0
Humanities	65	100.0	0	0.0
Education	12	100.0	0	0.0
Business	2	100.0	0	0.0
Journalism	1	100.0	0	0.0
Unknown	25	86.2	4	13.8
Total	280	-	25	-

Note. Three participants did not respond to this item.

Table 7
Discipline-linked differences in the Nature of the Teaching-Research Relationship

Teaching-Research Relationship Theme	"Hard" Disciplines (Engineering, Formal Sciences, Health Sciences, and Natural Sciences)		"Soft" Disciplines (Business, Education, Humanities, Journalism, Law, and Social Sciences)	
Research Influences Teaching	35	25.2%	92	48.4%
Teaching Influences Research	27	19.4%	47	24.7%
Reciprocal Relationship Between Teaching and Research	19	13.7%	25	13.2%
Disjointed/Antagonistic Relationship	12	8.6%	1	0.5%
Off-Topic	16	11.5%	7	3.7%
Blank	30	21.6%	18	9.5%
Total	139	100.0%	190	100.0%

Note. Twenty-nine participants did not identify their discipline and thus their responses are not included in this analysis. Some respondents identified multiple ways in which teaching and research are connected thus the number of responses exceeds the number of participants.

their acquisition of disciplinary knowledge, improves their ability to communicate in their discipline, and increases problem-solving skills. Curiously, in terms of improving disciplinary writing skills and conducting systematic observations, students' perceptions were almost evenly split: about half thought both teaching and research facilitated improvement in these areas, while about 40% perceived that usually research and sometimes teaching did so. However, the overarching interpretation of this question was that most students perceived that both teaching and research facilitated the development of key disciplinary skills.

Implications for Policy and Practice

Graduate students represent the future of the academy, and more broadly, the future of the disciplines in and beyond the academy. As Colbeck (2008) noted, academics who are highly committed to both teaching and research are energized when they engage in work that informs both activities. This study thus highlights a valuable opportunity for administrators establishing policies and procedures that help graduate students find connections between their teaching and research in order to improve both teaching and research at their institutions. Results from the current study offer several insights to help faculty and administrators promote graduate student development and teaching-research integration.

First, graduate students across disciplines overwhelmingly perceive a relationship between teaching and research. Most do so regardless of prior teaching and/or research experience. Further, most perceive that participation in both teaching and research

Table 8
The Nature of the Teaching-Research Relationship: Likert-Scale Items.

Item	N	Mean	SD
Doing research helps/will help me teach students about how research is conducted in my field.	306	4.47	0.85
Being knowledgeable about current research and research methods in my field helps/will help me to better design courses.	306	4.37	0.86
I share/will share aspects of my research with my students.	304	4.25	0.85
Teachers who frequently consider new perspectives while teaching generate more research hypotheses or are better able to see their research in a new way.	307	4.17	0.90
The same person can be an effective teacher and an effective researcher.	306	4.12	1.19
Through teaching, I find/will find students who are interested in research.	305	4.06	0.88
The connection between teaching and research depends on how close your research is to the subject that you teach.	305	3.85	1.04
I incorporate/will incorporate my students' ideas and interests into my research.	302	3.63	1.01
There is a disconnect between the kinds of skills that a good researcher needs and the kind of skills that a good teacher needs.	306	2.79	1.18
There is a disconnect between the kind of research that I do and the topics that I teach.	293	2.53	1.18

Note. Measured on a scale of 1 to 6 (1 = Strongly Disagree, 6 = Strongly Agree).

contributes to the attainment of fundamental academic skills. These findings suggest that faculty and administrators have a firm foundation on which to build students' ability to create highly permeable boundaries between teaching and research. The timeframe for the creation of these permeable boundaries is likely earlier in the graduate students' training, when professional habits are not yet set.

Second, most graduate students failed to perceive a bi-directional relationship between teaching and research. Admittedly, perceptions of unidirectional relationships between teaching and research are much preferred over either perceptions of an antagonistic or non-relationship. However, shaping graduate student professional development in a manner to support the identification and use of a bi-directional relationship would appear to be the most opportunistic. The connection that graduate students were less likely to report concerns how teaching impacts research. In this study, respondents rarely described in their own words the importance of doing research in order to be able to teach others how it is done/how to do it. This represents an opportunity for administrators to help graduate student instructors recognize the value of integrating inquiry-based learning, which involves teaching both disciplinary content and the methods by which new scientific knowledge is developed. Though researchers have not specifically examined how best to train graduate student instructors to implement inquiry-teaching approaches, Anderson (2002) suggests that collaboration with other teachers and experts is essential for teachers to adopt inquiry-teaching methods.

As others have noted (Brew & Boud, 1995; Grant & Wakelin, 2009; Hattie & Marsh, 1996), researchers have also paid considerably less attention to how one's teaching can inform one's research. Not only do those who study the teaching-research nexus pay less attention to the impact of teaching on research, but this study, along with the work of Grant and Wakelin (2009), suggests that academics, too, are less likely to perceive this connection. The influence of teaching on research is pronounced in the field of education in which instructors develop new questions and insights about teaching and learning that they can study as part of research in their discipline (Duckworth, 1986). In other fields, however, this connection is less evident. We perceive this as another opportunity for higher education policy-makers and administrators. If publishing SoTL studies were more highly valued and rewarded in non-education disciplines (Boshier, 2009; McKinney; 2006, Shapiro, 2006), this would likely help academics both use their research to improve their teaching practices and to use their teaching experiences to conduct research. Administrators or higher education policy-makers who are interested in changing the culture or policies within departments, colleges, or institutions to place greater value on and reward SoTL may find it useful to (a) develop programs that include workshops and learning communities on SoTL; (b) identify faculty fellows who can mentor instructors new to doing SoTL; (c) offer grants or other internal funding mechanisms to support SoTL; (d) design opportunities for instructors to engage in SoTL-based collaboration with instructors from other departments, colleges, or universities; (e) create an institutional journal for

Table 9
Participants' Perceptions of How Teaching and Research Facilitate Attainment of Academic Skills

Item	Neither Teaching Nor Research	Usually Teaching and Sometimes Research	Usually Research and Sometimes Teaching	Both Teaching and Research	Total
	N (%)				
Provides/will provide me with an opportunity to develop knowledge about my field.	1 (0.3%)	11 (3.6%)	68 (22.2%)	226 (73.9%)	306
Improves/will improve my ability to communicate about my field.	2 (0.7%)	58 (19.0%)	20 (6.5%)	226 (73.9%)	306
Improves/will improve my writing skills.	9 (3.0%)	18 (5.9%)	130 (42.9%)	146 (48.2%)	303
Encourages/will encourage me to view problems from multiple or new perspectives.	2 (1.0%)	42 (13.8%)	54 (17.8%)	206 (67.8%)	304
Improves/will improve my ability to conduct systematic observations.	5 (1.7%)	27 (8.9 %)	119 (39.3%)	152 (50.2%)	303

publishing SoTL; and (f) adopt tenure and promotion guidelines that reward SoTL publications (Cruz, Ellern, Ford, Moss, & White, 2009; Huber & Morreale, 2002; Shapiro, 2006; Shulman, 1999).

Although the view that an antagonistic relationship exists between teaching and relationship was relatively rare among graduate students in this study, systematic causes of this view may be at work. For example, some graduate students who held this view explained that they perceived this relationship because the topics they taught differed from the topics they researched. As one graduate student in statistics noted, "I haven't related my research with my teaching experience. My research was also at a higher level than what I was teaching." Austin (2002) previously noted this concern among graduate students: teaching assistantships typically reflect departmental needs rather than the budding interests of graduate students and can result in a pronounced rift between the content of graduate students' teaching duties and their research. This highlights the opportunity for graduate coordinators and administrators to assist graduate students in aligning their teaching and research by enabling them to teach courses in their research areas. If it is not possible to enable graduate students to teach entire courses that focus on their areas of interest, an alternative is that administrators help them to combat "curriculum creep," or the increasing demands that are placed on teachers to cover an increasingly larger knowledge base (Webster, 2002, p. 16). This will allow instructors time to integrate brief lessons that draw on their research to enhance their teaching.

It is of note that the data for this study were collected at a workshop required for graduate student teaching and research assistants, the content of which did not include a discussion of teaching-research integration. This represented a lost opportunity to broach this important topic and create a space for dialogue to which students from across the disciplinary context can contribute. We further suggest that many other opportunities to open dialogue around this topic exist with the graduate education curriculum. For example, it is widely acknowledged that students are keen observers of faculty life (Austin & McDaniels, 2006). Thus, we suggest any format that encourages candid discussion about and observation of teaching-research integration in daily faculty life will be of interest to many graduate students. This may include, for example, events such as "brown bag" lunches at which graduate students and faculty can share their successes and challenges around teaching-research integration or receive professional development on resource management. These may be particularly salient in "hard" disciplines in which it may be more difficult to achieve this integration.

Research question four explored how teaching and research facilitate the attainment of academic skills. Of note, over 40% of graduate students reported that improving disciplinary writing skills and the ability to conduct observations is better developed through research. This finding may be useful to administrators when designing professional development activities; academics who desire to improve their writing and observation skills may be better able to develop these skills through research rather than teaching. The finding that research plays a more integral role in writing than does teaching may also explain why correlative studies that compare teaching effectiveness with publications (number and/or quality) do not show positive relationships.

Directions for Future Research

This study reinforces the value of an institutional structure that endorses and supports both teaching and

research. Study findings indicate that these activities directly improve one another by a variety of means, as well as indirectly improve one another by helping to develop skill sets necessary for being an effective researcher and teacher. This finding corroborates research indicating that engaging in both research and teaching during graduate school is related to stronger graduate students' research skills (Feldon, et al. 2011).

We hope that future research extends and deepens this analysis in multiple ways. First, rather than examine how doing both teaching and research (which could include simply balancing the two) impacts skill development, future work should examine how *integrating* teaching and research impacts critical graduate education outcomes, such as skill development, time-to-degree completion, and success in obtaining a faculty position. Second, this study suggests that teaching-research integration may contribute to higher quality work and increased efficiency, which is critical given the ever-growing scope of faculty responsibilities (Theall, Mullinix, & Arreola, 2010). However, while many doctoral students are trained at research-extensive institutions, many will not secure employment at such institutions after obtaining their PhDs. In addition, academia is moving towards the "unbundling" of academic responsibilities with an increasing number of non-tenure track appointments (Austin, 2002, p. 100). Thus, the number of graduate students who secure tenure-track positions that include both teaching and research responsibilities is declining (Curtis & Thorton, 2013; Gill, 2013; Wood & Townsend, 2013; Vick & Furlong, 2008). Instead, many graduate students are often employed outside academia (Golde & Dore, 2004) or at institutions dedicated to undergraduate education (Krebs, 2014). We thus encourage future research to examine the research expectations and teaching-research integration of faculty at these "teaching colleges." Toward this aim, longitudinal studies that follow graduates of research-extensive doctoral programs to their post-PhD institutions could be particularly insightful. Such research could examine in more detail how institutional culture affects perceptions of teaching-research integration. This could include a close investigation into how graduate students' initial perceptions of the teaching-research next is influenced by their faculty advisors, who may play an even more prominent role in shaping students' views than the general institutional emphasis. By then tracking students from their research-extensive graduate programs to their positions at teaching-focused institutions, this research could then identify whether students' views in their doctoral programs continue to characterize their perceptions as faculty members, or whether their views are predominantly shaped by their new institution's culture.

For graduate students who secure positions at "teaching-focused institutions" that place less emphasis on disciplinary research, SoTL may be the mechanism through which they may integrate teaching and research, in particular because such research may be conducted without a substantial budget or research equipment. But it does require the acquisition of skill sets which may be further from some disciplinary fields than others. For example, scholars in the humanities or social sciences may already have familiarity with qualitative research methodologies, text analysis techniques and other approaches that may be more disparate from existing skill sets for scholars in the hard sciences. Further, SoTL is likely to be valued at higher education institutions focused on undergraduate teaching. If faculty at these institutions are engaging in research or SoTL, it will also be informative to explore if and how these faculty use this research to inform their teaching, as well as the impact that integration has on faculty work efficiency, productivity, salary and, where appropriate, tenure and promotion.

In short, we suggest that future research explore the extent to which teaching-research integration is possible and helpful for all faculty, but perhaps most especially faculty at teaching-centered institutions, at which most new faculty members will secure their first and perhaps long-term faculty positions. Findings from this line of inquiry could be used to better train graduate students who have this career goal in mind.

This study also corroborated findings from prior research that instructors in the "hard" disciplines perceive more difficulty in integrating their teaching and research (Colbeck, 1998; Feldman, 1987). We offered three hypotheses to explain the differing perceptions of graduate students in the "hard" disciplines vs. the "soft" disciplines, including that (a) due to limited teaching and research experience, graduate students may not have yet had the opportunity to explore connections between their teaching and research, (b) graduate students in the "hard" disciplines may have fewer opportunities to modify their course curricula to allow for teaching-research integration, and (c) the nature of work in the "hard" disciplines encourages more focused work and less juggling of responsibilities and resources. Future research should investigate these distinct hypotheses as well as identify other explanations that may shed light on discipline-linked differences in teaching-research integration.

We suggest that in-depth qualitative studies that examine the nature of graduate students' teaching and research experiences and the contexts and cultures in which those experiences are embedded are needed to better understand these students' perceptions of the teaching-research relationship. While the categorizations of "hard" and "soft" are common in discussions of disciplinary differences, major distinctions in how

knowledge is structured exist between disciplines in the "hard" category, as well as between those in the "soft" category (Donald, 2002). These distinctions have implications for both teaching and learning in the specific discipline, and likely influence how the teaching-research relationship is conceptualized within the specific discipline by graduate students and faculty alike. It is beyond the scope of the current effort to disaggregate students' responses to questions about perceptions of the teaching-research relationship by discipline (by biology, chemistry, and physics, for example). However, we suggest that finer-grained studies that do so are the next step in discerning how disciplinary knowledge structures shape the perceptions of teaching-research relationships that necessarily emerge from them.

Conclusion

As Colbeck (2008) noted, instructors who are highly committed to both teaching and research are energized when they engage in work that informs both activities. This study thus highlights a valuable opportunity for administrators establishing policies and procedures – to help graduate students find connections between their teaching and research in order to improve both teaching and research at their institutions.

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