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Perceived norms for interactive teaching and their relationship to instructional decision-making: a mixed methods study

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Abstract Normative expectations for acceptable behaviors related to undergraduate instruction are known to exist within academic settings. Yet few studies have examined disciplinary variation in norms for interactive teaching, and their relationship to teaching practice, particularly from a cognitive perspective. This study examines these problems using survey ($n = 436$) and interview ($n = 56$) data collected from faculty at three research universities in the United States in math, physics, chemistry, biology and geology departments. These data are analyzed using quantitative (i.e., ANOVA and ANCOVA) and qualitative (i.e., thematic and causal network analysis) techniques to provide multi-faceted accounts of normative systems. Results indicate that perceived norms for interactive teaching are weak or non-existent, yet other types of norms including those regarding course content, tacit norms for instructional autonomy and norms instantiated in course syllabi are present. Significant differences in perceived norms were found between institutions and disciplines, with biology and physics departments at two research sites exhibiting significantly stronger norms than other departments. Analyses of relationships between perceived norms and teaching practice indicated significant relationships between norm strength and the use of two teaching methods. Further, analyses of interview data revealed complex chains of decision-making involving considerations of course syllabi, student characteristics, and feedback mechanisms. Implications for pedagogical reform include the need to understand local cultural conditions and decision-making patterns to inform program design and implementation.

Keywords Undergraduate instruction · Norms · Interactive teaching · Mixed methods · Faculty culture

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Introduction

Increasingly, policymakers and faculty[1] developers are focusing on pedagogical reform efforts that aim to encourage faculty to adopt interactive teaching practices, particularly in math and science (National Research Council 2010; Seymour 2002). These efforts are based on a growing body of evidence from the learning sciences that indicate student learning is enhanced through directly engaging students in the learning process as opposed to simply conveying facts, concepts and/or procedural knowledge in a way that relegates the student to a role as a passive observer or note-taker (NRC 2000). Yet despite substantial investments in pedagogical reforms at the postsecondary level, evidence suggests that faculty are slow to adopt research-based teaching methods, and that the considerable investments being made in pedagogical reform are having minimal impacts (Lazerson et al. 2000; Dancy and Henderson 2010).

While structural features such as workload constraints and incentive systems are known to influence faculty teaching, cultural norms play a critical role in shaping teaching practice by demarcating the range of permissible and desirable behaviors (Austin 1990). As such, an extensive body of literature exists examining the norms that faculty have for undergraduate teaching, including inviolable acts that require sanction, admonitory norms for behaviors that are merely disapproved of, and norms related to instructional improvement (Braxton et al. 1996; Braxton and Bayer 1999). This line of inquiry tends to focus on individuals' descriptions of prevalent behaviors in their social groups (i.e., descriptive norms) wherein norms function to maintain the stability of social systems and to forge groups of individuals into coherent units (i.e., a functionalist view of social order) (Parsons 1951; Braxton 2010a), which in academia are most commonly disciplinary units such as departments or research units (Clark 1983; Austin 1994).

However, little is known about disciplinary differences on norms for interactive teaching, despite significant attention to the role that the disciplines play in pedagogical reform initiatives (Neumann et al. 2002). Perhaps an even more pressing gap in the literature, however, is the lack of insight into the relationship between norms and interactive teaching methods in general, and of the underlying mechanisms whereby norms influence instructional decision-making in particular. Indeed, researchers have long acknowledged that there is often a "painful contrast" between norms and behavior (Merton 1976, p. 40, cited in Braxton 2010a). Given that much of the literature relies on statistical analyses of survey data that necessarily obscure the subtle features of individual decision-making, an alternative approach is necessary that elucidates the processes by which norms influence (or not) decisions about classroom teaching. Such an approach would need to account for the influence of both cognitive characteristics of individual faculty as well as the socio-cultural forces at work within particular Institutions of Higher Education (IHEs) (Hora 2012; Lattuca 2005). For example, research in social psychology has empirically demonstrated the relationship between mental representations and behavior, and how individuals' perceptions of group expectations to conform to particular behaviors (i.e., perceived norms) influence both decision-making and overt behaviors (Bandura 1977; Ajzen and Fishbein 1980).

This perspective emphasizes the powerful role that the mere perception of being sanctioned for violating a norm can be sufficient to influence decision-making—a phenomenon that is obscured when focusing exclusively on descriptive norms (Sripada and

[1] By *faculty*, we mean all people who hold undergraduate teaching positions (excluding graduate student teaching assistants)—whether full- or part-time, tenured or untenured—in postsecondary institutions.

Stich 2007). In addition, a cognitive approach to the study of norms in academia is warranted by research that demonstrates how there is not a simple one-to-one correspondence between perceptions and behavior, but that decision-making unfolds in cognitively complex patterns where particular inputs "activate" other mental representations in a web-like manner (Feldon et al. 2010; Shavelson and Stern 1981). Importantly, some of these representations are encoded perceptions of the actors' structural and social environment (Simon 1991; Greeno 1998). Despite the promise of a psychologically oriented analysis of norms and their relationship to teaching, no systematic analyses have been conducted to examine the role that they play in shaping teaching practices at the post-secondary level. This is a crucial empirical and practical problem, given that insights into the role that cultural norms play in shaping teaching practice can be used to inform the design and implementation of pedagogical reform efforts (Tierney 2008; Braxton 2010a). In response to this gap in the literature, the study reported in this paper adopts a cognitive approach to the analysis of how the socio-cultural environment influences instructional decision-making. A mixed-methods design was used to examine this complex dynamic, drawing on interviews ($n = 56$) and surveys ($n = 436$) with math and science faculty at three large research universities in the United States. The research questions motivating this study are: (1) To what degree do perceived norms for interactive teaching exist? (2) Do faculty in different institutions and disciplines vary in their perception of these norms? and, (3) How, if at all, do perceived norms influence faculty teaching practices?

Background

Norms have long been an important topic of study in disciplines such as anthropology, sociology and psychology. For anthropologists, norms for appropriate behaviors are a key component of culture, or what the anthropologist Ward Goodenough famously called "whatever it is one has to know or believe in order to operate in a manner acceptable to members (of a group)" (Goodenough 1957, p.11). In sociology, extensive work on norms can be traced back to Durkheim's view that norms are essential social facts that represent the collective unconscious of social groups (Durkheim 1897/1951). Sociologists such as Parsons (1951) and Merton (1976) elaborated on these basic ideas and focused on how norms act to serve a group function, driving behavior in part by establishing and maintaining patterns of acceptable practices that serve to protect the interests of particular groups. An important mechanism by which normative systems are maintained is through the detection of norm violations and the subsequent punitive measures that act to discourage future violations.

The functionalist view of norms as determining and maintaining social stability has been dominant in analyses of norms and cultural phenomena within IHEs, where norms are widely viewed as functioning to maintain the stability of the social system of a college or university (Braxton 2010a). Research in this area generally focuses on the norms that individuals describe as being prevalent within their peer group or at their institution (i.e., descriptive norms). For example, in a paper exploring academic norms related to teaching, Braxton et al. (1992) derived normative structures for undergraduate teaching in four domains based on faculty descriptions of dominant norms in their institutions: interpersonal disregard, particularistic grading, moral turpitude, and inadequate planning. Additional research identified seven inviolable norms (i.e., behaviors that are egregious violations of acceptable conduct such as grading students on metrics other than merit) and

nine admonitory norms (i.e., behaviors that inappropriate but with weaker severity, such as coming late to class) related to undergraduate teaching (Braxton and Bayer 1999).

In the only extant study examining norms related to pedagogical reform, Braxton et al. (1996) investigated the presence of norms to support instructional improvement and found they existed for only three areas (i.e., providing feedback on student performance, fostering egalitarianism in classrooms, and maintaining a systematic program of advisement). Importantly, the researchers found that faculty do not consider it inappropriate to avoid reading about pedagogy, bypassing professional development, and refusing to integrate new teaching techniques—a situation that the researchers speculate will inhibit reform initiatives (Braxton et al. 1996). This is largely because entreaties to adopt new teaching methods will not be reinforced by existing expectations or mechanisms to enforce compliance with these desired behaviors.

Importantly, the norms and expectations that develop within particular contexts may be strongly tied to two key aspects of organizational life in IHEs: the institution and the discipline. For example, Braxton et al. (1996) found evidence that biology and psychology had stronger norms for encouraging more egalitarian classroom climates than mathematics. Variation among disciplines can be explained in part by the fact that different fields have distinct "knowledge traditions, categories of thought, and related codes of conduct" (Clark 1983, p. 76). The influence of disciplines on descriptive norms points to the important role of context, along with how norms are situated within, or even embody, organizational processes and policies that constitute the structure of organizational life. As such, Braxton (2010b, p.243) argues that norms "index" goals and values associated with particular institutions, disciplines, and organizational roles, thereby foregrounding the need to account for how norms are situated within particular organizational settings.

One feature of this body of research is that it relies on a "black box" approach to the relationship between norms and behavior, which is based in part on the reliance on statistical analyses of survey data—a methodology that necessarily reduces social phenomena (e.g., norms) to individual variables and obscures the more subtle processes of social and psychological life. Such an approach simplifies the relationship between norms and practice and "assumes a simplicity and linearity of attitudes and behaviors that may not exist in complex organizations" (Umbach 2007, p. 280). In contrast, some researchers have focused on psychologically oriented accounts of the relationship between norms and behavior in academia (e.g., Hora 2012), as evidence from research in cognitive and social psychology examining these mechanisms has made it difficult to ignore the role of human cognition and individual agency in mediating these dynamics. For example, researchers have recently been focusing on a specific type of norm—those that entail pressure for group members to conform (i.e., perceived norms) and their relationship to overt behaviors (Rimal and Real 2003). According to this approach, perceptions of the socio-cultural environment can influence decision-making through individuals' desire to conform to the expectations of their group, particularly if sanctions for the violation of group norms exist (Ajzen and Fishbein 1980).

Thus, the mere perception of being sanctioned for violating a norm can be sufficient to influence behavior, and these perceptions can be internalized and encoded as a distinct type of mental representation (Sripada and Stich 2007). This means that norms may carry weight without needing to be formally institutionalized and that they affect behavior simply by someone perceiving that a particular rule ought to be followed. Over time, individuals will draw upon these perceptions of constraints and affordances within their social and structural environment as part of their decision-making processes (Greeno 1994), and they may even become a core aspect of decision-making criteria for academic

planning and in-class teaching behaviors (Shavelson and Stern 1981; Stark 2000). While limitations to focusing on perceptions of norms as opposed to their reported prevalence exist, including the subconscious nature of some norms (Bargh and Williams 2006), eliciting perceptions of group norms can shed light on how an individual's decisions about teaching are influenced by features of human cognition and the socio-cultural environment in ways that a functionalist account cannot.

Methods

The study reported in this paper is a part of a research project examining the cognitive, cultural and contextual factors related to teaching practices in the science, technology, engineering and mathematics (STEM) disciplines, and how dynamics among these elements either impede or support the adoption of pedagogical reforms. For this paper we analyzed survey and interview data from the first wave of data collection (i.e., Spring 2010) from this larger study. A mixed methods approach is particularly appropriate for this analysis, given the complexity of cultural dynamics and teaching practice within complex organizations such as IHEs; we use both quantitative analyses of survey data and qualitative analyses of interview data in a complementary fashion in order to provide a nuanced and multi-dimensional accounting of the relationships among norms, disciplinary and institutional contexts, and teaching practice (Tashakkori and Teddlie 2002).

Participants and sampling procedures

The population of interest for this study included instructors in mathematics, biology, geological sciences, chemistry, and physics at three IHEs in the U.S. These sites were selected based on three criteria: (a) public research-intensive institutions as defined by the Carnegie Foundation for the Advancement of Teaching (2007); (b) institutions with undergraduate enrollments of similar size based on figures from fall 2006; and (c) institutions with similar 4-year averages of National Science Foundation Division of Undergraduate Education (DUE) funding, which indicates the level of funding for pedagogical reform activities at a given institution. Based on these criteria, we selected Institution A located on the West Coast, Institution B located in the Mountain West, and Institution C located in the Midwest. Two distinct sampling approaches were taken for the survey and interview components of the study. For the survey, the sampling frame included all tenure-track faculty, adjunct faculty, and instructional staff listed on departmental webpages. In addition, a list of individuals who were actively teaching undergraduate courses in the spring of 2010 was compiled from online course schedules. In addition to the faculty and staff listed on departmental webpages, some active instructors were graduate students or post-doctoral researchers, in which case these individuals were added to the sample. The final sampling frame for the survey was 977 instructors, and at the end of the month long period of fielding the survey, there were 436 respondents, yielding a final response rate of 45%. The sampling frame for the interviews included those individuals who were actively teaching undergraduate courses in the spring of 2010. This group included 334 individuals, each of whom were contacted up to twice by email requesting interviews. Those who responded ($n = 137$, or 41%) and whose schedule allowed for participation in the study were scheduled for an interview ($n = 56$, or 15% of those contacted). Detailed information about the samples are included in Table 1. Differences in the two samples should be noted,

Table 1 Description of sample

	Survey *n*	Interview *n*
Total	436	56
Institution		
A	125	18
B	118	20
C	179	18
Discipline		
Math	108	18
Physics	75	11
Chemistry	58	8
Biology	116	11
Earth/space science	76	8
Missing cases	3	N/A
Level of course		
Lower division	266	38
Upper division	165	18
Missing cases	5	N/A
Size of course		
50 or less	148	10
51–100	75	18
101–150	49	9
151 or more	160	19
Missing cases	4	N/A
Sex		
Female	119	22
Male	309	34
Missing cases	8	N/A
Position type		
Lecturer/instructor (non tenure-track)	87	28
Assistant professor	78	6
Associate professor	58	4
Professor	209	18
Missing cases	4	N/A

and conclusions drawn from each type of data may not be comparable given differences in the samples.

Data collection and measures

Data were collected in two phases. First, a hard-copy of the survey was mailed in March of 2010, with web-based versions of the instrument sent to non-respondents via three follow-up e-mails. Second, a team of three analysts conducted interviews with instructors at each research site in week-long visits to each IHE in April of 2010.

Survey: perceived norms

Given the lack of existing instruments regarding perceived norms for interactive teaching, new items were constructed for use in the study. A three-question scale for "interactive teaching norms" was created based on the phrasing and general approach of the "Community College Teaching Behaviors Inventory" (e.g., Bayer and Braxton 1998). The items were introduced with the following question: "How much do your colleagues or department have expectations for your actions in the following professional activities?" with the following three options: "Expectation to use techniques other than lecture," "Expectation to have students be actively involved in class," and "Expectation to use a variety of teaching methods." The response scale included five response options: not at all—no expectations (1), very little—causal conversation around department mention what one is expected to do (2), some—expectations are common knowledge in your department (3), quite a bit—colleagues would speak to you if you weren't acting in line with expectations (4), a great deal—strong expectations to act a certain way—there would be significant negative implications if expectations are not met (5). It is important to note that the response items included references to sanctions, thus inserting punitive element to the responses. The three items exhibited high reliability with a Cronbach's alpha score of .90.

Survey—reported teaching methods

Another set of survey questions elicited the regularity with which respondents used particular teaching methods. These methods were identified during the pilot phase of the study in collaboration with a group of STEM faculty. The items were introduced with the following question: "How often, if at all, have you used each of these teaching methods?" with the following six items: "instructor presents content by lecturing," "demonstration of content or working through problems," "whole class discussion or Q & A," "small group work," "use of multi-media aids," and "real-time polling." In terms of degree of student–teacher interaction, one method could be considered to involve minimal interaction (i.e., lecturing), three could be considered to involve substantial interaction (i.e., whole class discussion, small group work, and real-time polling), and two cannot be characterized according to degree of interactivity (i.e., demonstrations or working through problems and use of multi-media). Instructors were asked to answer this question in relation to their most recently taught undergraduate course. Response options included four options: never (1), sometimes (2), often (3) and always (4).

Interviews

Semi-structured interviews were conducted using a protocol consisting of 17 open-ended questions. The interviews followed the ethnographic interview method of Spradley (1977) where the responses to these questions provided a point of departure for further conversation on the topic. The primary question of interest from the protocol for this paper is: "If you didn't use particular teaching techniques would your colleagues care?" Affirmative responses to this question were followed up with the following probe, "How, if at all, do these expectations influence how you teach?" A second question, not intentionally designed to produce data regarding teaching-related norms, was "How much leeway do you have in determining the content of the course?" Each interview took approximately 30–45 min and took place in respondents' offices or nearby conference rooms.

Data analysis

Statistical analyses of survey data

The survey data were first examined to ensure that they met assumptions of analysis of variance (ANOVA) tests, including normality, independence and homoscedasticity. Then, in order to explore disciplinary and institutional variation on the norms for interactive teaching, a two-factor ANOVA was conducted with institutions as the first factor and disciplines as the second factor. Post hoc comparisons were conducted using Tukeys HSD or Fishers LSD as appropriate, and the significance level for all tests was .05. Next, analyses of the relationship between norms and teaching methods were conducted by first identifying three groups of varying norm strengths: 3.5–5 (strong), 2–3.49 (weak) and 1–1.99 (none). The groupings were based on Braxton et al.'s (1996) convention of using a mean score of 3.5 as a cut-off for norm detection in their studies. Then, either one-way ANOVAs or analysis of covariance (ANCOVA) tests were conducted depending on whether institution and/or discipline correlated with norm groups. The dependent variables for these analyses were teaching methods (i.e., lecturing, whole class discussion, small group work, working out problems, real-time polling, and use of multi-media aids).

Thematic and causal network analysis of interview data

All interviews were transcribed and entered into NVivo® qualitative software and analyzed using a structured approach to grounded theory (Corbin and Strauss 2007) to identify themes in the data, and causal network analysis (Miles and Huberman 1994) was used to identify and then visually depict relationships between pairs of themes. The first step in the analysis involved two analysts (i.e., the authors) developing a coding scheme in order to segment the data into manageable and thematically coherent units. The coding scheme was created using an inductive coding process in which new codes were created based on data in ten randomly selected transcripts, with each successive instance of the code compared to previous instances in order to confirm or alter the code and its definition (i.e., the constant comparative method) (Glaser and Strauss 1967). After this preliminary analysis, a final coding scheme comprised of 10 categories and 135 individual codes was developed and applied to five randomly selected transcripts, using utterances regarding a particular code (e.g., norms for teaching) as the primary unit of analysis. Importantly, the coding process often resulted in particular passages being coded with multiple codes. For example, the following passage was coded as "norms" but it also includes references to other codes in the coding scheme (e.g., autonomy, student evaluations):

> There are not any expectations for teaching, and you're allowed to pretty much go your own way. There are evaluations, and student feedback is looked at, and the bad teachers are told to improve their teaching but for the most part it's go your own way.

In this case, the codes for "autonomy" and "student evaluations" were also applied to the utterance. After applying the coding scheme to the five transcripts, inter-rater reliability was assessed by calculating the percentage of agreement between the analysts in applying the codes (89%). The analysts then applied the coding scheme to all 56 transcripts. The first author then conducted the remaining analyses. The text segments coded as "norms" were analyzed to identify the presence or absence of a norm, as well as the type of norm being articulated by the respondent. Then, the relationship between norms and other codes were analyzed by running a matrix query in NVivo®, in which utterances coded with specific

pairs of codes (e.g., norms and autonomy) were identified. These utterances were then analyzed to identify statements where respondents clearly linked norms to another code (e.g., autonomy and student evaluations in the quote above), and these relationships were noted in a table of what Miles and Huberman (1994) call "causal fragments." This process of identifying causal fragments was repeated for all data coded as norms, such that multiple instances of particular causal fragments could be identified, and ultimately put into a graphic display depicting relationships between pairs of codes. It is important to note that the resulting displays represent the accounts of a relatively small number of respondents from our study, and that these data should not be extrapolated to entire departments or institutions nor viewed as definitive accounts of action and behavior. Despite these limitations, causal network analysis and related methods such as verbal analysis (Chi 1997) are robust techniques for identifying relationships between concepts and visually depicting them in a structured manner.

Results

In this section, we present results for each of the research questions, drawing on both survey and interview data as appropriate to address specific questions.

Description of perceived norms: survey results

Table 2, shows the responses to the norms for interactive teaching scale for the entire sample, as well as responses by institution and discipline. Though the response items used in this study vary somewhat from those used by Braxton et al. (1996), we adopt their criterion of counting norms to exist within a group if average scores are 3.5 or higher. Applying this criterion, these results indicate that no norms for interactive teaching exist for any group.

Description of perceived norms: interview results

Interview results were examined regarding the presence and type of perceived norms for interactive teaching. It is important to note that the data reported in this section include responses to not only the direct question eliciting respondent's perception of teaching-

Table 2 Means and standard deviations for perceived norms for interactive teaching

Perceived norm for interactive teaching	*n*	Mean	SD
Total	422	2.49	0.97
Institution			
A	115	2.38	0.93
B	118	2.76	1.01
C	179	2.24	0.86
Discipline			
Math	105	2.25	0.79
Physics	74	3.05	1.03
Chemistry	55	2.34	0.83
Biology	114	2.65	0.95
Geology	73	2.10	0.93

Table 3 Presence or absence of perceived norms for teaching and content

	# Respondents	Teaching norms present	Content norms present
Total	56	26	36
Institution			
A	18	7	13
B	20	8	13
C	18	11	10
Discipline			
Math	18	9	15
Physics	11	6	9
Chemistry	9	5	7
Biology	11	6	5
Geology	8	1	2

related norms, but also to a question regarding instructor autonomy for selecting course content. We did not anticipate that the latter question would provide data related to perceived norms for teaching, but many responses to the question focused on norms for creating course syllabi and identifying course content. As a result, norms for course content are included in this analysis (see Table 3).

Perceived norms for teaching

Twenty-six respondents perceived that their colleagues held normative expectations for teaching. Eight of the respondents simply noted the existence of norms, while others specified that expectations existed regarding the use of specific teaching methods. These included generalized norms regarding the use of interactive teaching methods such as "not just talking at students" (4), norms to use problem sets and work through problem solutions (3), norms to use demonstrations (3), and norms to use lecture (2). One individual reported an expectation to lecture in class, saying that if she didn't lecture, "They would think I was somehow not doing what I'm supposed to be doing." One faculty member perceived expectations to do worked problems on the board, noting that this was the only viable method to get students to learn to do calculations and work with the necessary mathematics. Another respondent reported departmental expectations to teach in an interactive manner. This respondent shared an anecdote about a new instructor that presented clear lectures, but made no efforts to engage the class or do any classroom management when students were talking, reading, sleeping, etc. When this instructor failed to engage the students after peer interventions, she was fired. Other expectations for teaching dealt with specific types of instructional technology. These included norms regarding the use of course websites (2), norms for using clicker-response systems (3), and norms for the use of PowerPoint slides and other graphics (1). Finally, some respondents observed that teaching-related norms spoke more to "what" should be taught rather than "how" faculty should teach. These norms related to content and course syllabi are discussed in the next section.

Perceived norms governing course content: the presence of "instantiated" norms

Thirty-six respondents referred to norms for selecting course content in response to questions about teaching norms and the amount of autonomy they enjoyed in regards to

course planning. In many cases, expectations for what should be taught were discussed in relation to course syllabi, which in this case represent norms instantiated in physical form. This process of norms becoming instantiated in course syllabi occurred in four distinct ways. First, 13 faculty reported that the "canon" of the field dictated which topics were included in the syllabus. In two instances, a particular introductory text for physics courses was cited as an example of a text that accurately captured this canon, and so the organization of the book and its suggested activities was used to structure the entire course. In another case, a respondent noted that the content for introductory courses in his field was just "known" and "established" to the entire discipline, which made it relatively easy to develop a syllabus. In another case, a chemistry faculty noted that while her colleagues were "indifferent" to details of how she taught, they had strong expectations for the "list of topics" she would cover in a given course. Second, four respondents perceived that the expectations of course coordinators played a significant role in shaping course syllabi as well as assessments and homework assignments. In these cases, a course had multiple instructors and class sessions, which required a coordinator to ensure that all students were exposed to the same material at the same time. Thus, the coordinator held considerable decision-making power in structuring the course, and their expectations regarding appropriate content, sequencing and assessments were evident in the course syllabus. Third, three respondents stated that they structured their syllabi in part on the expectations for content coverage that they perceived were contained in university course catalogues or departmental descriptions of courses. Finally, three faculty reported that content-related norms were particularly salient for lower-division courses that were prerequisites for other more advanced courses, as expertise was dependent upon the acquisition of knowledge in a sequence progressing over time towards more sophistication.

Absence of perceived norms for teaching: the presence of "tacit" norms

It is notable that 30 respondents perceived that no norms for teaching existed amongst their colleagues. In some cases, these respondents simply answered "No" to the question about the presence of perceived norms for teaching. However, in other cases the denial of the presence of norms for teaching was immediately followed by an observation about another, more taken-for-granted type of norm—that of instructional autonomy (19). In these cases, while respondents did not directly perceive that norms for teaching existed, they did perceive and report some group expectations related to teaching—namely, that of autonomy to decide what to teach and how to teach it. For example, one faculty member responded that "I don't think that they would care, because we have an enormous amount of autonomy."

This norm for instructional autonomy was linked to two different views of teaching within departmental contexts—that of not knowing (or caring) about their colleagues' teaching practices, and that of convictions that there should be no mandates regarding teaching. In the first case, a few respondents stated that they had no idea about what happened in their colleagues' classrooms (3). One respondent stated: "I don't care what they care about, and I do what I do." In the second case, several respondents expressed a strongly held sentiment that instructors should be able to do whatever they wanted in their own classrooms (11). The latitude granted to their colleagues was sometimes explained by appealing to the differing strengths and weaknesses that instructors have, especially regarding the ability to keep students' attention. For example, one respondent stated, "if students have learning styles, then what about different teaching styles too?" In these cases respondents did not indicate a clear antipathy to specific teaching methods per se, such as

interactive approaches, but underscored the sentiment that decisions about how to teach should be left to the instructor's own prerogative.

Autonomy is an interesting case as a type of norm, as it refers to a view of teaching as an individualistic pursuit, but one that is shared among group members. In this way, autonomy can be viewed as an "anti-norm" norm, as it is clear that an expectation regarding autonomy is widely held in the study sample, despite the claim that no norms for teaching exist. As a result, we consider this type of norm to be a "tacit norm." Capturing the presence of tacit norms is particularly important given the fact that many cultural norms and expectations are tacit and sometimes difficult for group members to recognize (Geertz 1973; Aarts and Dijksterhuis 2003).

Disciplinary and institutional variation: survey results

A two-way ANOVA was used to test for differences in perceived norms for interactive teaching norms by institution (Factor A) and discipline (Factor B). Results indicated a main effect of institution, $F\ (2,404) = 11.861$, $p < .05$ (.000), a main effect by discipline, $F\ (4,404) = 11.328$, $p < .05$ (.000), and an interaction effect between institution and discipline, $F\ (8,404) = 2.929$, $p < .05$ (.003). Next, a simple effects test for disciplines at the different institutions indicated that differences between institutions existed for biology, $F\ (2,404) = 4.198$, $p < .05$, chemistry, $F\ (2,404) = 3.513$, $p < .05$ and physics, $F\ (2,404) = 13.699$, $p < .05$, but not for geology or math. Posthoc comparisons using the Tukey HSD test between pairs of institutions for specific disciplines were conducted. Results indicated that Institutions A and B had significantly stronger norms than Institution C in biology, Institution B had significantly stronger norms than Institution A in chemistry, and Institution B had significantly stronger norms than Institutions A and C in physics.

A simple effects test for institutions at the different disciplines indicated that differences existed for perceived norms for interactive teaching at Institution A, $F\ (4,404) = 4.944$, $p < .05$, and Institution B, $F\ (4,404) = 13.358$, $p < .05$, but not at institution C. Posthoc comparisons using the Tukey's HSD test between pairs of disciplines at specific institutions were conducted. Results indicated that at institution A, biology had significantly stronger norms than chemistry, geology and math, while physics had significantly stronger norms than chemistry, geology and math. At Institution B, biology had significantly stronger norms than geology and math, while physics had significantly stronger norms than biology, chemistry, geology and math. These results indicate that a substantial portion of the variability in perceived norms for interactive teaching originates in the biology and physics departments at Institutions A and B.

Disciplinary and institutional variation: interview results

The interview data also provides insights into disciplinary and institutional variation on perceived norms for interactive teaching. For example, nine physics faculty reported content-related norms that were linked to discipline-wide consensus on the "canon" of the field that undergraduates should know about the foundations of physics. In relation to interactive teaching, some physics faculty reported the existence of factions within their departments where some faculty had strong expectations regarding teaching that were tied to pedagogical reform initiatives, particularly at Institution B. At this institution, a prominent group of faculty had advocated for interactive teaching methods for several years. One respondent observed that these norms for interactive teaching were informal, with enforcement of the norms constituting "soft pressure." She stated that if she did not

use interactive teaching techniques she could envision being approached in this manner: "The conversation would probably start with, 'So I heard you weren't using demonstrations. That's odd. You know I'm a huge believer in those- why?' and then it would go on from there and I would assume they would try and convince me to use demos I think." However, the presence and activities of these education-minded groups of faculty also attracted a certain amount of resistance and even acrimony, as some respondents reported that advocates were overly dogmatic in their approach.

For math faculty, nine perceived norms for interactive teaching, and 15 reported the presence of content-related norms. In regards to teaching-related norms, two respondents stated that their colleagues would be surprised (and disappointed) if they did not extensively work through problems with their students. In addition, one of the unique characteristics of math faculty in the study was that several were teaching courses that had multiple sections and thus had a fixed curriculum where several classes shared a syllabus, textbooks, lecture notes, and assessments, thereby imposing a structured set of expectations on the instructors teaching the same course. While physics and math faculty often referred to their disciplines when discussing norms, this was less frequent in interviews with those in biology, chemistry, and geology.

Exploring the relationship between perceived norms and teaching: survey data

To explore the relationship between norms and teaching, one-way ANOVA and/or ANCOVA tests were performed depending on whether norm groups covaried with discipline type or institution. Statistically significant effects were identified for two teaching practices: real-time polling $F(2,410) = 5.335$, $p < .01$ (.005), and whole-class discussion $F(2,404) = 5.61$, $p < .01$ (.004). Posthoc comparisons using the Fishers LSD test between different norm strength groups were conducted. Results indicated that both strong and weak norm groups were significantly more likely to use real-time polling techniques than groups with no perceived norms for interactive teaching, and that strong norm groups were significantly more likely to use whole class discussions than groups with weak or no norms.

Exploring the relationship between perceived norms and teaching: interview data

The three causal networks reported here illuminate ways that norms may influence different aspects of teaching practice. Given the relatively small number of respondents who provided information about the causal networks, these analyses should be carefully interpreted as the accounts of a sub-sample of faculty within the institutions and disciplinary groups represented in this study.

Causal network 1: course syllabi impose time constraints that lead to lecturing and no questions posed to students

While the data do not provide direct evidence pertaining to the relationship among norms, syllabi, and classroom instruction, research on distributed cognition and organizational behavior indicates that intentionally designed objects or other tools (e.g., course syllabi, instructional technology, etc.) shape what behaviors are possible and desirable within a given environment (Halverson 2003; Simon 1991). In the case of course textbooks and syllabi, the data suggest that in some cases these tools provide a high degree of structure

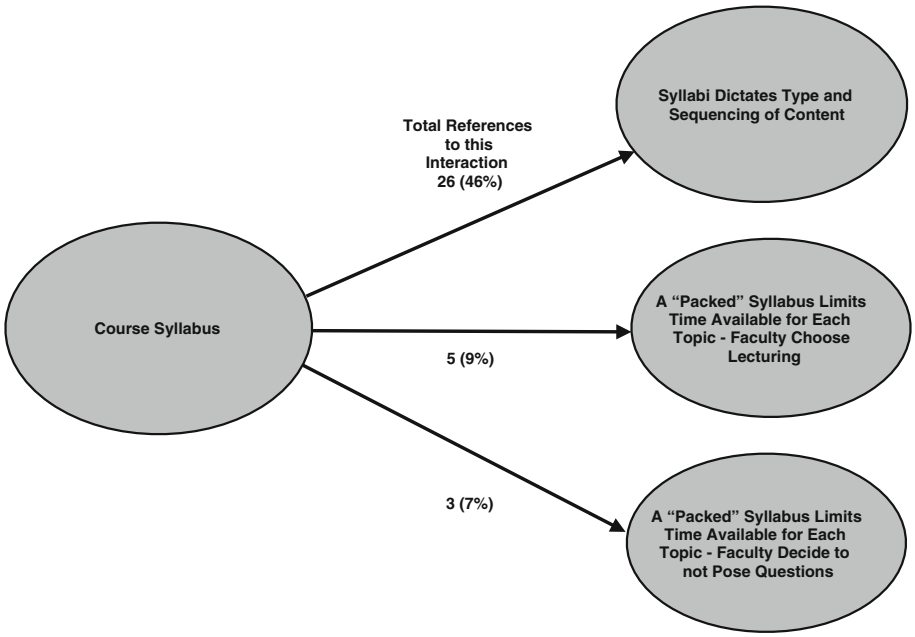

Fig. 1 Causal network for the instantiated norm of course syllabi

that exerts considerable influence on how they teach in the classroom (see Fig. 1). For example, one respondent observed that "There is a built-in level expectation about class activities, and we actually have a textbook containing just an activities manual," which is then strictly followed when teaching the course. Overall, 26 faculty reported that the syllabus exerts some influence on their teaching by dictating the type and sequencing of content in their courses. In addition, five faculty reported that the course syllabi influenced their teaching by determining the sequencing of material and the amount of time allotted for particular topics. Importantly, the sheer amount of content included in the syllabi required four of these faculty to cover a large number of topics in a relatively brief amount of time, which led to the regular use of lecturing as faculty perceived this pedagogical method to be the most efficient use of class time. In addition, three of the faculty reporting that the syllabus imposed substantial time constraints reported that posing questions to students in class was untenable given the amount of time required to engage in question-and-answer exchanges with students.

Causal network 2: dynamics influencing the use of interactive teaching methods

One of the core problems facing pedagogical reform is to identify the factors that lead faculty to adopt interactive teaching methods. This causal network focuses on the relationship among norms related to interactive teaching and the instructional decision-making processes of faculty (see Fig. 2). While 22 respondents reported that they regularly attempt to use interactive techniques to engage students in the classroom such as clickers, small group work, or problem-based learning, only three of them cited norms within their departments as exerting a strong influence on this decision. Interestingly, these instructors traced the origins of these norms to specific individuals active in pedagogical reform

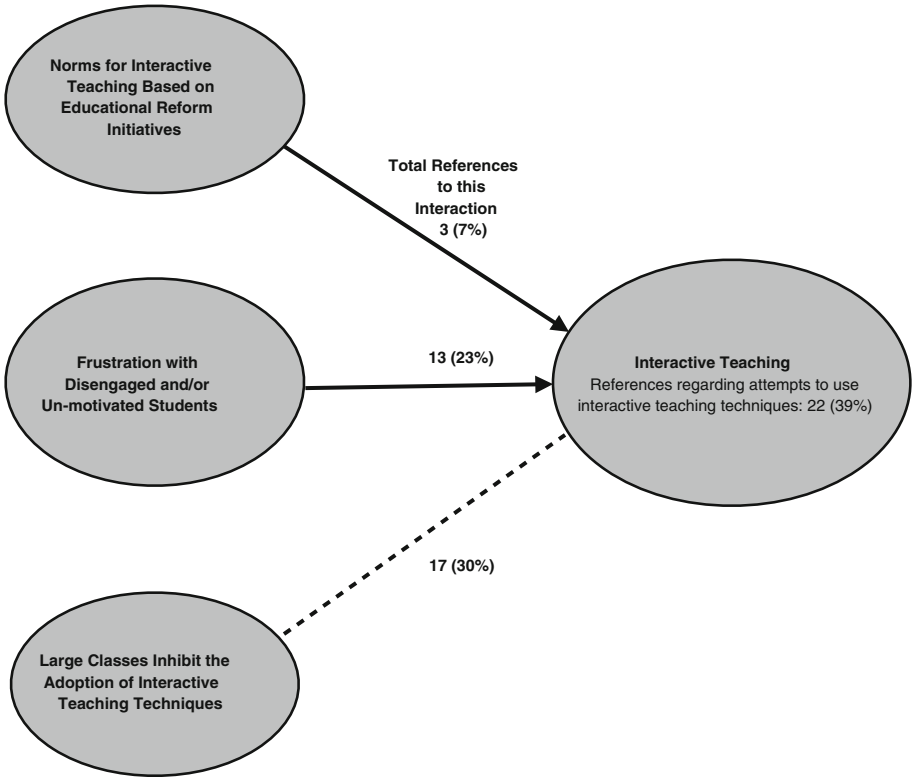

Fig. 2 Causal network for dynamics influencing the use of interactive teaching methods

initiatives within their institutions. Other factors appear to play a stronger role than norms in shaping faculty adoption of interactive methods in the classroom. For example, 13 faculty reported that they sought out more interactive modes of instruction based on their frustration with students who exhibited little interest or motivation in their courses. Conversely, structural factors such as large class sizes (e.g., over 100 students) were cited by 17 faculty as reasons why they did not use interactive teaching methods. While it is not possible to rule out the role of norms in both personal motivation or structural features of organizations, these data suggest that perceived norms are but one of many factors that influence an instructor's decision to adopt interactive teaching methods.

Causal network 3: students act as the primary mechanism for detecting norm violations

One of the ways that perceived norms can influence behavior is that the perception that someone could be sanctioned for violating the dominant norms in a group could result in conformity to that norm (Sripada and Stich 2007). In the case of teaching in academic settings, few mechanisms exist that would alert group members to the violation of teaching-related norms. As one respondent noted "This is my fifth semester teaching and no one has ever come in, observe me or evaluated me, so I have no feedback as to whether the department likes me or doesn't like what I'm doing." Thus, while 18 respondents noted

that classroom observations by their colleagues could theoretically act as a mechanism to detect poor teaching, these observations are done irregularly. As such, the primary mechanism by which an individual's teaching is assessed is through student end-of-semester evaluations (37). In cases where the evaluations are relatively poor, a faculty member may be instructed to attend professional development workshops or to at least consider working on their teaching. Another formal mechanism for detecting poor teaching is through complaints to department chairpersons (5). For example, one faculty member discussed having adopted a technique using extensive group work rather than lecturing in a large chemistry course. He said, "In the first 2 weeks … the department received 20 complaints that I was doing something irresponsible here in this class because I wasn't lecturing." Finally, students may provide informal feedback to faculty regarding how well they like or dislike their teaching through conversations before or after class, during office hours, or in hallway conversations (8). In this way, violations of student expectations for what constitutes quality teaching are the primary way that administrators and faculty have of gauging the efficacy of instruction within a given department (Fig. 3).

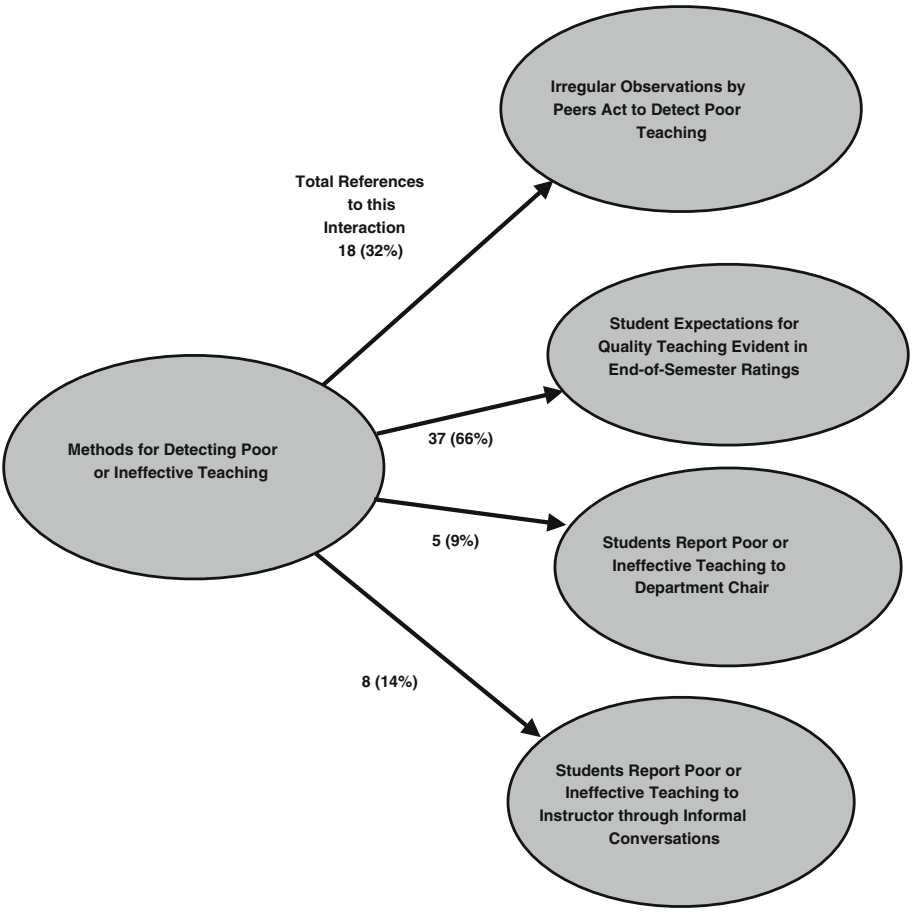

Fig. 3 Students act as the primary mechanism for detecting norm violations

Discussion

One of the major findings of this study is that different types of norms operate within the socio-cultural milieus of IHEs—not just faculty descriptions of dominant expectations of peer groups as elicited through survey or questionnaire techniques, which is the dominant approach in the field (e.g., Braxton et al. 1996). Such an approach necessarily results in accounts that obscure other types of norms that appear to be present and active in academic settings (i.e., perceived norms, tacit norms, and instantiated norms) while also assuming a "linearity" between culture and teaching that may be over-simplifying phenomena that are actually far more complex and nuanced (Umbach 2007, p. 280). The findings reported in this paper extend and enhance research on norms in IHEs by revealing the multiplicity of norms regarding instructional practice, variation along institutional and disciplinary lines, and the complexity of decision-making processes.

In particular, while the results indicate weak perceived norms for interactive teaching, with 30 of 56 respondents reporting that no norms existed and a mean score from the survey of 2.49 (which indicated that no norms at all were evident in the sample), it would be a mistake to conclude from these findings that faculty perceived no norms for teaching at all, as evidenced by the widespread presence of tacit and instantiated norms. The "taken for granted" or tacit nature of norms is a common feature of many conceptions of culture, as much cultural knowledge is so deeply embedded within group and personal experience that it is no longer viewed as remarkable (e.g., Geertz 1973; Strauss and Quinn 1998). In academia, it is not unsurprising to find that one of these tacit norms centers on the notion of faculty autonomy, and the results reported in this paper suggest that it operates as a type of "anti-norm" norm regarding classroom behavior.

An additional consideration regarding the discovery of a tacitly held norm of instructional autonomy is methodological. Since these norms are by definition tacit and not easily available to conscious deliberation, instruments such as surveys or interviews may be less than effective in eliciting them. One promising avenue for the empirical analysis of tacit norms is through the use of priming techniques that have been used in social psychology research (e.g., Bargh and Williams 2006). This is particularly important given limitations with eliciting norms via self-report techniques such as surveys and interviews, as norms may be so tacit as to be unavailable or "invisible" to individuals. Consequently, future research exploring norms in IHEs would benefit from drawing on methodologies such as experiments or in-depth ethnographic analyses of particular populations to examine the tacit nature of normative expectations.

Another key finding centers on the fact that faculty operate at the intersection of three distinct socio-cultural fields of activity: the institution, the discipline, and the department (Austin 1994). Data reported in this paper indicate the importance of norms at the departmental level (e.g., physics and biology departments at Institutions A and B), such that aggregating data to higher units such as Colleges or entire IHEs would mask this important variability. Further, in focusing on norms at such macro-level units reinforces the discredited notion of culture as a consensus-based phenomenon whereby all group members exhibit similar beliefs, values, and practices, whereas an alternative view is that culture is best viewed as being generated in smaller groups where localized meanings are constructed and reproduced (Martin 2002). Indeed, some even suggest that departments are not appropriate units of analyses given the many sub-cultures that exist within them, and that smaller "working groups" comprised of faculty who regularly interact on specific tasks should be the focus of cultural analysis (Knight and Trowler 2000).

Finally, the causal network analyses indicate that the relationship between norms of all types and instructional behavior entails a complex chain of factors, and that no one-to-one relationship exists between a norm, whether perceived, tacit, or instantiated, and teaching practices. Instead, the relationship appears to be distal—and more affected by instantiated norms such as course syllabi and tacit norms such as autonomy, instead of through directly perceived normative expectations. It should also be noted that this approach—using interview data to construct causal networks—is but a preliminary step in empirical analyses of instructional decision-making. This approach does not address the specific cognitive mechanisms that inform decision-making such as dual processing or decision heuristics (Gigerenzer and Goldstein 1996), but instead provides the broad outlines of decision premises that may be used in academic organizations (Simon 1991).

Conclusion: policy implications for pedagogical reform in math and science

In their study on norms for undergraduate teaching reform, Braxton et al. (1996) found that no norms existed regarding teaching improvement. That is, faculty could ignore professional development, not read educational literature in their disciplines, and otherwise fail to continually improve their teaching practices with no punitive measures or displeasure expressed by their colleagues. Braxton et al. theorized that given this situation, educators and advocates of pedagogical reform faced an uphill battle because "normative support for a given initiative, or lack thereof, significantly affects its likelihood of being successfully implemented" (1996, p. 620). This view suggests that policymakers direct attention and resources to fostering strong normative systems for interactive teaching, whose function would be to ensure that faculty comply with the expectations of their peers.

The evidence presented in this paper provides two insights on these matters. First, normative systems for interactive teaching are comprised of multiple indicators and phenomena, such that attempts to create strong norms would necessitate targeting a variety of focal points as opposed to a single one (e.g., group beliefs). Thus, no single policy intervention or leverage point is likely to be a panacea for the challenges facing pedagogical reform. Second, instead of assuming that group-level expectations directly determine behavior, a more complex and nuanced process mediates the relationship between norms and behavior. Furthermore, researchers are increasingly recognizing that instead of striving to change or alter factors whose manipulation will alter behavior unilaterally, policymakers should instead aim to align their interventions with the multi-faceted social realities of faculty members as they experience them in their local settings (e.g., Henderson and Dancy 2008). This recommendation is grounded in the belief that "educational development programs are social products and themselves instantiate teaching and learning regimes which may be more, or less, compatible with those that participants bring to them from other contexts" (Trowler and Cooper 2002, p. 236). That is, pedagogical reform initiatives embody particular ways of thinking about teaching, learning, and faculty work that may or may not align with those of faculty in local institutional settings.

Towards this end, we agree with the Braxton et al. suggestion that (1996, p. 621) "individual colleges and universities may be best served if they understand the normative structure among their own faculty." One approach to providing information about cultural features of an organization is to conduct a cultural audit that elicits information about a wide variety of cultural forms such as artifacts, symbols, recurrent practices, and tacit beliefs—to name but a few of the phenomena often included in an audit's framework (e.g., Whitt 1993). An exercise of this nature could reveal both cultural elements that should be

built upon (e.g., best practices in TA training) as well as negative influences on pedagogical improvement (e.g., pockets of faculty who actively disparage undergraduate instruction). As a result, while we strongly disagree with the notion that culture is something that can be managed or altered, particularly by upper-level administrators or policymakers, it is possible that change agents can nudge their institutions and/or departments towards adopting new practices and ways of thinking. Indeed, some theorists suggest that cultural evolution often unfolds in this manner, where resonance between pre-existing norms and those of a newly introduced set of practices or beliefs lead to new cultural forms (Kroeber 1944; Herskovits 1964). In this way, both "positive" and "negative" normative expectations active within a group may provide a foundation upon which to build and develop new norms and practices that more actively support the principles of the learning sciences.

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